

Assessing income inequality with tax data - Switzerland from 1917 to 2010

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Abstract

There is empirical evidence that economic inequality increased in the majority of western countries over the last decades (OECD 2011, Gornick and Jäntti 2013). In Switzerland, however, the development is unclear, as there is evidence for trends in both directions. Part of the inconclusive picture is due to different methodological approaches. In this paper we discuss the role of tax-data concerning the assessment of inequality in income. The focus of the discussion lays herein to show the benefits and shortcomings of tax data compared to current "state of the art" measurement concepts of economic inequality. We present common and new strategies to handle tax data specific methodological difficulties and compare results out of aggregated federal tax statistics to results from the Household Budget Survey (HBS). We find theoretical inconsistencies in both tax and survey data which both result in an underestimation of inequality. Following the results from tax-data Switzerland experienced in slight rise in inequality in recent years, similar to other western countries due to a polarization of the income distribution.

I. INTRODUCTION

Economic resources can be seen as central indicator for life chances in general and a multitude of outcomes like physical and mental health, life expectancy and crime in particular (Wilkinson and Pickett, 2009). While the study of social inequality can be considered as one of the core subjects of sociology in more recent years the concern about the widening gap was addressed by global leaders (World Economic Forum, 2013) and scholars alike. Empirical evidence acknowledge the supposed trend that economic inequality increased in the majority of western countries over the last decades (OECD 2008, OECD 2011, Gornick and Jäntti 2013, Salverda et al. 2014). Although the rise was not uniform, a common pattern seems to be identifiable, which can be referred to as the "hollowing of the the middle class" (Alderson and Doran, 2013). Households are moving

towards the top and the bottom of the distribution relative to the past, which is especially problematic as the middle class can be seen as the core of western democracies or as it is stated by Stiglitz (2012, 117): "our democracy is being put at peril."

Given the importance of the subject a constant reflection about reliability of empirical data seems appropriate. Atkinson (2013) observes advances in technology and methodology which improves the core sources of inequality research, the household surveys. On the other hand the labor intensive and expensive surveys around the world are subject to budget cuts and the instrument itself faces problems in form of low response rates, which affects the assessment of inequality undisputedly. These concerns have led to the search of alternative data sources, which can supplement the established survey data studies.

Already Kuznets (1955) used tax data to examine the relationship between economic growth and personal distribution of income. Then it took several decades until Piketty (2001, 2003), Piketty and Saez (2003) made the use of tax data fashionable again. Following his approach studies on several countries were conducted (Atkinson and Piketty, 2007, 2010). Today, all existing top income tax statistics based time series are collected and accessible through the world top incomes database (Alvaredo et al., 2014).

As we focus our paper on the case of Switzerland, it is important to embed our work in the context of given publications concerning inequality in income. What is known about Switzerland so far? Looking for official data, three main sources has to be mentioned, which can be considered as de facto official data sources: EU-SILC, HBS and LIS-data. Figure 1 shows the results stemming from this three sources while looking at Gini of equivalised disposable income. Up to the day, EU-SILC or Statistics on Income and Living Conditions is the main source used for policy monitoring at EU-level. The main focus of EU-SILC is to collect data on a common “framework” to ensure comparability among EU-countries and countries living around or within the EU. As a Non-EU member Switzerland implemented the instrument not from the beginning (2004) but as from 2007. Therefore this times-series doesn’t cover time points before 2007. As graph XY shows, following the results from SILC income inequality decreased from 2007 to 2013.¹ The second important source concerning the distribution of income is the Household Budget Survey (HBS). The

main focus of this survey lays in providing detailed data on household budgets. This allows researcher to look at different income concepts like income before and after public transfers. Since 2000 the survey has been conducted on a continuous basis, which allows to look at a consistent time series from 2000 to 2011. As it can be seen from figure 1 the trend is rather stable.² Both time-series (SILC and HBS) cover a relatively short time period. A longer period is covered in the LIS-Data-set (1982-2004). Data-provider for the LIS Data is the Swiss Federal Statistical Office too. In contrast to the aforementioned surveys the LIS-data is harmonized out of three surveys: Swiss Income and Wealth Survey (1982), Swiss Poverty Survey (1992) and the Income and Consumption survey (2000, 2002, 2004). All in all the LIS dataset contains the longest time series on inequality for Switzerland. Analyzing this data Gornick and Jäntti (2013) found for Switzerland a quite substantially decreases in income inequality, contradictory to the development in most other western countries. This result is supported by Grabka and Kuhn (2012) analyzing the Swiss Household Panel (2000-2009).³

¹Data shown in the graph was downloaded from the Eurostat Metadata-portal http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/ilc_esms.htm last accessed 21.Mai 2014.

²figures shown in the graph were calculated out of the original datasets, which were kindly provided by Swiss Federal Statistical Office.

³A further official database for income distribution is the OECD-Database. It includes measures from Income and Consumption survey as well. Additional data for 2008 is available from EU-Survey of Income and Living Conditions (EU-SILC). But this change in survey is considered as a strict break. Comparison before and since 2008 is not recommended (OECD 2012:315). For the sake of completeness the database constructed by Deininger and Squire (1996) and the World Income Inequality Database (WIID) have to be mentioned. Both datasets do not contain figures for recent years for Switzerland. A further important database on inequality is the GINI database which has been derived from the GINI Country Reports (Nolan et al., 2014). But this dataset doesn’t cover Switzerland.

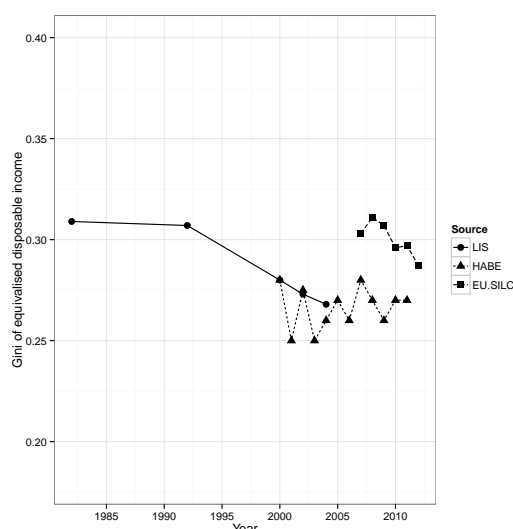


Figure 1: Trends in income inequality

Whereas the aforementioned publications focused on disposable household income from survey data, the revival of tax-data-inequality studies lead to fruitful insights for Switzerland as well. Dell et al. (2007) used tax data from the Federal Tax Administration to assess the concentration of the highest incomes and wealth (top-shares) over time. In contrast to most other examined countries, Switzerland did not experience a reduction in income and wealth concentration from the pre-First World War period to the decades following the second World War (up to 1996). Using the same approach Foellmi and Martínez (2013) expand the Dell et al. time series to 2008 finding that the share of top income has risen, the top 0.01% share even doubled in the last observed 20 years. A result which opposes the outcome of official data published by the Swiss Federal Statistical Office.⁴

Divergence can be explained with several factors. First of all, different data sources were used. The official data providers trust on survey data, whereas the later mentioned publica-

tions use tax data. It is assumed that the coverage of top incomes is better in tax data than it is in survey data (non-respondent bias), which is a crucial issue concerning inequality. On the other hand the focus on top income neglects other changes in the distribution of income as it is not possible to see, whether newer concerns like the “hollowing of the middle class” occurred in Switzerland or not, which leads to the second point. Different measure of inequality hampers the comparability. Third, different income concepts and different units of analysis were used. As it is shown by Modetta and Müller (2012) the income distribution is strongly affected by governmental redistribution, reducing inequality substantially. With the focus on tax data the change in institutional settings is not covered. Also neglected is the household structure, whereas it is unclear how inequality is affected whether one looks at household income or at income of tax units. It can be assumed, that inequality corresponding to different concepts react differently on demographic change (change in household structure).

Up to the day, Switzerland can be situated according to the actual level of income inequality in western societies as there is a huge effort to collect data which can be harmonized to comparable measures (see Luxembourg income study, EU-SILC). However, it is unclear how the bias through non-response affects the overall measure of inequality. For the US Atkinson et al. (2009) estimate that CPS survey data fail to capture about half of the overall increase in inequality measured by the Gini coefficient, a result confirmed by Alvaredo (2011). Likewise a long and consistent time-series allowing to identify and explore development patterns on every point of the distribution (not only the top-shares) is missing. Building on recent developments in the field of inequality research, we assess the suitability of the publicly accessible tax data to report inequality and its changes

⁴There are other studies on Switzerland covering different periods but not the recent years. Flückiger et al. (2002) and also Jeitziner and Peters (2007, 2009) report constant inequality from 1960-1996 respectively from 1995 to 2003. Covering a similar time period Bauer and T. (1994) and Bolzani and Naga (2001) found decreasing inequality. On the other hand Buchmann and Sacchi (1995) and Ernst et al. (2000) found an increase in the 1980s.

over time. First of all this includes a discussion of the accessible measures in context of a reflection about the state of the art conceptualization of economic resources as an indicator for economic well-being (see section II. *Data and measurement concepts*). Second, we examine the role of methodological decisions along with an in-depth distributional analysis (see sections III. *Methods* and IV. *Results*). Against the background of all methodological issues we discuss the long-term inequality development in Switzerland – as well as more recent periods in detail – using all relevant data.

II. DATA AND MEASUREMENT CONCEPTS

Studies on inequality have to address several thorny challenges. It starts with answering three crucial questions: First of all one has to define, which concepts should to be looked at. This refers to answering the question about inequality of what. Secondly one has to be clear about the unit of analysis. This refers to answering the question about inequality among whom. Thirdly, one has to choose an appropriate measure of inequality. All these questions are ideally answered considering theory and a given research question. Often it has to be answered in context of a given dataset. Therefore we start this section with a description of the FTA-Tax Data. Based on a review on the literature about the measurement concepts in an ideal world, we discuss the advantages and shortcomings of tax data compared to other data sources - namely survey data.

I. Tax statistics in Switzerland

Our data comes from the Swiss Federal Tax Administration (FTA). Federal taxes are collected and documented by the FTA since 1915. Being called a war-tax in the beginning, the

federal tax was renamed to crisis levy in 1934, defense-tax in 1939 and is finally known as direct federal tax since 1983. The time frame we were able to collect ranges from 1945 to 2010 including 44 tax periods for cantons and Switzerland.⁵ While the FTA provides data in electronic form since 1973 we collected earlier data by scanning hard copies. Data is available for Switzerland plus all cantons and basically covers every tax unit (individual or household) in Switzerland liable to pay federal taxes. This exempts all tax units with taxable income below a certain threshold (e.g. CHF 16.900 for singles in 2010). Furthermore the FTA differentiates between two groups of tax units, so called normal cases and special cases. A normal case is a tax unit residing in a swiss canton without foreign source income and being liable to taxation all year long. All other tax units and very few that are taxed based on the style of living because they don't work (Pauschalbesteuerte) are special cases.

Data is provided by the FTA in an aggregate form for privacy reasons, i.e. they are classified into numerous income brackets. While we don't know individual incomes we still have sufficient information (number of tax units per income bracket plus sum of incomes within each bracket) to calculate percentiles, Gini coefficients and other desired measures. However, equivalization (weighting income by household members) is not possible from these aggregate data. In any parts of the article where we point to equivalized income, the data stem from ready-made calculations (percentiles, Gini coefficients) provided by the FTA⁶. Their measures are calculated from the same source (FTA data) but used the number of children and marriage status as an approximation of household size to calculate inequality measures that are pseudo equivalized.

⁵Between 1993 and 2003 there is no exact data available for aggregate Switzerland (but for individual cantons) because of a system change from taxation assessed in arrears (Praenumerando-System) to taxation assessed on current year income (Postnumerando-System) which was implemented by cantons in different years.

⁶These calculations were done on commission of the FTA within the SNF project Sinergia Nr. 130648 "The Swiss Confederation: A Natural Laboratory for Research on Fiscal and Political Decentralization" by Raphael Parchet and Stefanie Brilon in coordination with Prof. Dr. Marius Brühlhart.

The FTA provides two income measures: taxable income and net income. Net income here is an administrative term and means taxable income plus social deductions (children and supported persons) but not including other deductions like donations or health-care costs. Both measures are designed for taxation purposes which might limit the suitability to measure inequality as we will discuss later.

II. Standards for measuring economic resources and inequality

Concepts on measuring economic resources

Most studies on inequality focus on income inequality solely. However, recent activities emphasize the need of a broader conceptualization. A recent publication from the OECD (2013) condense these ideas into the ICW framework (income, consumption and wealth), which is meant to be an internationally agreed framework on micro-level statistics.⁷ According to the framework it is best to look at income, consumption and wealth as three separate but interrelated dimensions of people's economic well-being. To gain policy relevant insight, it is recommended to look at the distribution of all three distributions simultaneously. Some households with low income, for example, may report adequate levels of consumption expenditure or wealth holdings, or vice-versa. But it is also stated (OECD, 2013, 18): "[...] integrated analysis at the household level has significant data requirements that go beyond the measurement efforts currently undertaken in most countries."⁸

This last statement holds for Switzerland too, although the HBS study is strongly influenced by the recommendations of the Canberra group handbook (United Nations, 2011), which concepts are part of the ICW framework. Albeit the awareness of an assessment of income, consumption and wealth simultaneously is rising, we focus our analysis on income, which is undoubtedly a crucial indicator of economic well-being. It should be noted, that the Federal Tax Administration (FTA) publishes statistics on income and wealth but it is not possible to analyze the joint distribution on the individual or household level. Also measures of consumption are largely missing in tax data, albeit deductions can in some sense be understood as mandatory consumptions.

Defining income

The assessment of income inequality is influenced by the definition of the income itself. Market income or disposable income for example differ by substantial meaning and by the expected degree of inequality. Therefore the awareness of the analyzed concept is crucial. Terminology can slightly differ, while common concepts can be identified (for detailed discussion see: OECD (2013, 44), United Nations (2011, 24)). Figure 2 shows a stylized framework, which includes a distinction of common income sources⁹ and shows the central steps of redistribution, which eventually lead to disposable income: the income measure, which finally shapes the possibility to consume. Within this framework common other income definitions are situated.

⁷Harmonization with other international standards was an important objective that guided the work of the expert group in developing the ICW Framework presented in this publication. Considered main standards were the System of National Accounts (SNA, 2008), the Canberra Group Handbook on Household Income Statistics (United Nations, 2011), the final report of the 17th International Conference of Labour Statisticians (International Labour Organisation (ILO), 2004) and the UNECE/CES recommendations for the 2010 Censuses of Population and Housing (UNECE and EUROSTAT, 2006)

⁸The Luxembourg Wealth Study Database is currently facing this shortcomings by collecting and providing a database following this broader concept of economic well-being. <http://www.lisdatacenter.org/our-data/lws-database/>

⁹Income from production of household services for own consumption is excluded because this income is hard to measure and not covered in the FTA tax data

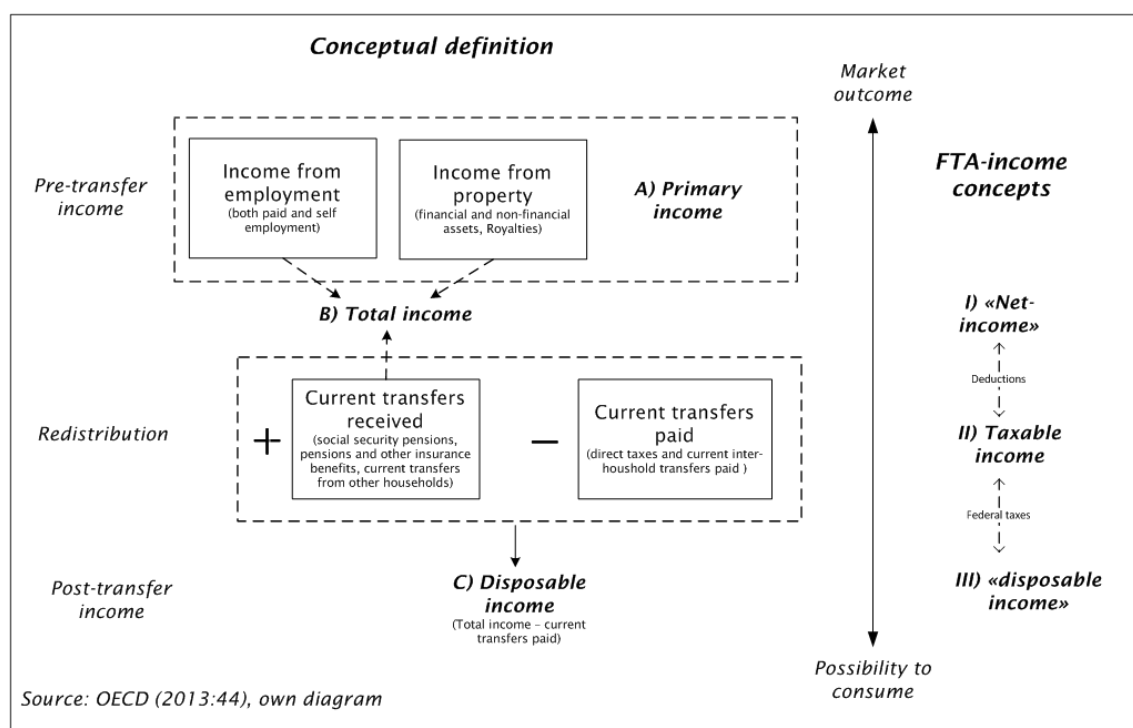


Figure 2: Income definitions

The central income reported through tax statistics is the taxable income. It includes all reported incomes (income from employment, income from property and received transfers¹⁰) minus several deductions. It is therefore neither a pre-transfer income nor a post-transfer income measure. It's rather something in between. As the FTA tax statistics include some but not all deductions¹¹ it is possible to calculate a sort of total income, which is called "net income" (Reineinkommen). As some deductions can be interpreted as compulsory expenses similar to taxes the step towards total income is a step away from the income, which can be used for consumption. Similar when calculating the disposable income out of the taxable income through accounting the reported federal taxes, this is a step towards

the income, which is left in the basket for consumption (disposable income). Again it is not a "pure" disposable income, because cantonal, municipal taxes and taxes from churches, which represent the bulk of taxes in Switzerland, are missing.

Statistical units

The agreed standard on the statistical units, which should be the base of inequality analysis, are households not individuals (OECD, 2013, 60). Indeed it are individuals, who receive income, own assets and experience economic well-being, but their possibility to do so, is strongly tied to the concept of household. A household comprises all persons under the same housing arrangement. The basic underlying assumption for collecting data on house-

¹⁰Means-tested benefits are not taxed and therefore not included in tax data. Income for low income groups are therefore underestimated. However, (Piketty, 2003) note that non-taxable social security benefits grew as a share of personal income in the US but find that these changes had only a trivial impact on top income shares.

¹¹The difference between the real total income and the taxable income are deductions. These include: professional expenses, travel expenses, interest on debt, alimonies, training costs, two-earner deduction, party contributions, private pension provision "Säule 3a", buying into the pension plan and sideline deductions

hold level instead of individual level is, that people in the same household share resources and therefore pool their incomes (when two or more earners live together) and/or use the household income to provide the essentials of living for every household member (also non-earning members, like children). Additionally, there are economies of scale when people share living space and commodities and they therefore benefit from the sharing. To compare the individual economic well-being among individuals living in different households usually equivalence scales are used (see OECD 2013, 173, Buhmann et al. 1988).

In tax data, however, the units are represented according to administrative rules. Tax units therefore neither represent individuals in every case nor true households. Tax units rather represent individuals and couples, but couples, who are married or officially registered. This doesn't imply, that those couples live together, as it is needed to satisfy the definition of a household. On the other hand, it is quite likely that more than one tax unit lives in the same household (unmarried/unregistered couples, see Müller and Schoch (2014, 99)). It is therefore not directly possible to elicit households and household income from tax data. This might influence the assessment of inequality development, taking into account the change from traditional household and family structures over the last century.

Measuring inequality or concentration

To be able to make qualifying statements about a distribution or to compare different distributions, the concept of inequality turned out to be the most appropriate and thus the most commonly used dimension. The Gini coefficient is the most known measure and mainly used for international comparison. As it is derived from the Lorenz-curve, the quantified amount of inequality can unpretentiously be described in a formal and visual way. Therefore the Gini coefficient is easily interpretable. Furthermore it has several desired statistical properties Engelhardt (2000). (1) "**principle of population**":

the assessment of inequality is independent of the population size (2) "**Requirement of Bresciani-Turroni**": the measure is sensitive for changes of income shares, but not for absolute changes (e.g. doubling of all income) (3) "*weak principle of transfers*" or "*requirement of Pigou-Dalton*": transfers from richer households lead to a reduction of inequality. However, several drawbacks are reported in the literature. The most important point is, that the underlying distributional form of the measured inequality is unknown and it is therefore not possible to see if the measure is driven by a few rich or many poor individuals. This can also be problematic for comparison between countries or over time. In extreme cases two totally different distributions share the same Gini-coefficient.

The recent wave of tax-data studies do not report Gini-coefficients. Rather top income shares are informed on, which are calculated not only with tax data, but corrected using marginal distributions of income and population using external sources (census data and national accounts). This procedure ensures, that the inequality measure is not biased because of non-fillers, who do not appear in tax statistics. Leigh (2007) compares top income shares with other inequality measures and asks, whether they are a useful measure of inequality in a society. He tries to answer this question empirically by comparing measures of inequality based on top income shares with measures of household or family inequality. He finds a strong positive relationship, but concludes (P.600): "top income shares are far from perfect as a measure of distribution of income across society." Top income shares hence inform not completely on how inequality evolves elsewhere in the distribution. Furthermore, top income shares only weakly satisfy the Pigou-Dalton transfer principle (in contrast to the Gini-Coefficient as mentioned above). A transfer from rich to poor will indeed never increase the top income shares, but if the transfer is between individuals, who are either both within the top group or both outside the top group,

then the share measure will remain unchanged.

Newer branches of inequality studies emphasize the need for broader measures of inequality, which allow more detailed analyses about the change of inequality and namely statements about the area of change (downgrading/upgrading). The polarization index developed by (Handcock and Morris, 1999) is capable of doing this. Recently this index was applied in the work of (Alderson et al., 2005) and (Alderson and Doran, 2013). This approach is rooted in relative distribution methods. It includes a precise comparison of the shape of two distributions (groups, over time). As the main advantage this approach allows to characterize the change in detail. It is possible to see which parts of the distribution changed, e.g. whether a polarization occurred (reduction of middle class) – which equals an increase of inequality – or this change is driven by either a change in the upper or lower part of the distribution.

The literature mentions several other metrics with desired properties we will not discuss here (see for example Cowell (2000) and Hao and Naiman (2010)).

Population Coverage

Often inequality is assessed on national level, which implies, that studies try to cover the whole population of the country of interest. This is a special thorny task for surveys working with samples, because nonresponse is a major source of bias (Bethlehem et al., 2011). (Korinek et al., 2006) show, that the position in the income distribution influence the probability to participate in a survey. Low income and high income households are more likely to refuse survey response, which leads to an overrepresentation of middle income households. This process can be referred to as the "middle-class bias" (Diekmann, 2009). Missing data in household surveys is therefore not missing at random, which has an impact on the measures of inequality. The magnitude of this bias in Switzerland, however, is unknown. Strategies

to handle this kind of bias are discussed in the literature (Särndal et al., 2003), but require a register for every unit, that is proportional to income. Currently no such register exists for Switzerland Müller and Schoch (2014, 43). Currently used micro datasets, which are used for official publications concerning inequality in Switzerland (SILC and HABE) are furthermore confronted with a constructed coverage problem, because these surveys rely on the phone register, which excludes households not having a registered connection.

The issue of incomplete coverage is less dramatic with tax data. Essentially every permanent resident in Switzerland over 18 years of age (respectively 20 years of age prior to 1996) is taxed on a yearly base (or every two years before the change of the tax system). Basically this leads to a full representation of the adult population of Switzerland and a complete coverage of the income distribution. This includes a separation of normal cases, which embrace the majority of taxpayers, and the special cases, which cover (not only) foreign nationals living in Switzerland but with a yearly or any other temporary resident permit only. Most important this includes high net wealth individuals taxed according to their expenditures. Special attention has to be paid to tax units with none or very low incomes. Even though they have to hand in a tax return, their income does not show up in the statistics if their income after deductions falls below the threshold (e.g. CHF 16.900 for singles in 2010) and they are therefore not taxed with direct federal taxes. This is possible for normal and special cases alike. From 1995/1996 until 2010 the number of non-taxed units is reported, but not for the years before. Dell et al. (2007) try to estimate the fraction of non-taxed by comparing the reported numbers of tax units to census reports about the number of adult population. According to their estimations this fraction drops from 94% in 1993/1994 to 63% back in 1945/46.

Another critical issue with tax data is the problem of tax evasion, which definitely can

bias the assessment of inequality. Alvaredo and Saez (2009) for example regard estimates of Spanish top incomes prior to 1981 as unreliable due to widespread tax evasion. Evasion can occur, when individuals try not to fill tax returns or by misreporting of incomes. In Switzerland non-fillers show up in the tax-statistics either way, as long as they are registered. This person gets an imputed income based on an older tax return and information given by employers. Only non registered non-fillers are not in the records. Therefore non-fillers are a minor problem. Not negligible is the circumstance, that individuals misreport incomes. Feld and Frey (2006) examine the role of tax evasion in

Switzerland by calculating the difference of the national accounts measures of primary income and the income reported to the tax authorities. They can show, that the average level of income tax evasion from 1965 to 1995 varies between 13% and 35%. They suggest, that evasion is heavily driven by capital income tax evasion.

Comparison of tax data and other data sources - advantages and shortcomings

Based on this sections previous discussion table 1 summarizes important differences between tax and survey data related to analyses of income inequality.

Table 1: *Comparison of tax and survey data*

	Tax data	Survey data
Statistical unit	tax units (individuals/married couples)	households
Concepts of economic resources	data-driven	theory-driven
Population coverage	total population	sample
Top incomes covered	yes	no
Low incomes covered?	no	yes
Comparison over time possible	long	short
Cross country comparison possible?	limited	possible

To define a standard of measuring economic resources and related inequality we discussed different dimensions of demands the data needs to meet. To sum up, ideally we want to measure *disposable income* for *all swiss households* yearly for an extended period of time. Tax data has one weakness when it comes to the ideal income measure as we need to work with “taxable income” which is designed to serve taxation purposes. However, both concepts – what needs to be taxed and what can be spent – are related as both address a distinction between necessary and voluntary expenses. By subtracting federal taxes from taxable income we are getting closer to the theoretically ideal income measure of disposable income. However we can not subtract the more important cantonal

and communal taxes. The second most important drawback with tax data is that it does not adequately address households. There are few situations in which the tax unit equals the household, that is for individuals living alone, with married partner and/or deductible children and nobody else. This “classic” household setup however became less common in the last decades so we need to assume statements about household inequality based on taxed data became more and more biased. Finally however, another advantage of tax data (over survey data) is indeed the observation period. While the FTA data we use range back to 1945, the earliest period of survey data is 2000 (HBS data). The striking feature of the long FTA time series is its consistency. Both

¹²Limitations might however exist due to tax evasion and major changes in the tax system, e.g. 1945. Furthermore,

population coverage and income measures are rather consistent for the complete observation period¹². This can not be said for survey data as these are based on samples and therefore require an ideal sampling design or reweighting to be representative and comparable over time. We will see how well sampling and weighting is done in the results section.

III. METHODS

In the last section we described the advantages and drawback of tax-data discussing five aspects, which we regard as crucial concerning the assessment of inequality. To get a feeling of the importance of these aspects, we exploit the FTA-tax data as far as possible and perform several insightful calculations addressing four of the five mentioned aspects. No further investigation is possible regarding aspect (1) concepts on measuring economic resource. But for the other four thematic areas, we can provide deeper insight. In general our main strategy is to apply different possible concepts within one conceptional area (income, units, measurement, population coverage) while holding other conceptual differences constant. With this strategy we want to show, the sensitiveness the assessment of inequality is especially if one looks at time trends.

To fulfill the above described task, we use two techniques. To assess the development over time, we calculate in general Gini-coefficients for all possible time points, allowing us the make time trends visible and to compare the result out of the FTA-tax data to other publications. For selected periods we expand the analysis with relative distribution methods, which allows an in-depth analysis of distributional differences and therefore catches the shortcomings of Gini-coefficients.

To calculate Gini-coefficients we follow common definitions, like it is described for example in (Jann, 2005). Because the relative dis-

tribution methods are not that widely known, we provide a short introduction of the important concepts in this section. We additionally expand the method section with an extended analysis about the importance of non-taxed, because the issue of non-taxed is a especially thorny one.

I. Relative distribution (RD) framework

The RD-framework is based on the concept of a “relative distribution”, a transformation of the data from two distributions into a single distribution that contains all of the information necessary for scale-invariant comparison. This allows to make distribution differences “visual” in an elegant way and it is also a base for summary statistics, which are more sensitive to detailed theoretical hypotheses in contrast to other measures like the Gini-coefficient or top income-shares, which inform either about the whole population or only about the top part of the distribution.

The goal of RD is to study the differences between two distributions. A common example could be the income distribution for man and women. Subject of the comparison can also be two distributions describing the same population, but stemming from two different data sources like survey or tax data or even comparison of the same source/population but for different time points, like the income distribution out of tax data for Switzerland today compared to an earlier time point. To describe how the two distributions are gone be transformed into a relative distribution, we start with defining the two distributions. One represents the reference population Y_0 and the other the comparison population Y . x represents our measure of interest (income). A first visual approach is to compare the two probability density functions (PDF). The PDF is a function $f(x)$ which describes the distribution of probability over the outcome set and

tax units with incomes too small to qualify for federal taxation are not documented before 1995 and treated as zeros afterwards making it difficult to track income development in the lower percentiles.

is defined for all possible values of x . This function integrates to 1, which means that the sum of all probabilities over all possible values is 100%. Out of the comparison of the PDF, it is possible to see, which values of x are more and less probable. This already allows to spot distributional differences over the whole scale of x visually.

The PDF can be characterized by its cumulative distribution function (CDF). The CDF can be formulated as $F(x)$, which represents the probability that a randomly chosen value is less than or equal to x . The relative distribution of Y to Y_0 is then defined as

$$R = F_0(Y) \quad (1)$$

R is obtained from Y by transforming it by the CDF for Y_0 , F_0 . R therefore measures the relative rank of Y compared to Y_0 .

$$g(r) = \frac{f(F_0^{-1}(r))}{f_0(F_0^{-1}(r))} \quad (2)$$

We can calculate the Probability Density Function $g(r)$ of R , where r represents the proportion of values and $F_0^{-1}(r)$ is the inverse cumulative distribution function, also called the quantile function. $g(r)$ can be interpreted as a density ratio, which is defined as the ratio of these two quantities evaluated at every percentile of the reference distribution [0,1]. With a complete overlap of both distributions the probability density function of the R is 1 at every point of the PDF. On the other hand, values higher than 1 represent higher probabilities in the comparison distribution than in the references distribution at this specific point and values lower than 1 respectively represent lower probabilities. It is a proper PDF in the sense that it integrates to 1 over the unit interval.

What we got through the above transformation of two distributions is the overall relative probability density. But differences between distributions can be divided into two basic components: changes in location and changes

in shape. If the comparative distribution is a simple location-shifted version of the reference distribution, then the difference between the two distributions can be parsimoniously summarized by this shift. Differences that remain after a location adjustment are differences in “shape” (scale, skewness and other distributional characteristics). When both types of shifts are operating, or when factors other than scale are changing in the shape component, we need a way to separate out the various effects. If we want to identify the effect of a location shift and separate it from other changes in the distribution, it is necessary to specify what scale this shift operates on. It is possible to adjust distributions by any measure of central tendency. Here we choose a median location adjustment because the median is a natural, robust and scale invariant unit of measurement. Because our interest lies in analyzing distributional differences concerning the degree of inequality, we will focus in the results section on shape differences and look therefore at the relative distribution after the distributions are adjusted for location differences.

Distributional polarization is of particular interest in the study of inequality. However, common inequality indicators (for example Gini or Theils index) are not designed to distinguish between growth in the upper and lower tails. Even if the measures register increasing inequality over time, one cannot distinguish a polarization of the distribution (increases in both tails) from upgrading (increases in the upper tail) or downgrading (increases in lower tail). The polarization index developed by (?) addresses this issue, because it is decomposable to distinguish differences in the upper and lower tails. Because it is based on the relative distribution it provides a simple link between what is observed in the graphical display and what is measured by the numerical summary.

The median relative polarization index (MRP) is defined as the mean absolute deviation around the median of the location-adjusted relative distribution, scaled to produce an index that varies between -1 and 1.

Given the scaling, a value of zero represents no differences in distributional shape; positive values represent more polarization (increases in the tails of the distribution); and negative values represent less polarization (convergence towards the center of the distribution). The measure catches only differences in distributional shape (not location). And it has several interesting features. MRP can be interpreted in terms of a proportional shift of mass in the distribution from more central to less central values. A value of 0.1, for example, is equivalent to a 10% population shift from the center of the distribution to the upper and lower quartiles and the MRP is decomposable along the scale of y . This makes it possible to compare the contribution of each section of the distribution to the overall polarization. A natural decomposition is the contributions made by components above (upper polarization index, URP) and below (lower polarization index, LRP) the median (of $g(r)$).

II. Non-taxed

Some tax units are missing in the FTA data as they do not qualify for taxation below a certain income threshold. The income distribution is therefore cut at the left end. For most of the observed range it is not documented how many tax units fall into this unobserved category. Since 1995 however the FTA provides the number of people not being taxed (we will call these tax units “zeros”). From 1995 to 2010 we can therefore estimate the bias we introduce when ignoring the zeros. In this section we will try to analyze whether the bias is stable over time (and cantons). If the bias was stable over time, we could still analyze trends and changes of inequality no matter how severe the bias is.

First it is useful to look at the descriptives plotting the share of zeros over time.

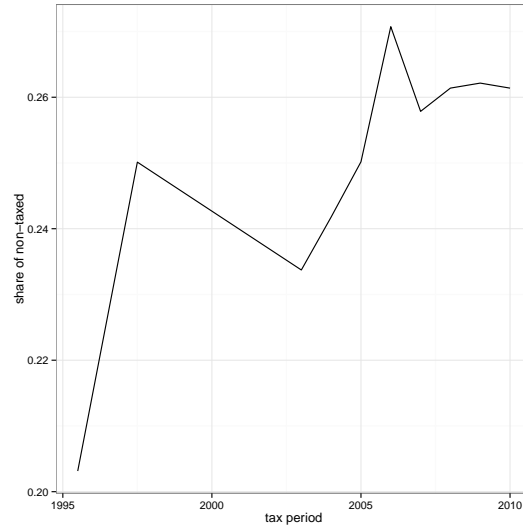


Figure 3: Share of tax units below federal tax liability threshold

The number of zeros increased slightly according to figure 3. Different interpretations seems possible. The increased share of zeros could be driven by the FTA’s inflation adjustments or an increase in social deductions. Another plausible explanation is the increasing number of unmarried couples filling in two separate tax forms instead of one so we observe two “small” incomes instead of one “large” income, thus inflating the number of people falling below the taxation threshold.

As we want to report reliably inequality time series we pursue two strategies:

1. Add the zeros as a separate group
2. Carry out a statistical test whether the share of zeros alters the Gini coefficient

By adding the zeros back as a separate group we need to make an assumption about the income distribution within that group. We know these cases had incomes between zero and the threshold (usually around 15,000 CHF for the period 1995-2010). In figure 10 we show Gini-coefficients calculated under the assumption of the zeros being zero. This is problematic for two reasons: first we know these units might earn more (up to the threshold) so Gini calculated on this assumptions will be too

high. Second we assume the zero group to be perfectly homogeneous which on the contrary has a lowering effect on the Gini coefficient. Therefore we must at least assume a distribution for the zeros that has some variance and ranges from zero to the threshold. We decided to use the most simple approach fulfilling both criteria which is to interpolate a uniform distribution between zero and each tax periods threshold.

The second approach investigates whether the FTA time series is suitable to analyze trends of inequality even if the inequality measures are biased. We can do this by regressing the inequality measure (here the Gini-coefficient) on the share of zeros. Simply spoken we test if cutting a larger (left) tail of the distribution changes the shape of the distribution. We include Gini-coefficient for all cantons in our analyses to improve the power of our statistical test¹³.

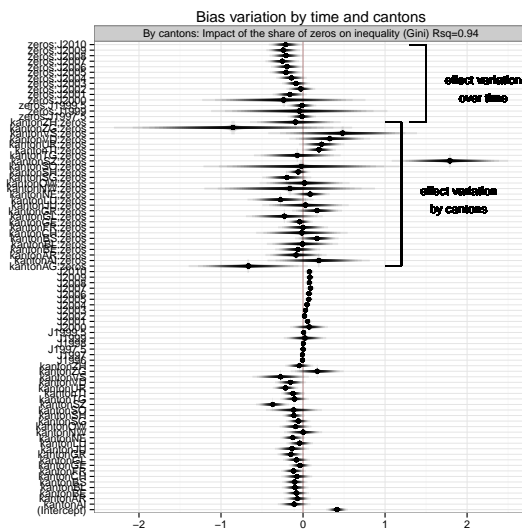


Figure 4: Bias variation by time and cantons

The model outputs a test statistic for each canton that tells us whether the variation of the zero-rate over time leads to a significant deviation from the typical “canton gini-level”. As the model has a decent fit we are not in great

danger of omitted variable bias. Using a joint F-Test we can now test if all canton interactions are zero.

In our case we can clearly reject the hypothesis that all interactions are zero ($p = 0$). This leads to the conclusion that Gini coefficients are biased by the variation of the zero-share. As a minimum a researcher using tax data should therefore control the share of unobserved people, while the best solution is to thoroughly the mechanisms behind a change in the zero share (e.g. this might be due to increased unemployment in one period and due to changes of the tax system in another period.). Fortunately the model coefficient of Switzerland as a whole is not significant suggesting that the cantonal biases cancel each other out. This seems plausible if the phenomenon is e.g. driven by tax competition because most of the “tax optimization” happens within Switzerland.

Figure 4 can be read as follows: A positive coefficient (e.g. Schwyz) states that we measure higher Gini coefficients in periods with many zeros. We can derive, that the distribution of incomes is more skewed for high incomes than for low incomes. Simply speaking, the contrast between low and middle class is less pronounced than the contrast between middle and top class. One possible explanation would be that incomes stem from two different distributions (populations): 1) local people of Schwyz who follow a less skewed distribution and 2) particularly rich people who moved to Schwyz (to avoid taxes).

A negative coefficient (e.g. Geneva) means the more zeros there are the smaller the Gini measure was compared to other tax periods within that canton (remember this is a fixed-effects model). This is the case we would usually expect: more zeros mask inequality that arises from the bottom.

Another information we can read from the coefficient plot is the (zero-)adjusted inequality development represented by the period dummies. However these values indicate an unweighted change of the Gini coefficient which

¹³Furthermore without cantonal data (but only data for aggregate Switzerland) it is impossible to distinguish whether inequality changed due to the number of unobserved people or any other variable that changed over time)

relates to cantons (not aggregate Switzerland). Fortunately the overall picture of inequality development looks very similar to the plain time series of Gini coefficients.

And there is even more to see from the model coefficients: The period-zero-interactions in the model state how an increase of zeros (cutting off a larger piece of the left tail) affects the Gini coefficient in each period compared to 1995. We can see that 2004 to 2010 the (negative) effect is significantly larger than 1995. To simplify: cutting off zeros increasingly leads to an underestimation of inequality measures, probably because the skewness in the left part of the distribution increased. To simplify: in the last decade tax units are increasingly pushed below the observable threshold concealing part of the inequality development. One less dramatic interpretation of this result is the increasing number of unmarried couples filling in two separate tax forms.

IV. RESULTS

In this section we will present results following the strategy introduced in the last section. As described this includes changing possible concepts within one field (income definition, statistical unit, measurement and population coverage) while holding other conceptual differences constant. To get the best possible comparison we rely on different data sources (FTA-tax data and HBS-survey data) and different time periods. The presentation of results therefore includes a description of the used data.

I. Defining income

Gini coefficients for taxable income, income before deductions and taxable income after federal tax

We start with the effect of income definition on the assessment of income inequality. As described in the previous section income definitions are either closer to the market outcome or the income, which shapes the possibility to consume (disposable income). With FTA-Tax data in-between income measures can be

defined. This includes

- *taxable income*: all incomes declared for taxes (earnings, income from property and current transfers received) minus several deductions
- *net income*: Is a sort of total income, which excludes some (but not all) deductions
- *taxable income after federal tax*: By subtracting federal taxes from the taxable income, we get closer to the disposable income

Following these three definitions we calculate Gini-coefficients out of the FTA-tax statistics. Because information about net income per income bracket is only reported from 1983/1984 until 2010, we can show differences over this time period.

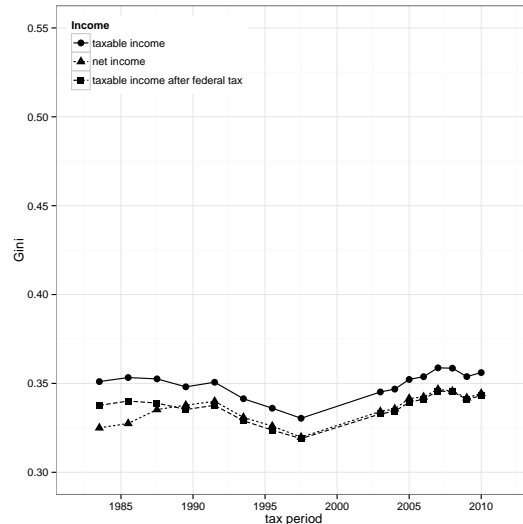


Figure 5

As

II. Statistical units – Equivalence scale

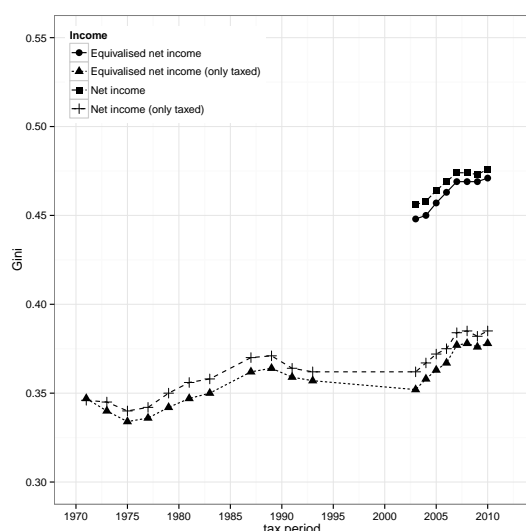


Figure 6

III. Measuring inequality

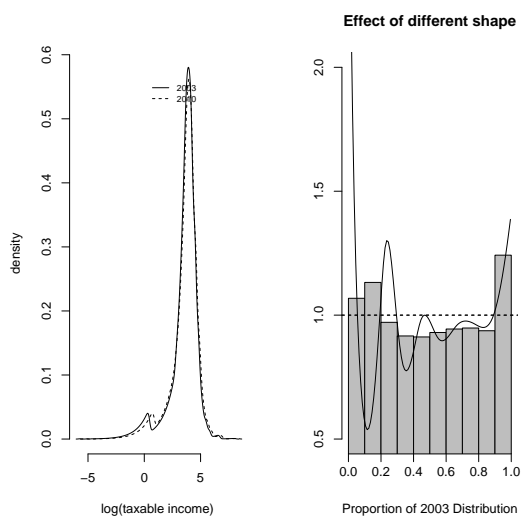


Figure 7

Table 2

Inequality Indices	
Median Index	0.058
Lower Index	0.072
Upper Index	0.045
Δ Gini	0.025

IV. Population coverage

Normal versus special cases

The FTA distinguishes normal from special cases as described in the data section. To test whether it matters which cases the researcher looks at we want to compare the distributions of normal and special cases. Unfortunately, the FTA stopped to publicly report data for special cases after tax period 1993/94. Therefore we will compare the two distributions for a rather old dataset. However the FTA does report aggregate statistics (e.g. percentiles) based on a pool of all cases (normal and special) for more recent periods¹⁴ which allows us to do a corresponding analysis for 2010 as well.

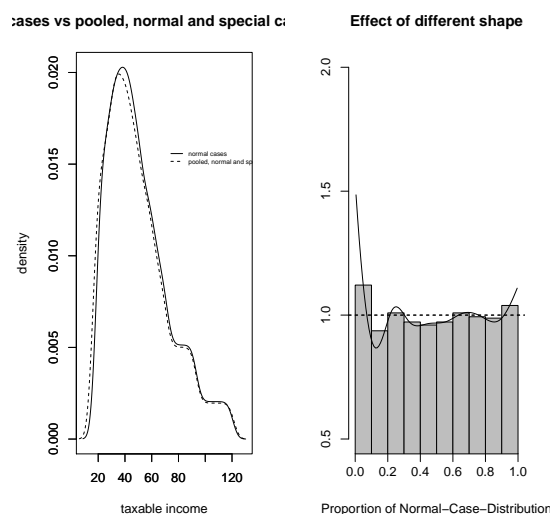


Figure 8

¹⁴These calculations were done on commission of the FTA within the SNF project Sinergia Nr. 130648 "The Swiss Confederation: A Natural Laboratory for Research on Fiscal and Political Decentralization" by Raphael Parchet and Stefanie Brilon in coordination with Prof. Dr. Marius Brühlhart.

Table 3

Inequality Indices	
Median Index	0.020
Lower Index	0.029
Upper Index	0.010
Δ Gini	0.013

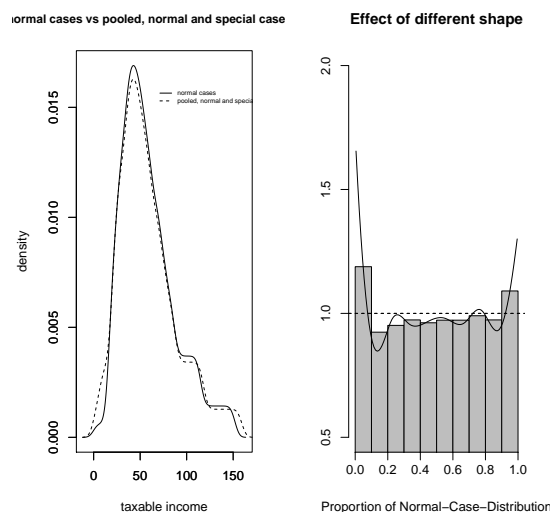


Figure 9

1993/94 a pooled data set of normal and special cases has a slightly higher density at both ends compared to data based in normal cases only (see figure 8). Special cases appear to have a slightly lower median income and their distribution is more skewed. Therefore special cases are more polarized than normal cases (see table 3), i.e. striving away from the median (positive Median Index of 0.02). This tendency is more pronounced in the lower than upper part of the distribution (Lower Index of 0.029 compared to Upper Index of 0.01). As the special cases consist of a broad mix of individuals it remains unclear which factor explains the differences of both distributions. Possible explanations can be immigrants partly concentrating in lower income percentiles, low income artists who belong to the special cases or a more technical selection effect: tax units not liable for taxation throughout the whole year are special cases; those cases might have lower incomes, e.g. if they moved and stopped working. To get a more complete picture we can look how the two distributions relate to each other in 2010 (see figure 9).

Table 4

Inequality Indices	
Median Index	0.031
Lower Index	0.039
Upper Index	0.022
Δ Gini	0.020

2010 the picture is similar but more apparent: Special cases appear more frequent around the lower percentiles of the pooled distribution (Lower Index of 0.039), however 2010 there is a more noteworthy effect in the upper part of the distribution (Upper Index of 0.022). According to figure 9 we can attribute this effect to the top percentiles. This gives credibility to the thesis that rich immigrants whose number increased between 1994 and 2010 drive the effect.

taxable income with and without non-taxed

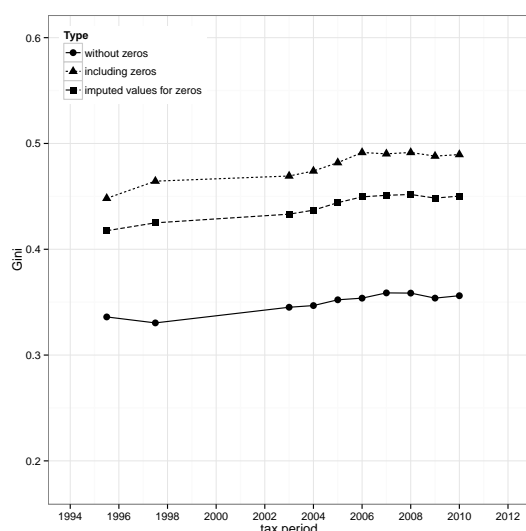


Figure 10

Including zeros leads to significantly higher gini coefficients. However we must keep in mind, that these might be artificially high values as we assume zero income for everyone in the zero group. We can conclude more from the graphic: the ratio between both measures seems to be quite constant although for aggregate Switzerland but there are minor deviations for multiple cantons as well as strong deviations for the cantons Geneva and Ticino. However the problems seem not to result from a shift in the zero-share over time but they are specific for the time-period when the tax system changed.

comparison of tax-data and survey data distribution

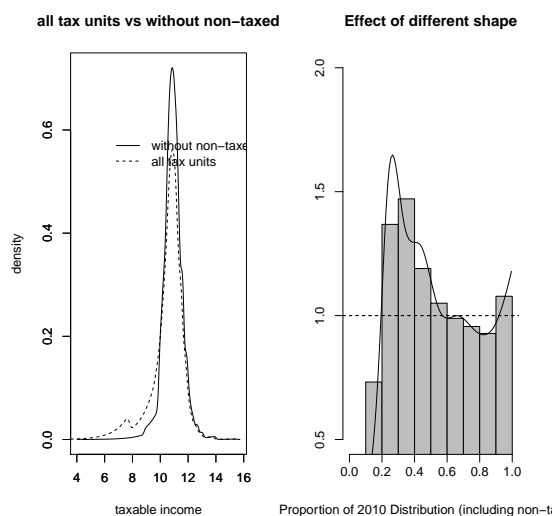


Figure 11

Table 5

Inequality Indices	
Median Index	-0.1084
Lower Index	-0.2155
Upper Index	-0.0013
Δ Gini	-0.0952

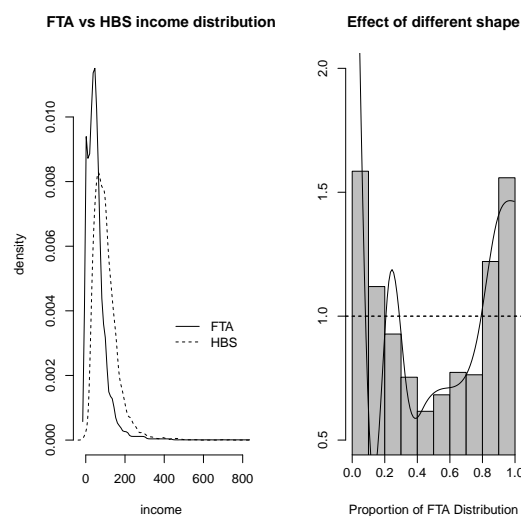


Figure 12

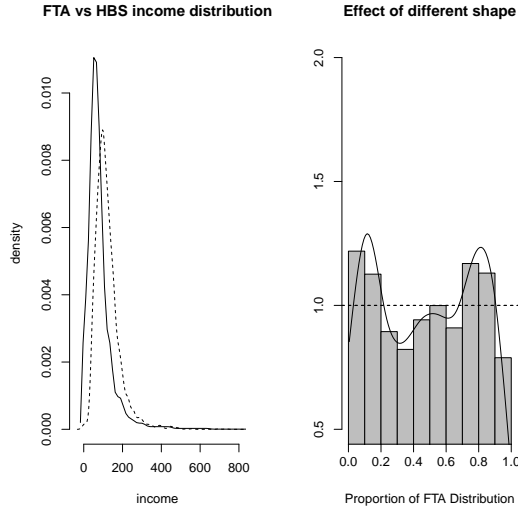


Figure 13

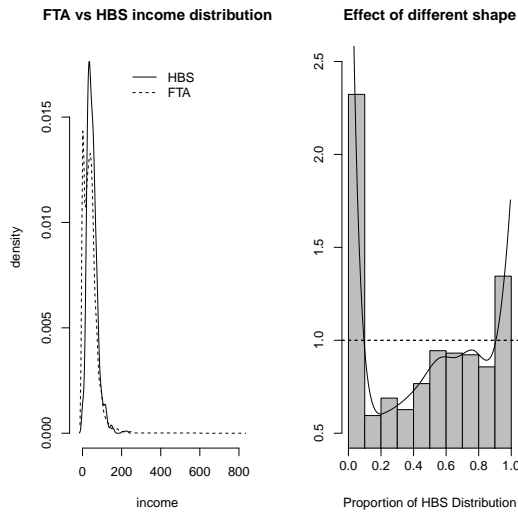


Figure 14

From the discussion in the data section we would expect differences between the income distributions from survey and tax data. Within the FTA data we observe zeros for incomes below the threshold to be liable for federal tax while survey data might cover this range. On the other hand we expect underreporting from both lowest percentiles and highest percentiles (middle class bias) within the survey data. Fig-

ure 12 (left) however reveals a more critical issue related to tax data, that is the median location of income compared to survey data. Although we try to measure similar concepts of income, survey data shows a median (93.000 CHF) more than twice as big as tax data (44.600 CHF). The issue here is clearly the assumptions of household composition. While survey data is likely to capture the correct household composition, tax data can only approximate households by using marital status. Splitting the data in married and unmarried tax units underpins this argument. From figure 13 we can see that married tax units (FTA data) and household with married couples (survey data) are better (but still not perfectly) comparable. Figure 13 (right) shows the expected shape difference between the two distributions: survey data has a bias towards the (median-adjusted) 80% to 90% percentile (of the FTA data distribution). Top percentiles are badly covered by survey data, suggesting that inequality measures based on survey data might underestimate inequality development that arises from changes in the incomes of the rich. Though, survey data can be of interest if one is interested in the lower 20% of the income distribution.

The bad household approximation within tax data needs to be addressed in further research. One possible way would be to link tax data to household ID's from the residential register.

V. Intertemporal comparison

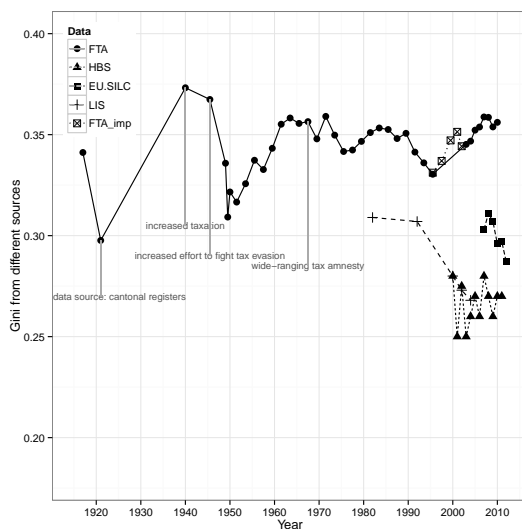


Figure 15

Figure 15 displays the most relevant Gini-coefficients that can be calculated for Switzerland. Although we can not adjust the Gini-coefficients to be perfectly valid, we can discuss the picture against the background of our analyses. For the periods before the second world war it is difficult to draw secure conclusions because these data points are based on unreliable data. 1933 only 13.7% of the population filled in a tax form (Dell et al., 2005). During the war we see a tendency towards lower income inequality. This might be attributable to a changed data base as the amount of non-fillers decreased during the war and shortly after. The period after the world war is characterized by strong economic growth as well as an increase in inequality. Our interpretation is that high income percentiles disproportionately profited from the economic upturn. After the oil crises there were alternating phases of social welfare expansion and economic upturns.

The more interesting part of the picture are the years around and past the millennium. Between 1997/98 and 2003 we see a gap in the FTA series caused by the change in the tax system. Our approach to impute the gap is to interpolate the income sums of all FTA-reported income brackets. This is fruitful because cantons switched the tax system in different years

so we gain at least some information about the trend within the gap. The spike 2001 can be explained by tax tricks: within the period the tax system changed, individuals were able to save taxes by shifting parts of their incomes into this period.

After the financial crisis most of the data sources (except EU SILC) state decreasing inequality. Our interpretation is that top percentiles lost relevant parts of their incomes from capital investments.

V. DISCUSSION

This article highlights the main disparities between taxdata based assessment of inequality opposed to given standard concepts of inequality as it is mainly applied with household-surveys. We reflected all important concerns based on the case of Switzerland. Can we measure what we want to measure? Do data include the cases we are interested in? The paper revealed tax data afflicted with numerous problems when it comes to analyzing inequality. On the pro side tax data is not a sample but covers the full population liable to federal tax. The documentation of tax data for almost 100 years makes it the only option if the researcher is interested in long term analyses of swiss income inequality, take it or leave it. On the contra side the researcher needs to keep in mind several limitations. According to our analyses we can give advice which issues are more or less serious. The biggest issue is that tax data does not capture households. In comparison to survey data we have seen that tax data extremely overestimates the share of singles/single households if we assume marital status to be a proxy for household composition. Luckily there is a way to fix this shortcoming for further research. For analyses of household income inequality, the researcher should gather household information, e.g. by linking tax data to the population register. The second most important drawback of tax data is the non-reporting of the non-taxed (low income) tax units. The best solution here would be to gather data directly from the FTA where these

information are available, although not published. As a minimum the researcher should keep an eye on the share of population “disappearing” below the threshold. The larger the share, the more likely it is to overlook increases in inequality if tax data is used without these cases. Minor issues are whether the researcher looks at all cases (including special cases) the FTA may provide or only normal cases. However this issue became more relevant in recent years as high income special cases became more frequent. Our recommendation is to use both normal and special cases wherever possible but it is not an important

issue. It is also not very important for the researcher whether the researcher looks at equivalized or non-equivalized incomes as long as the exact household structure is unknown. A more fruitful approach is to do separate analyses for married and unmarried tax units and treat the latter with healthy portion of caution.

VI. ACKNOWLEDGEMENTS

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VII. APPENDIX