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The ins and outs of top income mobility

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Abstract.: This paper is concerned with whether top income recipients are permanently there or only temporarily receive the highest incomes. The first part of the paper makes a methodological contribution to answering these questions. A family of top income mobility measures is introduced, based on differences in average annual incomes of top income earners in short-term and long-term distributions of income. The second part of the paper employs the rich Norwegian income tax records to study top income mobility in Norway since 1967, finding low levels of top income mobility, but a relatively large rise starting around 1990.

Keywords: Top income shares; income mobility; inequality

JEL Codes: J31; E24; D63; N34

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1. Introduction

Concerns about the rising share of top incomes in many countries are often countered with the view that the composition of the top income classes is constantly changing. Each year there are new entrants to the top 1 per cent and there are corresponding exits. High top incomes might not necessarily translate into high concentration of economic power. Calculation of top incomes from annual cross-sections does not reveal the extent of concentration over time. As increased economic liberalization was an important driver of increases in top income shares after 1980, it could be that there was, in fact, a much smaller increase in the concentration of "economic power", if income volatility and income mobility increased. In the famous quotation of Joseph Schumpeter, the class "resembles a hotel, or omnibus, always full, but always of different people". The reference of an "omnibus" dates this quotation and we have to ask whether this is indeed true today. How much mobility is there in the top income groups? How much difference would it make to measured top income shares if incomes were averaged over several years? In this paper we exploit the rich register data held by Statistics Norway covering the period 1967 to 2011 to explore the pattern of mobility at the top of the income distribution, about which relatively little is known. There has equally been little discussion of the theory of mobility measurement *applied specifically* to top incomes, and in this paper we propose a new approach.

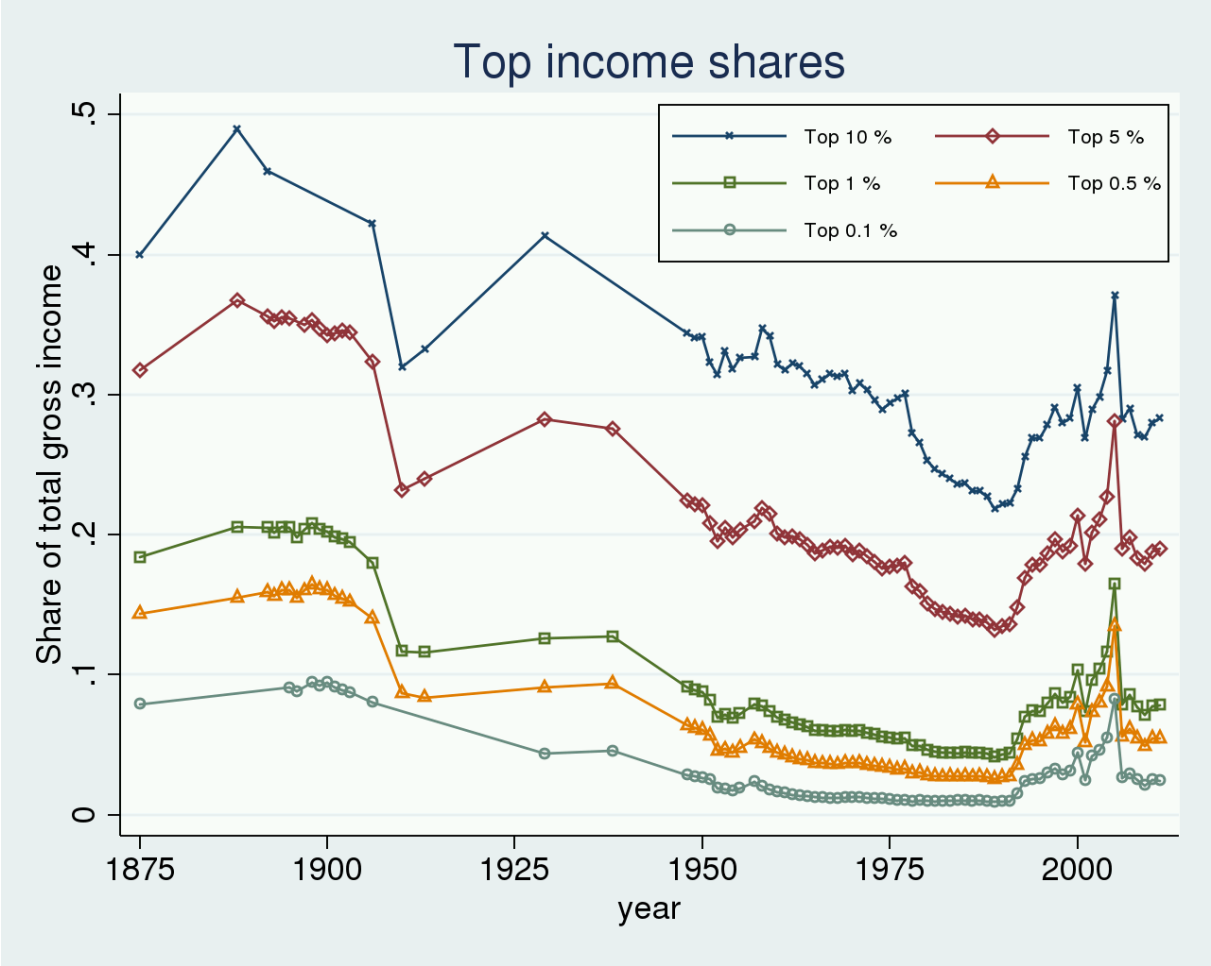
The context within which mobility is studied in this paper is one in which, after a long period of decline, top income shares in Norway have increased markedly – as illustrated in Figure 1. (The construction of this series is described in Appendix A, which updates the series in Aaberge and Atkinson (2010) to 2011, and adds new information covering the period 1892 to 1903.) From 1967, the beginning year for our investigation of mobility, to the end of the 1980s top income shares were declining. The lowest point was reached in 1989, when the top 10 per cent income share was 22 per cent (more or less the share of the top 1 per cent in 1888) and the top 0.1 per cent share was 0.61 per cent. What caused the subsequent change in direction? (By 2011, the top 10 per cent share was 28 per cent and that of the top 0.1 per cent was 2.44 per cent.) There was deregulation of relatively tightly regulated capital markets. The financial deregulation initiated in 1984 did not lead immediately to a rise in top shares, but its distributional impact was probably postponed by the economic recession and the related Norwegian banking crisis of 1988 to 1992. As the economy picked up speed from around 1990 forward, there is a steep increase in top income shares. At this point, there was also a series of tax reforms; from 1986 to 1992, the marginal tax on capital income was gradually reduced to a flat rate of 28%. This increased the incentives to realise dividends and capital incomes and led to a rise in the top income shares. There were also special circumstances, leading to two "spikes" for the top income shares. In 2000/2001, there was an increased tax on dividends which was removed in 2002.

Anticipating the increase, there is a spike in top income shares in 2000 (as dividends were realised before the reform) and a corresponding reversal in 2001. In 2006, the 2001 tax on dividends was again implemented. The extreme distributional response to the 2006 reform brought top income shares in 2005 to levels not seen since the early twentieth century. The share of the top 1 per cent rose by some 5 percentage points in 2005 and then halved in 2006. From the standpoint of the level of top shares, such spikes can be smoothed, but they raise particular issues for any study of mobility. There was a large turnover in the composition of the top income groups in that year, and we ask who it was who took advantage of this pre-announcement. Who benefited from the short-term income arbitrage possibilities?

It is against this background that we assess the extent of mobility at the top of the income distribution. But what do we mean by mobility? Mobility at the top is typically described in terms of people moving in and out of the top x per cent. Do people change rank? In the United States, Auten et al (2013) examined the persistence of individuals in the top 1 per cent of taxpayers (whether they stay in the same group), and found no large changes in the 1991-2009 period. It is clear however that the implications for concentration of economic power – our concern here – depend not only on changes in rank but also on the extent of income change. In a country where incomes are grouped closely together, a small increase may be sufficient to take a person into the top x per cent, and this country may therefore exhibit apparently high mobility in terms of ranks. It is therefore necessary to consider both the correlation of ranks over time and the marginal distributions of income. We begin therefore by proposing in Section 2 a general framework in terms of the "top income mobility curve" for comparing income distributions with regard to the extent of income mobility, when mobility is defined to be associated with the equalization of long-term income. The proposed summary measures of top income mobility admit a decomposition of mobility with regard to the contribution from the mean and the spread in the distribution of permanent income of top income earners.

Section 3 describes the empirical evidence for Norway and shows how the top income mobility curve provides evidence about the extent of mobility in top incomes and how mobility has changed over the period 1967 to the present. In order to understand better who enters and leaves the top income groups, we examine mobility over the life-cycle and across cohorts. Particular attention is paid to the episode in 2005 described above, when top income shares in Norway spiked as a result of the pre-announcement of a permanent dividend tax implemented in 2006. The conclusions of the paper are summarised in Section 4.

Figure 1 Top income shares in Norway, 1875-2011



Sources: see Appendix A.

2. Measuring top income mobility

In order to provide a framework, we start from the position that top income mobility is defined in terms of the concentration of economic power. "Economic power" can be defined in different ways, but here we take it to mean control over a disproportionate fraction of total economic resources. This approach has two implications. The first is that the variable with which we are concerned is income, rather than consumption. Power can be exercised without consumption, and there are forms of consumption, such as the value of public services and in-kind benefits, that are not under the control of the individual. Secondly, we are concerned with what happens at the top: it is the fact that the share of the top x per cent is a multiple of x that gives them a disproportionate say. Or, stated in terms of growth, the rising share of the top x per cent means that they have secured a disproportionate fraction of the gains from growth.

From the perspective of economic power, the extent of mobility is clearly crucial. Control over resources has a very different meaning where it is exercised each year by the same people from a situation where we all get our turn at the steering wheel. This leads us to focus on what happens when the accounting period of income is extended from one to several periods; for example from one to ten years. As such, our measure is similar to that adopted in the literature on overall mobility. Shorrocks (1978), for example, defines overall income mobility as "the extent to which the income distribution is equalised as the accounting period is extended" (1978, page 378). As indicated by the reference to "equality", these measures have a basis in welfare economics. Our focus is however different. Rather than measuring mobility across the entire income distribution, our concern in this paper is about top income shares, on the basis that these are the locus of economic power.[1] We are concerned with the total of resources accruing over time to the top groups – the right hand side of the intertemporal budget constraint – not with any resulting welfare derived from consumption. Issues such as the costs associated with income transfers to smooth consumption do not arise.

2.1 Top Income Mobility Curves

Our focus on economic resources means that mobility has to be considered in terms of the distance travelled and not position in the ranking. A move from the fifth percentile to the top

[1] The approach adopted here differs, for example, from that of Aaberge and Mogstad (2014), who deal with overall mobility and argue in favour of using a measure of permanent income derived from intertemporal choice theory.

percentile has a different meaning if income thereby trebles than if it increases by only 50 per cent.[2] We therefore consider the level of income that results from mobility. Specifically, we investigate the income shares of long-term income, X, measured as the undiscounted sum of annual income (discounting could readily be introduced) over r years. In other words, where X_t denotes the income variable in year t with distribution function F_t, mean $\mu_t = EX_t$ and Lorenz curve L_t, $X = \sum_{t=1}^{r} X_t$ is the long-term income with distribution F, mean $\mu = \sum_{t=1}^{r} \mu_t$ and Lorenz curve L. We are concerned with the richest 100(1-a) per cent of the population, and to this end define the top income mobility (TIM) curve as a function of u for $a \le u \le 1$ as:

$$T(u) = \sum_{t=1}^{r} \frac{\mu_t}{\mu}(1 - L_t(u)) - (1 - L(u)) = \sum_{t=1}^{r} \frac{\mu_t}{\mu}(L(u) - L_t(u)), \quad a \le u \le 1 \tag{2.1}$$

Thus, $T(u)$ measures the gap between the observed income share $(1 - L(u))$ of the top 100(1-u) per cent and their hypothetical maximum share in the case where their positions in the short-term income distributions are assumed to be fixed; i.e. the richest person in period 1 is assigned the highest income in the remaining r-1 periods, the second richest person in period 1 is assigned the second highest incomes in the r-1 remaining periods, etc. This is illustrated in Figure 2. Note that T(u) is non-negative, since

$$L(u) \ge \sum_{t=1}^{r} \frac{\mu_t}{\mu} L_t(u)$$

and that equality is attained if and only if there is no mobility among the top income earners, which means that $T(u)=0$ in this case.

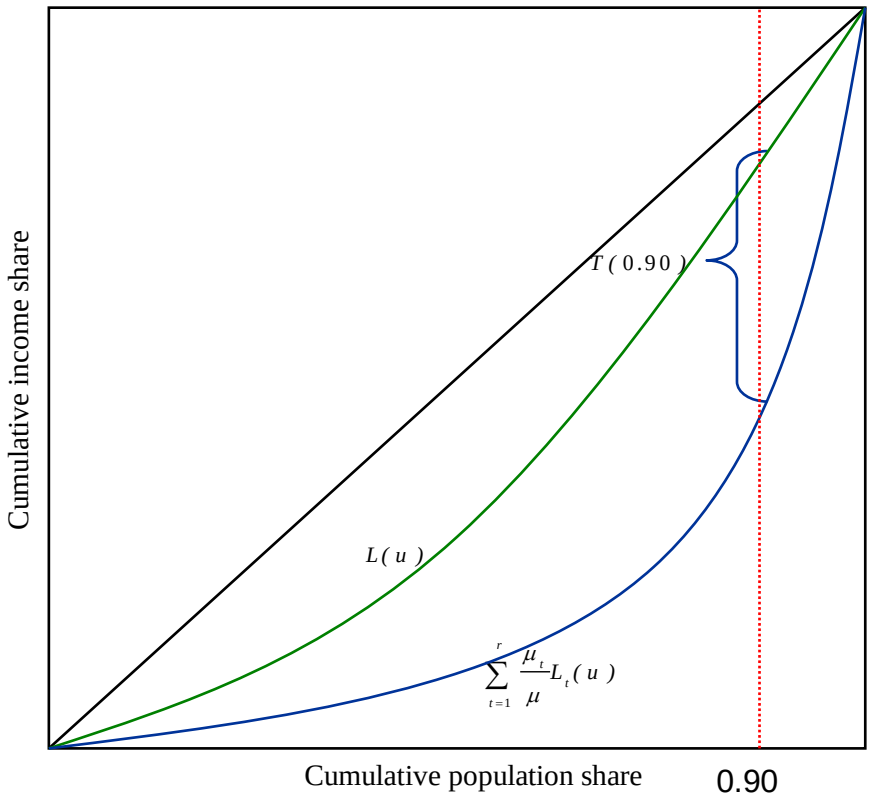
The derivative of the TIM curve provides information of the impact of top income mobility on different parts of the upper tail of the distribution of long-term income. The derivative of T is given by

$$T'(u) = \frac{F^{-1}(u) - \sum_{t=1}^{r} F_t^{-1}(u)}{\mu}, \quad u \in [a,1]. \tag{2.2}$$

[2] With a Pareto upper tail, income at the top percentile is 3 times that at the 95th percentile if the Pareto coefficient is 1.46; it is 1.5 times if the Pareto coefficient is 4.

The slope of the TIM curve, multiplied by μ, measures the difference between quantile-specific income in the permanent income distribution and the sum of the corresponding quantile-specific incomes in each year. In the upper part of the distribution, this can be negative, indicating the "loss" of the top income groups from mobility.

Figure 2 Illustration of the relationship between T(u) and the Lorenz curve (u=0.90 marked)



2.2 Partial rankings

By allowing the proportion *u* of people classified as "rich" to vary, the TIM curve can be used to compare the degrees of mobility among affluent people in a society. Assume that T_1 and T_2 are two TIM curves, where $T_1(u) \geq T_2(u)$ $for\ all\ u \in [a,1]$ and the inequality is strict for at least one value of $u \in \langle a,1 \rangle$. Then we say that T_1 first-degree TIM dominates T_2 which justifies the claim that T_1 exhibits more top income mobility than T_2. It follows directly from the relationship between the TIM curve and the Lorenz curve (see (2.1)) that the higher of two non-intersecting TIM curves can be obtained from the lower TIM curve by transfers of long-term incomes, given that that the period-specific income distributions are kept fixed.

In practice, however, TIM curves might intersect, in which case weaker criteria than first-degree TIM dominance are required. Since TIM is concerned with the degree of mobility among the most affluent people in the society it appears attractive to introduce the criterion of second-degree downwards TIM dominance by integrating the TIM curve from above, which is parallel to the concept of "downwards Lorenz dominance" in Aaberge (2009).

Definition 2.1. *A TIM curve T_1 is said to* ***second-degree downwards dominate*** *a TIM curve T_2 if*

$$\int_u^1 T_1(t)dt \geq \int_u^1 T_2(t)dt \quad for\ all\ u \in [a,1]$$

and the inequality holds strictly for some $u \in \langle a,1 \rangle$.

Using integration by parts we get the following alternative expression for the integrated TIM curve,

$$(2.3) \qquad \int_u^1 T(s)ds = \sum_{t=1}^{r} \frac{\mu_t}{\mu} \int_u^1 (1 - L_t(s))ds - \int_u^1 (1 - L(s))ds = \frac{1}{\mu} \int_u^1 (s-u) \left(\sum_{t=1}^{r} F_t^{-1}(s) - F^{-1}(s) \right) ds .$$

The integrated TIM curve can be considered as a difference between weighted income shares, where the weights increase linearly with increasing rank of the income receiver in the income distribution. So that, if we are considering the top proportion 1-*u*, a weight of zero is given to those at the cut-off, but a weight of (1-*u*) to the very top income. Thus, second-degree downwards dominance means paying more attention to top income mobility the higher up in the long-term income distribution the mobility takes place.

2.3 Summary measures of top income mobility

In cases where downwards integrated TIM curves defined by (2.3) intersect, a ranking may require the application of a summary measure of top income mobility. Such summary measures do moreover offer quantification of the extent of top income mobility. By introducing an appropriate preference relation on the set of TIM curves, an axiomatically justified family of mobility measures can be obtained. To this end we introduce the ordering $\succeq$ defined on the family $\boldsymbol{T}$ of TIM curves. Since the TIM curve *T* is uniquely determined by two Lorenz curves, we can impose similar conditions on the ordering $\succeq$ as Aaberge (2001) used for an ordering defined on the family of Lorenz

curves. That is, the ordering $\succeq$ is assumed to be transitive, continuous, complete and to rank $T_1 \succeq T_2$ if $T_1(u) \geq T_2(u)$ *for all* $u \in [0,1]$. More importantly, to give the order relation $\succeq$ an empirical content we introduce the following independence condition

Axiom (Independence). *Let T_1, T_2 and T_3 be members of **T** and let $\alpha \in [0,1]$. Then $T_1 \succeq T_2$ implies $\alpha T_1 + (1-\alpha)T_3 \succeq \alpha T_2 + (1-\alpha)T_3$.*

The Independence Axiom requires that identical mixing interventions on the TIM curves being compared do not affect the ranking of TIM curves; the ranking depends solely on how the differences between the mixed TIM curves are judged. As an illustration, let us consider a simple example where we observe two countries 1 and 2 over two time periods, and the cross-section distribution is the same in both countries in both time periods. However, there is some difference in the permanent income (i.e. how individual incomes change over time) such that the top income mobility curves T_1 and T_2 intersect. According to the Independence Axiom, introducing a mixing with any third top income mobility curve, for example such as one where there is no mobility (the rank of individuals is the same in both periods) or one where incomes are perfectly re-shuffled, then any preference we had over T_1 and T_2 would be preserved after the mixing.

It can be proved that the ordering $\succeq$ which satisfies these axioms can be represented by the following family of top income mobility measures[3]:

$$\theta_q(a;T) = -\int_a^1 q(s)\,dT(s) = \frac{1}{\mu}\int_a^1 q(s)\Big(\sum_{t=1}^{r} F_t^{-1}(s) - F^{-1}(s)\Big)\,ds, \tag{2.4}$$

where q with $q(a) = 0$ is a positive non-decreasing weighting function defined on the unit interval and 100(1-a) is the proportion of people with higher income than $F^{-1}(a)$. This means that $\theta_q(a;T)$ is equal to a weighted average of the differences between the observed long-term income (over r periods) and its no-mobility counterpart for the richest 100(1-a) proportion of the population.

2.4 A specific mobility measure

[3] These four axioms are analogous to the four axioms underlying the expected utility theory for choice under uncertainty. For a proof of the characterization result we refer to Fishburn (1982).

The preference function q assigns weights to the long-term incomes of the individuals in accordance with their rank in the distribution of long-term income. What are the properties of the function $q(s)$? To begin with, first-degree mobility dominance requires that q is non-decreasing. In turn, second-degree downwards dominance requires that q be convex (see Theorem 2.1 in Appendix B). In order to arrive at a specific measure, we consider the following family of non-decreasing weighting functions q_k where $q_k'(a) = q_k(a) = 0$,

$$q_k(s) = \frac{k}{(1-a)}\left(\frac{s-a}{1-a}\right)^{k-1}, \; a \le s \le 1, \; k \ge 1. \tag{2.5}$$

Note that q_k is strictly convex for $k>2$ and strictly concave for $1 \le k < 2$, which means that the top income mobility measures do not satisfy the condition of second-degree downwards dominance when $1 \le k \le 2$. Inserting (2.5) into (2.4) yields the following family of top income mobility measures[4],

$$\tilde{\theta}_k(a;T) = \frac{k}{(1-a)^k \mu}\int_a^1 (s-a)^{k-1}\left(\sum_{t=1}^{r} F_t^{-1}(s) - F^{-1}(s)\right) ds, \; k \ge 1. \tag{2.6}$$

Referring back to (2.3), we can see that $k = 2$ is the case of integration under the TIM curve. When k=1

$$\tilde{\theta}_1(a;T) = \frac{\sum_{t=1}^{r} E\left(X_t \middle| X_t \ge F_t^{-1}(a)\right) - E\left(X \middle| X \ge F^{-1}(a)\right)}{\mu}, \tag{2.7}$$

which can be interpreted as "the loss in relative permanent income" for the top 100(1-a) per cent due to mobility . When k=2

$$\tilde{\theta}_2(a;T) = \tilde{\theta}_1(a;T) + \frac{1}{\mu}\left(\sum_{t=1}^{r} G^*(a;F_t) - G^*(a;F)\right), \tag{2.8}$$

where $G^*(a;F)$ and $G^*(a;F_t)$ denote the absolute Gini coefficients of the conditional distributions of X given $X \ge F^{-1}(a)$ and X_t given $X_t \ge F_t^{-1}(a)$. This means that the second term of $\tilde{\theta}_2$ is a measure of the difference in spread of the upper tail of the long-term distribution and the sum of spread of the

[4] Note that this family of top income mobility measures is associated with a family of rank-dependent measures of "affluence" (for a=0.5) introduced by Aaberge and Atkinson (2013).

upper tails of the cross-sectional distributions relative to the overall mean income. Thus, $\tilde{\theta}_2$ can be considered as a distributive adjusted version of the relative average gap measure $\tilde{\theta}_1$.

What happens when k is greater than 2 (i.e. the weights are strictly convex)? An interesting question is whether $\tilde{\theta}_k$ for $k>2$ has a similar relation to measures of spread as $\tilde{\theta}_2$ to the upper tail Gini coefficient. The upper tail version of the (absolute) Lorenz family of inequality measures (Aaberge, 2000) can be expressed as follows[5]

$$D_k^*(a;F) = \frac{k}{(k-1)(1-a)^k}\int_a^1 (s-a)^{k-1} F^{-1}(t)dt - \frac{\mu^*(a)}{k-1}, k \geq 2, \tag{2.9}$$

where $\mu^*(a) = E\left(X \middle| X \geq F^{-1}(a)\right)$. This leads to the following alternative expression for $\tilde{\theta}_k$ by inserting (2.9) into (2.6),

$$\tilde{\theta}_k(a;T) = \tilde{\theta}_1(a;T) + \frac{k-1}{\mu}\left(\sum_{t=1}^{r} D_k^*(a;F_t) - D_k^*(a;F)\right), k \geq 2. \tag{2.10}$$

Note that $D_2^*(a;F) = G^*(a;F)$ and that $D_k^*(a;F)$ increases its sensitivity to changes among the most affluent people with increasing *k*. This means that $D_3^*(a;F)$ is more sensitive to changes in the dispersion of incomes among the most affluent people than $G^*(a;F)$. The most affluence-sensitive $\tilde{\theta}_k$ measure is obtained as *k* approaches ∞. In this case the top income mobility measure is defined by

$$\tilde{\theta}_\infty(a;T) = \frac{\sum_{t=1}^{r} F_t^{-1}(1) - F^{-1}(1)}{\mu}, \tag{2.11}$$

where $F_t^{-1}(1)$ is the highest income in period *t* and $F^{-1}(1)$ is the highest long-term income.
It follows from (2.6) that $\tilde{\theta}_k$ can be given the following alternative expression for integer *k*,

$$\tilde{\theta}_k(a;T) = \frac{1}{\mu}\left[\sum_{t=1}^{r}\int_{F^{-1}(a)}^{\infty} x d\left(\frac{F_t(x)-a}{1-a}\right)^k - \int_{F^{-1}(a)}^{\infty} x d\left(\frac{F(x)-a}{1-a}\right)^k\right]. \tag{2.12}$$

[5] Note that the absolute Lorenz family of inequality measures can be considered as right-spread measures of dispersion. See e.g. Fernández-Ponce et al. (1998) and Shaked and Shanthikumar (1998) for a discussion on how to compare the right-spread variability of distribution functions.

Next, by noting that

$$\Pr(\max_{1\le i\le k} X_{i,t} \le x \,\Big|\, X_{i,t} \ge F_t^{-1}(a),\ i = 1,2,\ldots,k) = \left(\frac{F_t(x) - a}{1 - a}\right)^k \tag{2.13}$$

and

$$\Pr(\max_{1\le i\le k} X_{i} \le x \,\Big|\, X_{i} \ge F^{-1}(a),\ i = 1,2,\ldots,k) = \left(\frac{F(x) - a}{1 - a}\right)^k, \tag{2.14}$$

where $X_{1,t}, X_{2,t},\ldots, X_{k,t}, t = 1,2,\ldots,r$ and $X_1, X_2,\ldots, X_k$ are samples of k independent drawings from $F_t, t = 1,2,\ldots,r$ and F, we get by inserting for (2.13) and (2.14) in (2.12)

$$\tilde{\theta}_k(a;T) = \frac{1}{\mu}\left[\sum_{t=1}^{r} E\left(\max X_{i,t} \,\Big|\, X_{i,t} \ge F_t^{-1}(a)\right) - E\left(\max X_i \,\Big|\, X_i \ge F^{-1}(a)\right)\right] \tag{2.15}$$

which demonstrates that $\tilde{\theta}_k$ can be interpreted as the difference between the sum of expected maxima of samples of size k from r annual cross-sectional distributions $F_1, F_2,\ldots, F_k$ and the expected maximum of a sample of size k from the long-term distribution F. As is intuitively clear from expression (2.15) the higher k the more sensitive is $\tilde{\theta}_k$ with regard to mobility among people with the highest incomes. Note that the Gini associated mobility measure $\tilde{\theta}_2$ requires only two drawings from the long-term distribution and each of the cross-sectional distributions, which explains why the Gini coefficient is considered to be particular sensitive to changes that take place in the central part of unimodal income distributions that are neither strongly skewed to the right nor to the left (Atkinson, 1970, Aaberge, 2000). Note that most empirical distributions of income has this shape.

3. Top income mobility in Norway 1967-2011

There have been several studies of intra-generational top income mobility. Reference was made earlier to the results of Auten et al (2013) for the United States. Saez and Veall (2007) study mobility in Canada by comparing top 0.1% income shares for accounting periods of one, three, and five years, and argue that mobility has been roughly constant since 1982, although they do not compare this to any reference distribution. Jenderny (2015) shows that top income mobility was rather modest in Germany between 2001 and 2006. There have been studies of top income inter-generational mobility, notably that of Björklund, Roine and Waldenström (2012) for fathers and sons in Sweden. Here we present evidence on intra-generational mobility for Norway since 1967. This serves both to illustrate the application of the methods developed in the previous section and to throw light on a country and a period that is of considerable interest.

Starting in 1967, we use individual micro data from the national tax register, covering all individuals working and residing in Norway. The pre-tax income variable is commonly referred to as "net income", and is the income concept used for income taxation. The difference from the actual income (both labour and other income) paid to an individual is some minor basic deductions.[6] The income measure is consistent across the entire time period, although changes in the tax system affected the reporting of certain types of income.[7] We take our population to be all resident individuals aged 16 and above, including those with zero income. Those not found in the tax files are attribued zero income.

The data used are the same as those for calculating top income shares since 1967, with two exceptions; (i) we limit our analysis to individuals with permanent residence in Norway, and (ii) we

[6] Use of "net income" depresses top income shares by around 1.5 percentage points compared to gross income, as deductions are relatively more important for lower incomes. However, for the post-1993 period, where we also have data for gross incomes, both the trends and the mobility indices are virtually identical across the two definitions.

[7] Income as reported here should not be construed as being directly translatable to the consumption or some abstractly defined "welfare" of individuals. For example, the value of public services is not included. Moreover, as will be made clear below, changes of the tax system affected the income-reporting of some types of incomes after the tax reform. As the purpose of this paper is to describe the trend in top income mobility based on officially reported incomes - similar to that used in top income series for other countries - we find it reasonable to rely on the official individual-level income records. It should be noted that the usage of "net income" depresses top income shares by around 1.5 percentage points compared to gross income, as deductions are relatively more important for lower incomes. However, for the post-1993 period, where we also have data for gross incomes, both the trends and the mobility indices (as explained in Section 3) are virtually identical across the two definitions.

use as control total the total income from the tax registry rather than a national accounts based total. As is common in the literature (see Atkinson and Piketty, 2007, 2010), we focus on the shares of the top 10 per cent, 5 per cent, 1 per cent, 0.5 per cent and 0.1 per cent. Initially the number of periods used to calculate long-term income, *r*, is set at 10. A higher number of periods provides a greater potential for measuring higher mobility. On the other hand, the long "moving averages" give both shorter time series overall and less insight into short-term variations in mobility. For this reason, parts of the analyses are performed using shorter time windows. The periods are denoted by the end year. For any given end year, *t*, the long-term average income with $r = 10$ is calculated over a sample defined as those people who are resident and satisfy the age requirement in all ten years up to an including *t*. Those not resident for ten years in a row are thrown out for that particular ten-year period. This means that the sample changes with each end year, *t*. Those with zero income are included. This selection rule means that someone living in Norway for only eight years would never be in the sample for the ten-year averages, but would occur in six observations for the three-year averages. In calculating long-term income, incomes are adjusted using the Consumer Price Index, to give constant purchasing power.

3.1. The level of top income mobility

Figure 3 shows the overall evolution of ten-year top income shares since 1967. The highest line is the average of the top income shares over the last ten years. The lowest line, labelled "permanent", is the income share of those with the highest ten-year average incomes over the same years. The first observation is therefore for the years 1967 to 1976, shown as 1976; the last observation is for 2002 to 2011, shown as 2011. The figures are displayed for u=0.9, 0.95, 0.99, 0.995 and 0.999. The income shares for a ten year average are given in Appendix F.

Applying the first of the tools described in Section 2, the top income mobility (TIM) curve, $T(u)$, is given by the difference between the two graphs in the corresponding section of Figure 3. The first impression is that the difference is relatively small: there is low mobility. All differences are less than two percentage points. For the period 1991-2000, for example, the top 1 per cent share of long-term income was 7.42 per cent, whereas the average top 1 per cent share in the previous 10 years was 8.35 per cent. For the top 0.1 per cent, the corresponding figures were 2.39 per cent and 3.03 per cent.

The extent of top income mobility, defined as the difference (in percentage points) between these two income shares, is shown in Figure 4. As noted in the previous section, the derivative of $T(u)$ can be negative. However, in the Norwegian case $T(u)$ is decreasing in u in all years. For example, in the first period, 1967-1976, $T(0.9)=1.75$ percentage points while $T(0.95)=1.18$ percentage points. The differences between the hypothetical ten-year Lorenz curve (the connection of the marginal income

distributions by rank) and the associated observed Lorenz curve are larger when more people move in and out of the group in question over the years. If we consider an income distribution profile for a given year and look at increasingly higher incomes, there are typically two characteristics of such a distribution. First, the average absolute distance between individuals' incomes increases. Second, the average absolute income volatility increases. In the data, we see that the first effect is stronger than the second. Hence, the number of crossing income paths decreases as we move the threshold *u* towards the top end of the income distribution. We are measuring mobility here in absolute terms – since this provides a better guide to the degree of mobility across different time periods and different countries when the income shares are quite different.

The second conclusion that can be drawn from Figure 4 is that there was an increase in mobility after 1991. This increase particularly affected the very top. The degree of mobility for the top 0.1 per cent increased from less than 0.2 percentage points at the beginning of the period to around 1 percentage point. For the top 1 per cent, the increase was from 0.5 percentage points to above 1.5 percentage points. (For the top 10 per cent the increase was less marked.) In what follows, we explore some of the factors lying behind this increase in mobility.

Figure 3 Cross-sectional and long-term top income shares (ten-year averages) Norway 1967-2011

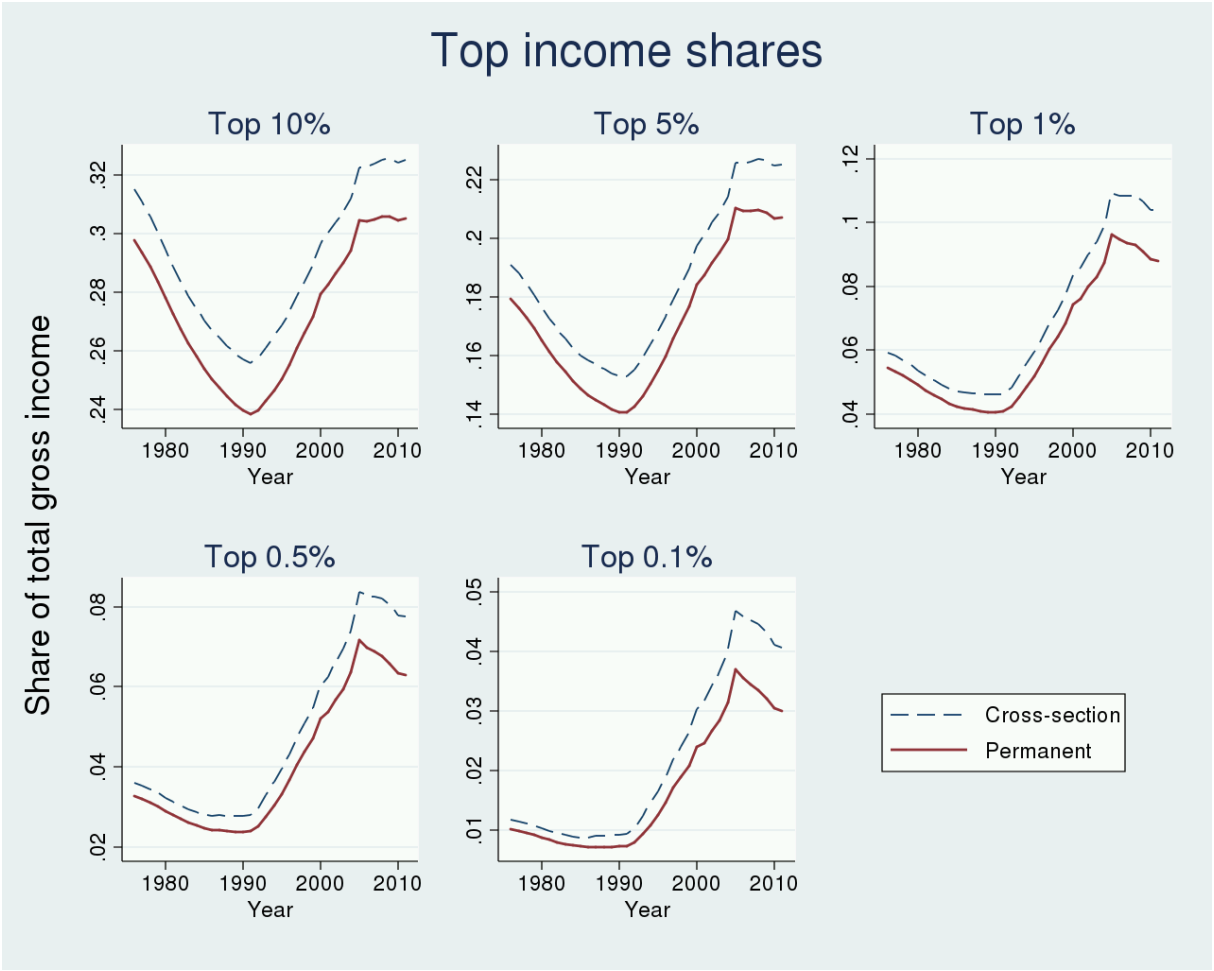
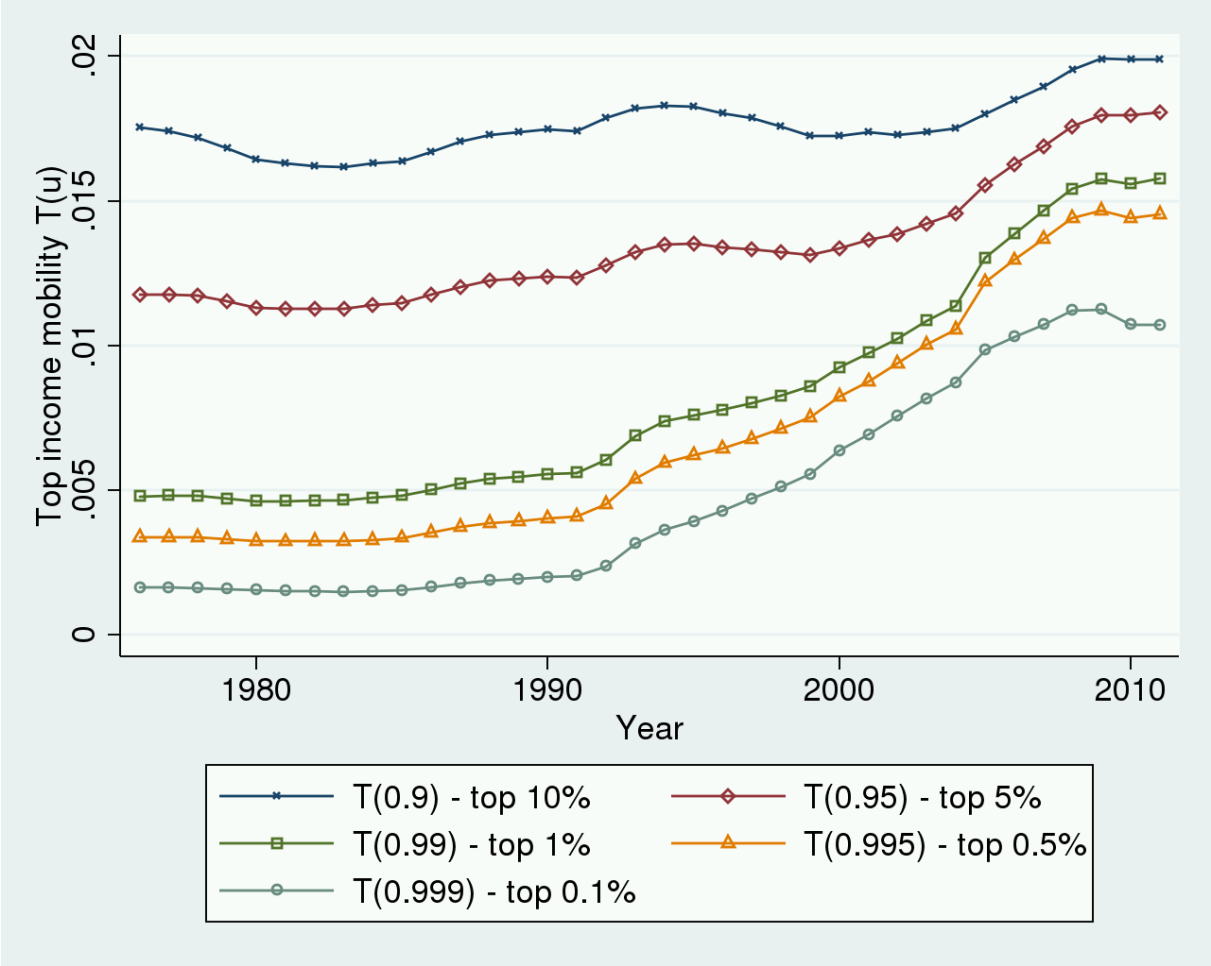


Figure 4 Top income mobility, selected quantiles Norway 1967-2011, using ten-year windows



Reading note: T(u) denoted the value of the total income mobility (TIM) curve at the u percentile.

3.2. The trend over time in top income mobility

Figure 4 shows an upward trend in top income mobility that is stronger at higher quantiles, levelling out after 2008 (and even decreasing for the very richest). However, the use of 10-year windows removes much of the information about short-term changes in top income mobility; the moving averages give a very smooth curve. For this reason, we now move to three-year instead of ten-year windows; the parameter *r* is set to 3. (The income shares for a 3 year average are given in Appendix F.) The development over time with this parameter is shown in Figure 5, which is the counterpart to Figure 4. (The top shares, the counterpart of Figure 3, are shown in Appendix C.) With the exception of the 2005 spike, the differences between the observed and the hypothetical are now all less than 1 percentage point. For the first part of the 2000s, they vary between 0.4 and 0.9 percentage points.

Even with the shorter observation intervals we see that as for the 10 year window case, for all five levels of u, a nearly trendless development in mobility from 1969 to 1991, followed by a period of rapid growth. In the period with falling top income shares, mobility was stable. From 1991, there is a steady increase in top income shares as well as in mobility. The change in mobility is gradual, going over several years, and is interrupted by decreases in 1995 and 2003. We see the highest effects at the top; $T(0.995)$, for example, increases from a pre-1990 level of 0.2 percentage points to more than one percentage point for the 2005-2007 period – an increase by more than a factor of five. $T(0.9)$, on the other hand, only increases by about 20%. In the mid-2000s, there is the spike discussed below in Section 3.6. After 2007, mobility recedes to previous levels. Our data end in 2011, when mobility was back at the levels of 1998 (for $T(0.999)$) to 2000 (for $T(0.9)$). Since the results are qualitatively similar for three- and ten-year windows, we use three-year windows in what follows in order to better capture short-term movements in mobility over time. However, we return to the issue of different window lengths in Section 3.4.

As stated in Section 2, while the level of the top income mobility curve reflects the degree of top income mobility, the slope represents the individual loss (or gain) from income mobility. For 1969-1989, the curve is relatively steep downwards sloping for the richest quantiles (high u), implying an individual at a high quantile in the three-year income distribution would experience a high income growth if moving to the same quantile in a hypothetical stationary cross-section distribution for the same three years.[8] However, except for the very richest, the curves for 1999 and 2009 are much flatter. We examine the development of $T'(u)$ over time in more detail in Figure 6.

[8] The top income mobility curves for the top half of the distribution (u>0.5) are given for selected years Appendix D.

Figure 5 Top income mobility, selected quantiles Norway 1967-2011, using three-year windows

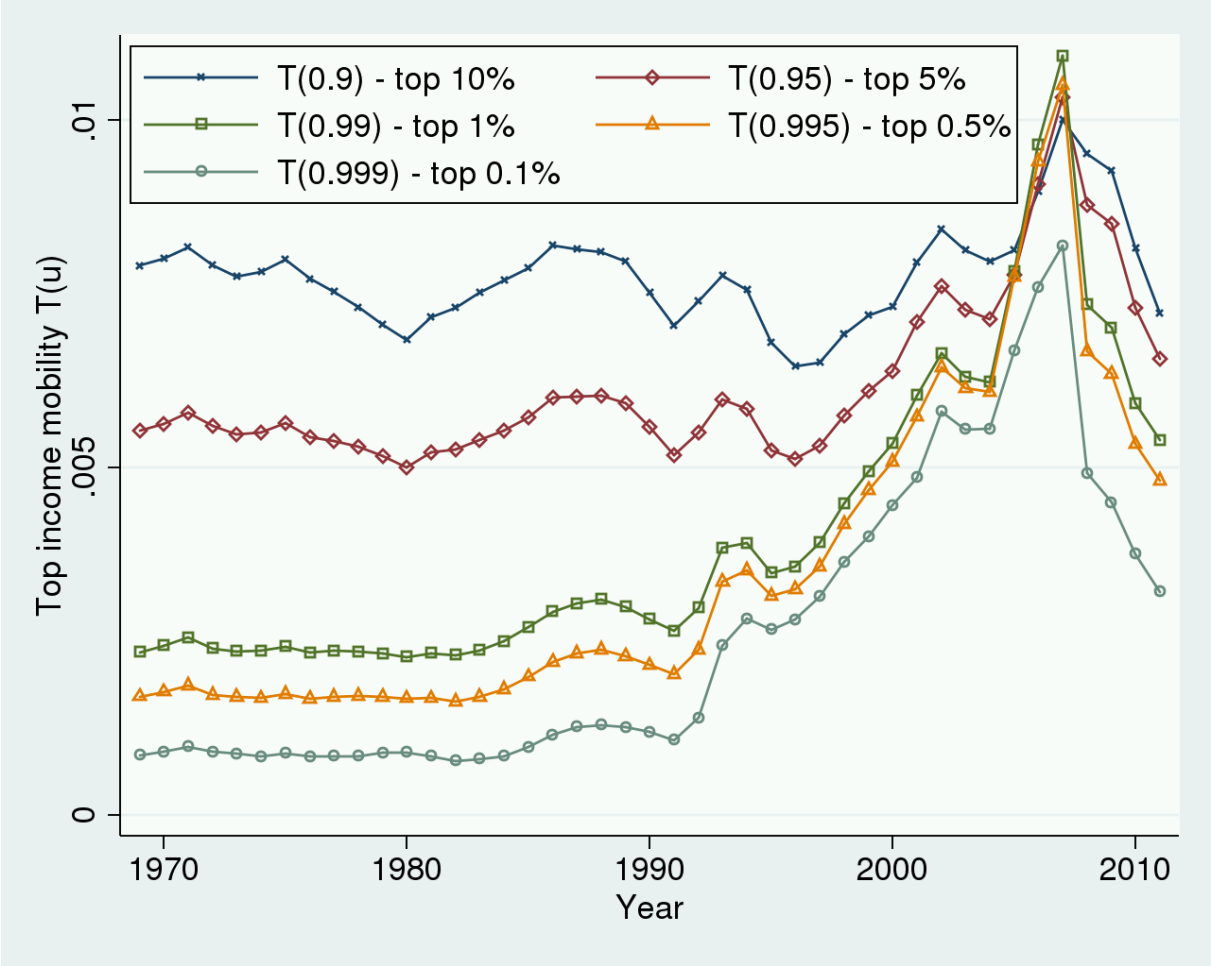


Figure 6 Derivatives of top income mobility curves based on three-year windows Norway 1969-2011

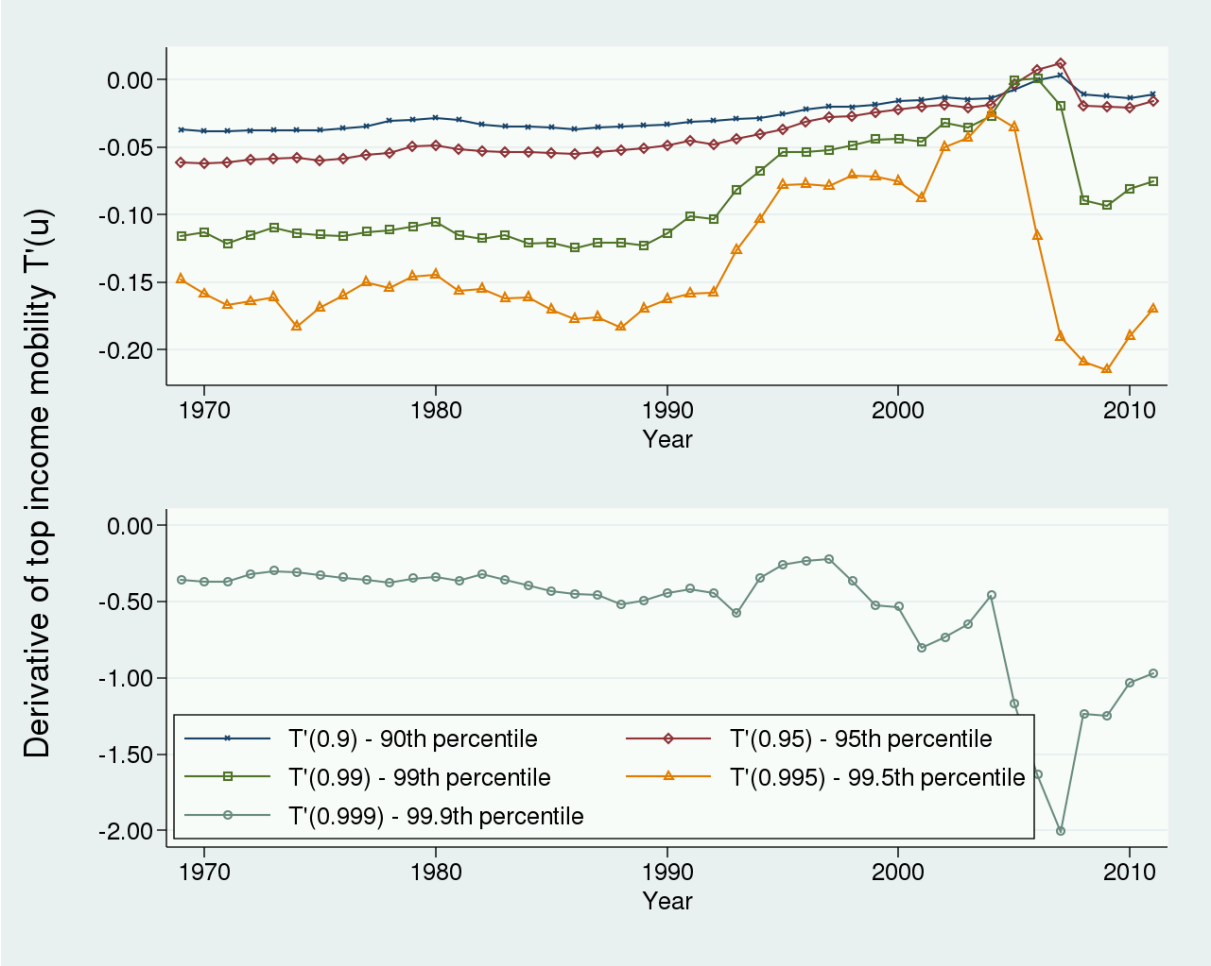


Figure 6 shows the stable time trend in losses from income mobility among the rich over time for five points near the top of the income distribution. Both the level and slope of the top income mobility curve did not change much in the first part of the period, from 1969 to the early 1990s. For example, in 1969, the slope of T at u=0.90 was minus 3.7 per cent – the "loss" for the individual at the 90th percentile divided by the overall mean income of the entire population. For the 99.5th percentile this loss was 14.8 per cent of the overall mean income. The higher share for the very richest reflects both the higher average incomes and the comparatively larger movements in and out of this very small group. From 1993 onward, the TIM curve becomes much less steep, as shown by higher values of $T'(u)$, in particular for the top 1 and 0.5 per cent. Contrasting these features with the increasing $T(u)$ curves shown in Figure 5, we get a broader picture of how mobility changed. While $T(u)$ summarizes changes in the difference of income shares above u, $T'(u)$ is equal to the difference between permanent income and hypothetical (no mobility) income for an individual at the u-quantile. Figure 6 shows that increasing mobility in the 1990s mainly took place at the very top (u=0.999), while the changes in the

last decade affected the top 1 per cent. At u=0.999, the slope of the *T* curve is very steep; $T'(u)$ is nearly always twice as high as for *u*=0.95. For this reason, the development over time is shown separately in the lower panel of Figure 6. There is a slight decrease in the slope from 1969 to 1993. After this, the change is similar to that observed in the upper panel. However, the subsequent decrease, first to the trough of 2001 and then to that in 2007, gives extremely low values. For 2005-2007 (t=2007 in the figure) the loss from mobility for the individual at the 999th per mille was twice the average income in the population. This reflects the large replacement of the very richest after the tax reform, as mentioned above. While "twice the average income" seems like a very high income, we should remember that the average income of the 1 per mille richest is much higher than that – in 2005, this group had on average more than fifty times the income of the average individual. These results show that most of the changes in mobility in the 2000s took place at the very top (1 % and above), and that this also drives a substantial part of the changes in top income mobility at the top 5% and top 10%.

3.3. Dominance results

This section examines whether it is possible to achieve a complete ranking of top income mobility when we compare the various three-year periods. First, we can examine first- and second-degree dominance, as defined in Section 2.2. By the first-degree dominance criteria of Definition 2.1, we find unambiguously increasing mobility in the early 1980s.[9] 1980 is dominated by the next nine top income mobility curves; 1981 by six out of seven, and 1982 by five out of six. The next unambiguous change is the decreasing mobility of the early 2000s, where 2002 dominates 2003 and 2004. Then, the increasing mobility in the mid-2000s is shown by 2005 and 2006 being dominated by 2007.

When we introduce the weaker second-degree downwards dominance criterion, we also find increasing mobility from 1970 to 1971, and several episodes of decreasing mobility in the early 1970s and late 1980s. The increase of the late 1990s is very robust, with for example 1997 being dominated by all subsequent years. The decrease from 2008 to 2009 is also unambiguous. However, there are still some periods where there is not second-degree dominance, such as when comparing the very early with very late periods. We therefore turn to the summary measures $\tilde{\theta}_k(a;T)$, defined in Section 2.3.

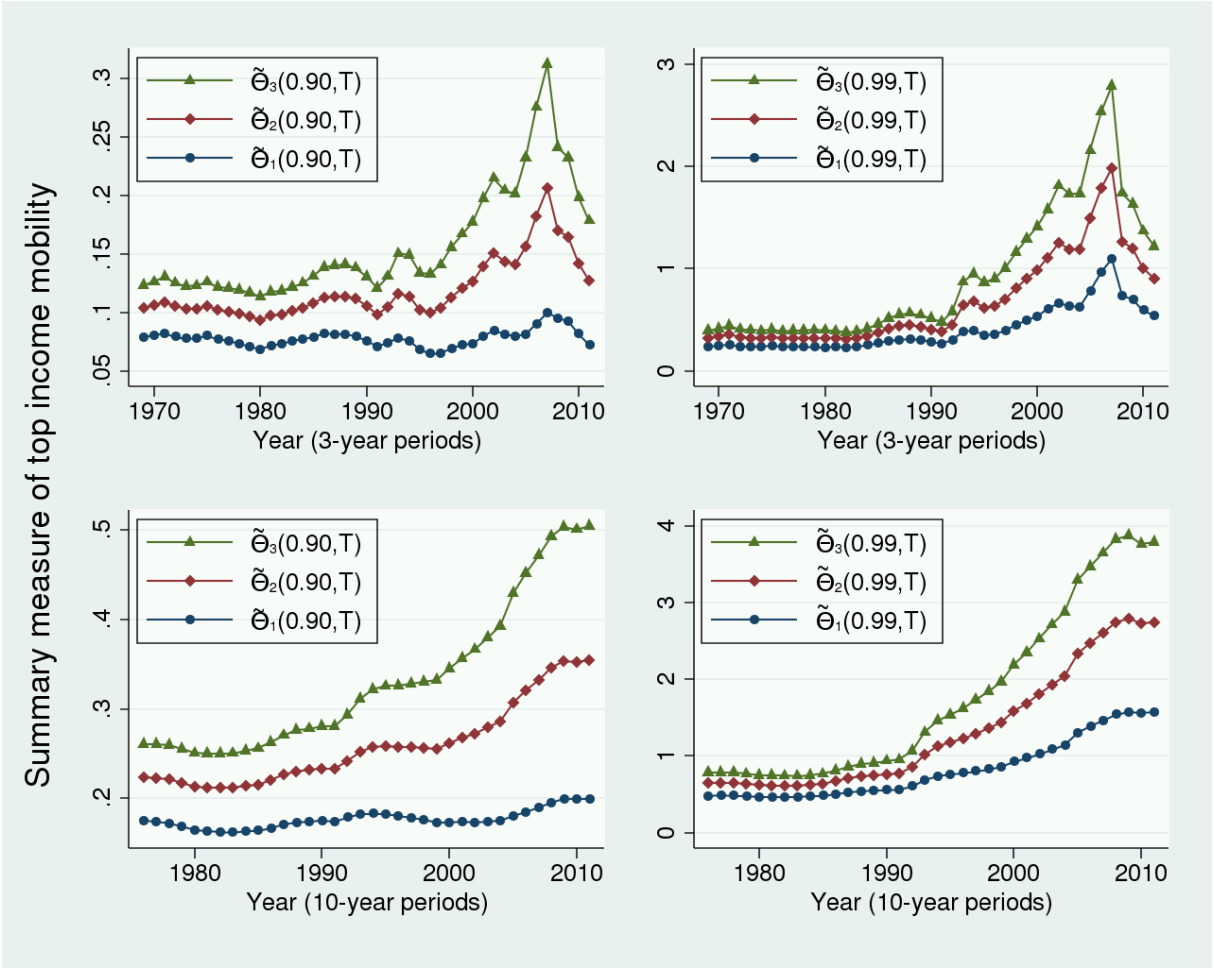
[9] Because there is a lot of volatility in *T* at the very top, Definitions 2.1 and 2.2 are applied only in the interval [0,0.99]. The integrands in 2.2 are however summed all the way up to 1. This implies that in some cases, first-degree dominance can be stricter than second-degree dominance. This is indeed the case in a small set of year comparisons, but does not affect the results to any substantial degree. Detailed tabulations of the year comparisons are available on request.

For this purpose, we have to decide on the field over which mobility is being measured: i.e. the value of *a*.

The two top panels of Figure 7 show the evolution of the summary measures $\tilde{\theta}_k(a;T)$ for three values of *k* and two values of *a*. For the top 10 per cent ($\tilde{\theta}_k(0.9;T)$), we see that the direction of change in mobility differs depending on the choice of weight function (the choice of *k*). For *k*=1 mobility is, as measured by a relative income gap, found to have been rather stable over the entire 45 years period, whereas $\tilde{\theta}_k(0.9;T)$ for *k*=2 and 3 stayed stable until the early 1990s when these measures rose sharply until 2005 and then declined. Since $\tilde{\theta}_k(0.9;T), k = 2,3$ can be decomposed with regard to the relative gap measure $\tilde{\theta}_1(0.9;T)$ and a measure that captures the reduction in relative spread of permanent incomes of the top 10 per cent that is due to mobility, we get that the change in mobility from the early 1990s is solely due to the change in spread among the top 10 per cent people. The magnitude of $\tilde{\theta}_1$ is approximately 0.08 over the entire period. This means that mobility has reduced the mean permanent income of the top 10 per cent by 8 per cent of the overall mean income or between 2.4 and 3.2 per cent of mean income for the top 10 per cent (for a top income share between 25 and 33 per cent). For *u*=0.99 (the top one per cent) there was an unambiguous increase in mobility from the early 1990s and onwards for all three values of *k*. Since $\tilde{\theta}_2$ rose more sharply than $\tilde{\theta}_1$ and $\tilde{\theta}_3$ rose more sharply than $\tilde{\theta}_2$, it follows that increased spread among the richest people drove the increase in top income mobility in this period. The magnitude of $\tilde{\theta}_1$ is approximately 0.25 from 1967 to 1990, which means that mobility reduced the mean permanent income of the top 1 per cent by 3 to 5 per cent of the mean income for the top 1 per cent. Thus, although mobility was higher among the most affluent people top income mobility cannot be considered to have been large over this period.

The lower two panels of Figure 7 show the summary measure when we measure income over ten instead of three years; the relative levels and development over time are similar to the three-year windows, except for the final decrease which is too short to appear in the ten-year windows. Note that the "losses" due to mobility measured by $\tilde{\theta}_1$ is shown to be approximately twice what we found for the three-year periods. We also observe that the mobility measure is more sensitive to the changes induced by the 2005 tax reform when the weight *k* is higher; this is again because the tax reform mainly concerned the top income earners.

Figure 7 Summary measures of top income mobility Norway 1969-2011, based on three- and ten-year windows



3.4. The sensitivity to time horizon

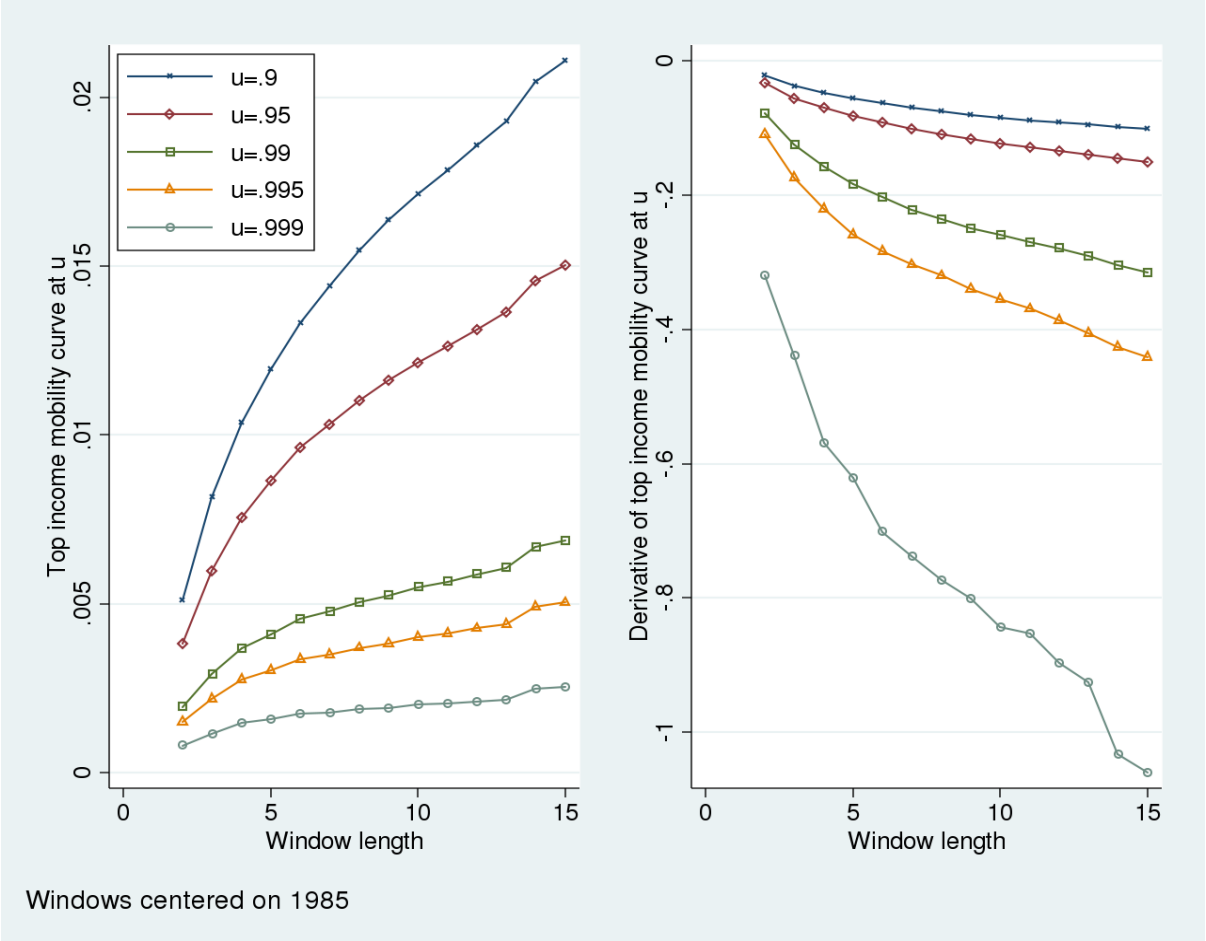
So far, we have looked at top income mobility over 3- and 10-year horizons. To verify that the results do not depend on these particular window lengths we provide mobility estimates for r varying from 2 to 15. The left panel of Figure 8 shows values for $T(u)$. with observation windows centered on 1985 (or 1985.5 in case of even-numbered horizon lengths). When the horizon length is increased, mobility goes up. One way of understanding this increase is that when we compare the cross-section and long-term income top income shares over more years, there are more income paths that cross over time. There is also the time-averaging effect, where longer intervals include the early 1990s that are more volatile. The increase in mobility is most visible for the top 10%, where we see an increase from 0.5 percentage points to 2.1 percentage points. For the top 0.1%, the increase is from

0.07 percentage points to 0.25 percentage points, which means that top income earners roughly speaking maintain their positions in the cross-sectional income distributions over time.

The right panel of Figure 8 shows how the loss from income mobility T'(u) changes with window length. Here it is also the case that the effects become stronger with longer windows - the loss grows as *r* moves from 2 to 15. Here the effects are strongest at the top, with T'(0.999) - the loss for the top 0.1% - varying from 32 to 106 per cent of the overall mean income. The latter case means that the top 0.1 per cent income share over 15 years would have increased from 0.76 per cent to 1.01 per cent if there were no mobility.

The time series of top income mobility with ten-year (Figure 4) and three-year (Figure 5) windows are consistent in terms of long-run trends. However, the levels are different, and by averaging over more years, the short-term variations in mobility, such as the peak in 2005-2007, do not stand out as much.

Figure 8 Top income mobility based on 2- to 15-year averages centered at 1985 (for odd numbers) and 1985-1986 (for even numbers) Norway



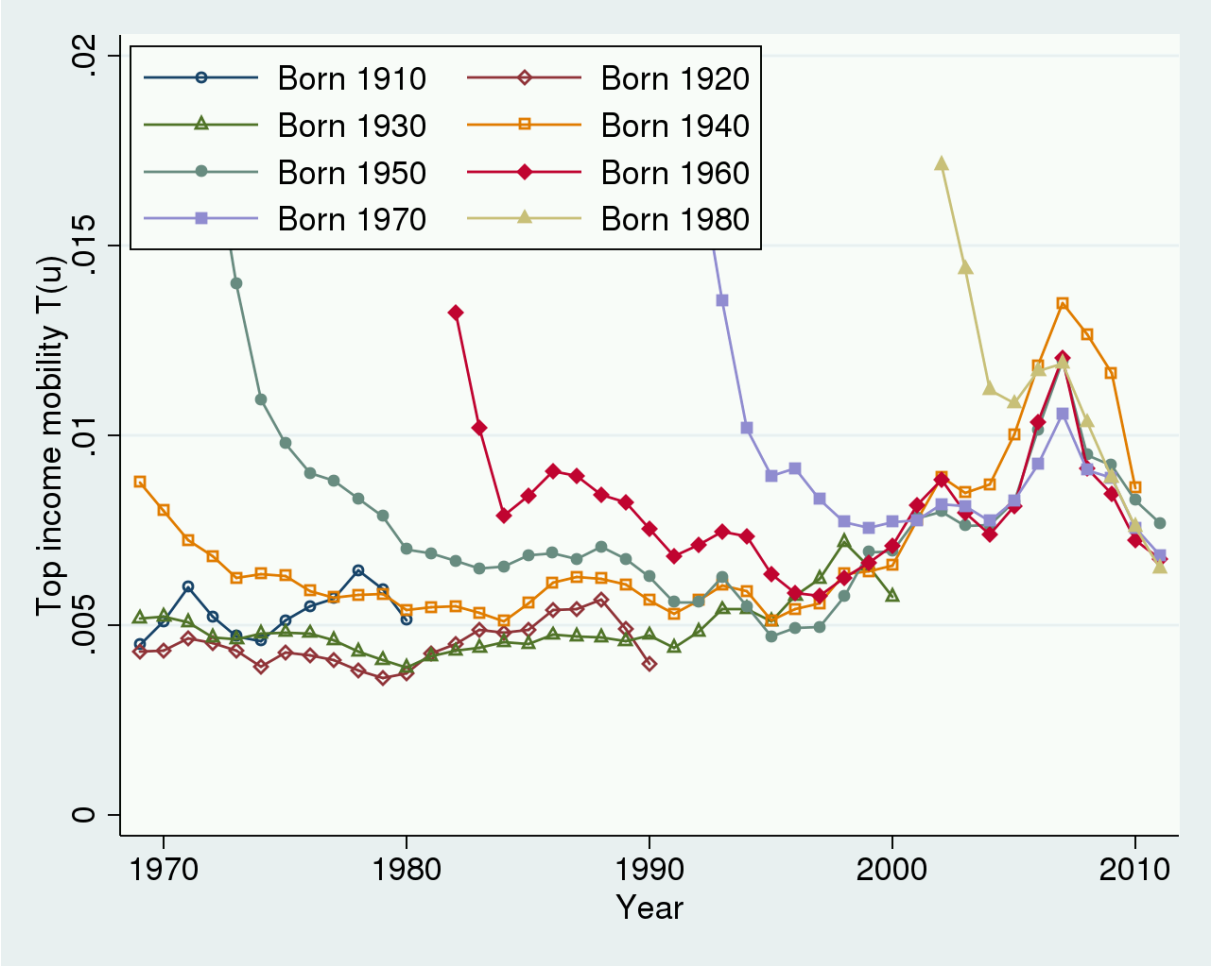
3.5 Top income mobility over the life-cycle

Can the change in mobility after 1990 be caused by a demographic bulge? Norway had a low birth rate from 1930-1945 followed by a high birth rate after 1945, as had many other Western countries. Perhaps the reaching of "mature age" by the late-1940s cohorts was responsible for the increase in top income shares and mobility? To study this question, we split the sample into different cohorts, and study them separately. Figure 9 contains T(0.95) levels based on rolling three-year windows within separate cohorts; for ease of presentation, only every tenth cohort is shown. Further evidence is presented in Appendix E.

From the figure, it is evident that the increase after 1990 takes place among all cohorts, as does the decrease after 2005. In addition, we observe that the level of T(0.95) within cohorts is not

very different from T(0.95) for the entire population. We do, however, see a clearly pronounced life-cycle effect. The curves start when individuals are 20 (covering incomes from 18, 19 and 20 years of age) and in these early years mobility is very high. In the first years, the low-educated have much higher income than those still in school; as the higher-educated enter the labour force there is a lot of re-shuffling of the income distribution. Interestingly, we do not see this for the people at the very top (for example the top 0.1%; see appendix figure), suggesting that at the very top, incomes are to a larger extent inherited rather than earned. The life-cycle profiles also show a small "hump" around the ages 60-70. Individuals retire (with associated income loss) at this age, but at different times, leading to changes in the ranking of individuals by income. At age 70 (the curves end at 70-72), this effect has passed as pension incomes are relatively stable. Besides these start and end effects, the main drivers described in the previous section appear to dominate.

Figure 9 Top income mobility of the 5 per cent richest in selected cohorts Norway 1967-2011



3.6 Mobility and the 2005 tax reform

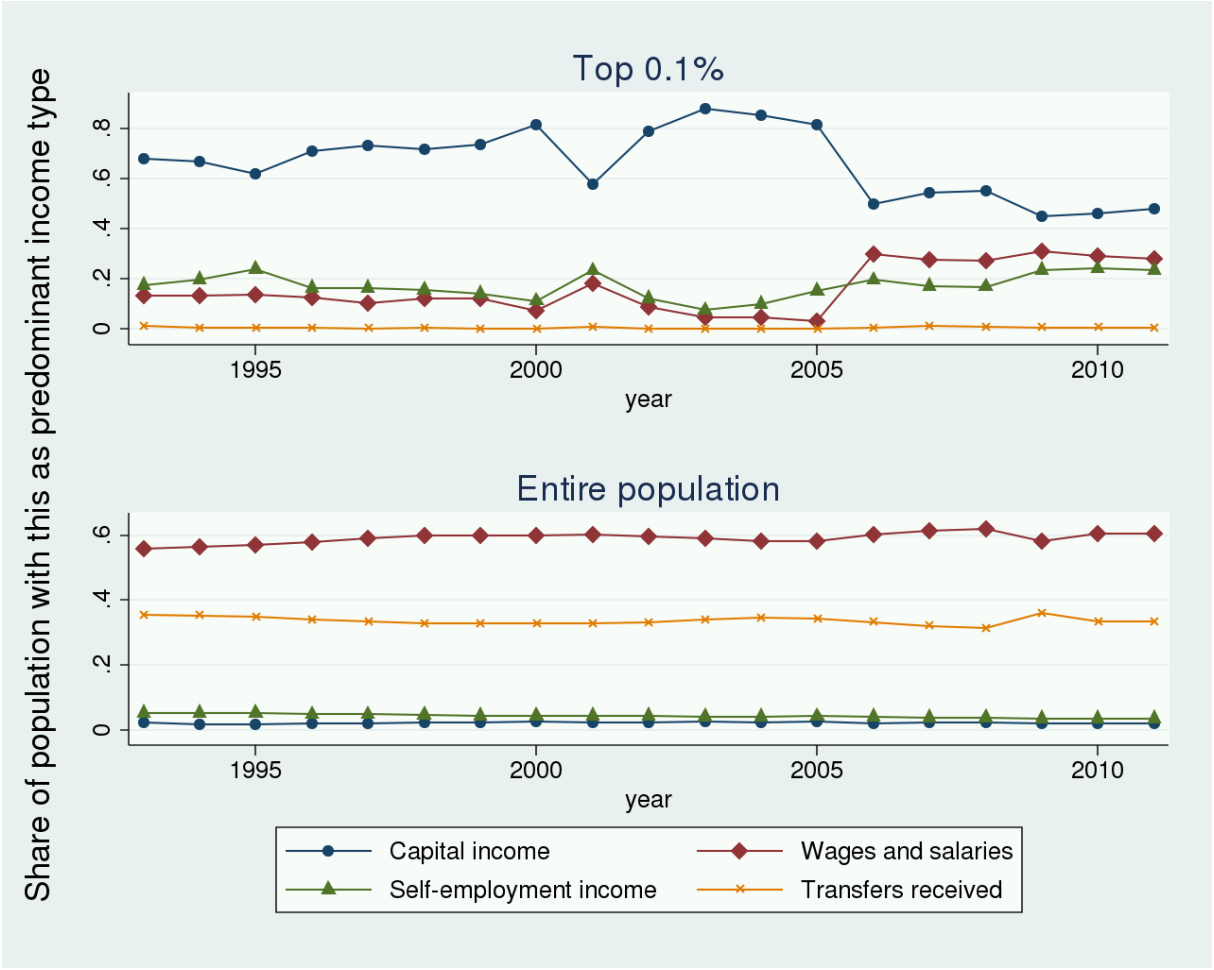
A striking feature of the behaviour of top shares in Figure 1 is the spike in 2005. This spike is first and foremost due to the implementation of a tax reform in 2006, where taxes on dividends increased from 0 to 28 per cent. Thus, the rise in top shares in 2005, and the subsequent fall in top income shares from 2005 to 2006, is largely due to a change in the income reporting behaviour. As Figure 5 shows top mobility calculated with rolling three-year windows, the 2005, 2006 and 2007 calculations are affected. A large part of the previous top income earners long-termly adjusted their income through legal means such as for owner-managers of closely held firms to increase dividends in 2005 (the tax on dividends was to be increased in 2006 from 0 to 28 per cent), and the low permanence of the top income population suggests that this adjustment persisted after 2006.

As stated earlier, we base the estimates in this paper on income as officially defined by the tax authorities. Even so, it is useful to examine in more detail how the 2005 reform affected the reported incomes of individuals at the top of the income distribution. To this end, from 1993 onwards, we can make use of more detailed data on income composition from the tax records. Income is decomposed into wages and salaries, net self-employment income, net capital income and net transfers. We then classify individuals according to which type of income constituted the largest share of total income in any given year, and then show the population by largest income component in the lower panel of Figure 10. It is evident that there is not much change over time: around 60 per cent of the population get their main income from wages and salaries, around 35 % from transfers (the majority of these are retirees receiving public pensions), while less than six percent have self-employment income as the most important source and less than three per cent have capital income.

We then turn to the income composition of the richest 0.1 per cent. Until 2005, between 60 and 80 per cent of this group has their main income from capital, while an additional twenty per cent have their main income from self-employment. There is a one-year change with the tax reform in 2001, where the "usual" top income holders choose not to realize capital income as a tax adjustment. However, 2002 looks similar to 2000.

The reform of 2005, however, changes the composition of top income earners permanently. Many capital-income earners disappear from the top 0.1 per cent - in 2005, 81 per cent of the top 0.1 per cent derived their largest income component from capital, down to 50 per cent in 2006 and a maximum for the post-reform period of 55 per cent in 2008. Self-employment income is largely unaffected, while wages and salaries increase. In the years before 2005, around 40% of the top 0.1% in any given year was also there the year before. In 2006, however, this number is down to 19%, and the previous top income holders do not return in the subsequent years. Around nine per cent of the top 0.1% in 2005 report incomes in the bottom decile in 2006; among the rest, most are found from the eighth decile upwards. The "new" recruits into the very top from 2006 onward mainly come from the top 10 %, showing that the high mobility in this year is caused by an exit of a group of capital income earners rather than a radical upward mobility of some particular group. Moreover, the threshold to enter the top 0.1 percent was much higher than usual in 2005 (as was the overall mean income), possibly reflecting artificially high reported incomes in this year. Correspondingly, the top 0.1 threshold in 2006 was lower than usual; in fact, this is the only year in which individuals in the top 0.1 on average held lower incomes than they did the year before.

Figure 10 Proportion of individuals by largest income component for the top 0.1 per cent and the entire population Norway 1993-2011



4. Conclusions

This paper has sought to make two contributions to the study of top income mobility. The first is to provide a theoretical framework, introducing the "top income mobility curve" and a family of associated summary measures for comparing income distributions with regard to the extent of income mobility, when mobility is defined to accommodate the notion of top income mobility as an equalizer of long-term income among top income earners. The second is to provide empirical evidence about the extent of mobility, and changes over time, in Norway from 1967 to 2010. We have identified two major changes in top income mobility. First, there was a steady increase in top income mobility from the early 1990s and onwards. For the top 0.1 per cent, mobility increased from 0.11 percentage points

in 1991 to 0.58 percentage points in 2002. This can be explained by the general increase in top incomes in this period mainly due to the liberalization of the capital market. Second, there was a large spike in top income mobility in 2005, in anticipation of the 2006 tax reform. For the top 1 per cent, top income earners mobility increased from 0.6 percentage points in 2004 to 1.1 percentage points in 2007, and returned to the 2004-level in 2011. Still, we found a permanent change in the identity of the top income earners after the reform. In the years leading up to the change in tax reporting incentives, capital income was the largest income component for 80 per cent of the top 0.1 per cent. After the reform, approximately 50 per cent of the top 0.1 per cent had capital income as their most important component.

Within-cohort top income mobility at the top 5 per cent shows to be very high at young age, when individuals enter the labor market, but decreases steeply until around age 25 and then slowly until age 45. This within-cohort pattern is remarkably stable over time, though the aggregate trends in top income mobility emerge for each of the cohorts. For the very highest income shares, there is no clear within-cohort pattern. This likely reflects different across-generation transmission methods; education and self-made successes among the moderately well-off such as the top 5 per cent and inheritance among the top 0.1 per cent.

The estimated summary measures of top income mobility show that the development of overall top income mobility varies with the chosen weight assigned to the most affluent people. While short-term mobility is shown to be stable when the mobility measurement only captures the effect on the mean permanent income of the top 10 per cent, the summary measures that account for the effect on the spread of permanent income of the top 10 per cent show an increase in mobility during the 1990s. This means that increases in top income mobility have been larger among those with very high incomes.

Even though there were large changes in top income mobility over the last four decades, the magnitude of the effect of the changes in mobility on the income shares was moderate. When income is averaged over three years, the difference between long-term and cross-section income of the top 10 per cent only reached one percentage point once during the 42-year period. Increasing the number of years over which incomes are averaged does, as expected, increase the level of mobility. Changes over time, however, are robust also to the choice of accounting period.

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Appendices (Intended for online publication)

Appendix A: Data sources for top shares and updating estimates to 2011

The construction of top shares updates that in Aaberge and Atkinson (2010), where a fuller description of the underlying methods is given. Total income for the top x per cent is constructed from the income files using "ordinary incomes". Unlike the data used in this paper, the control total in the long series presented in Figure 1 (and available in the World Wealth and Income Database) is constructed from total household income in the National Accounts (a constant 72 % share of the total). As the National Accounts are periodically revised, the updating process has resulted in small changes in the historical numbers back to 1978. For the years prior to 2002, this difference is always less than 0.4 percentage points. For the later years the revision is somewhat higher. The revised control totals are given in Table A.2.

In addition to the updating to 2011, new data have been added for 1892 to 1903 (see Table A.1 for the sources).[10] For some years, the threshold is too high to reliably estimate the income shares for the top 10 %. New control totals, using the same methodology as reported by Aaberge and Atkinson (2010), are given in Table A.2.

The resulting series for top shares over the period 1875 to 2011 is given in Table A.3.

[10] We are most grateful to Facundo Alvaredo for pointing out the existence of these data.

Table A.1 Sources of top income shares

Year	Source	Comparison to A&A (2010)
1875	Ot. Prp. 11 (1881), pp. 20-25	Same
1888	St. Prp. 48 (1890), p. 42 and 122	Revised (new source)
1892	Ot. Prp. 39 (1893), vol. 3B	New source
1893	St. Prp. 91 (1894), vol. 2B	New source
1894	St. Prp. 112 (1895), vol. 2B	New source
1895	St. Prp. 104 (1896), vol. 2B	New source
1896	St. Prp. 89 (1898), pp. 24-31	Same
1897	Statsskattens fordeling 1892/93-1898/99	New source
1898	Statsskattens fordeling 1899/00-1905/06	New source
1899	Statsskattens fordeling 1899/00-1905/06	New source
1900	Statsskattens fordeling 1899/00-1905/06	New source
1901	Statsskattens fordeling 1899/00-1905/06	New source
1902	Statsskattens fordeling 1899/00-1905/06	Revised (new source)
1903	Statsskattens fordeling 1899/00-1905/06	New source
1906	Rygg (1910), p. 50 and 69	Same
1910	NOS VI.57 (1915), p. 29*	Revised (new source)
1913	NOS VI.57 (1915), p. 30*	Same
1929	Statistisk Årbok 1936, p. 11	Same
1938	Statistiske Meddelelser 1941 (11-12), p. 333	Same
1948 to 1977	See Aaberge and Atkinson (2010)	Same
1978 to 2007	See Aaberge and Atkinson (2010)	Minor adjustment to control total (Revised NA)
2008 to 2011	Statistical registers and National Accounts	New data

Table A.2 Revised control totals

Control totals for new years, based on Old Definition of Private Income	
	MNOK
1892	490
1893	500
1894	503
1895	514
1896	538
1897	560
1898	606
1899	638
1900	668
1901	657
1902	652
1903	648
2000	697 332
2001	731 486
2002	789 216
2003	828 107
2004	854 120
2005	918 359
2006	908 676
2007	1 005 373
2008	1 110 046
2009	1 138 789
2010	1 184 684
2011	1 255 926

Table A.3 Annual top income shares, all observations

	10 %	5 %	1 %	0.50 %	0.10 %
1875	40.00 %	31.74 %	18.37 %	14.37 %	7.89 %
1888	48.93 %	36.72 %	20.53 %	15.51 %	
1892	45.95 %	35.60 %	20.48 %	15.91 %	
1893		35.26 %	20.14 %	15.65 %	
1894		35.54 %	20.52 %	16.01 %	
1895		35.46 %	20.51 %	16.03 %	9.08 %
1896			19.80 %	15.46 %	8.79 %
1897		34.99 %	20.35 %	16.00 %	
1898		35.35 %	20.79 %	16.42 %	9.44 %
1899		34.69 %	20.38 %	16.09 %	9.21 %
1900		34.23 %	20.18 %	16.02 %	9.43 %
1901		34.39 %	19.84 %	15.66 %	9.09 %
1902		34.60 %	19.71 %	15.41 %	8.90 %
1903		34.43 %	19.46 %	15.19 %	8.74 %
1906	42.19 %	32.36 %	17.98 %	13.99 %	8.03 %
1910	31.94 %	23.15 %	11.67 %	8.69 %	
1913	33.21 %	23.96 %	11.61 %	8.37 %	
1929	41.32 %	28.25 %	12.57 %	9.06 %	4.35 %
1938		27.56 %	12.72 %	9.38 %	4.56 %
1948	34.38 %	22.46 %	9.10 %	6.36 %	2.83 %
1949	34.02 %	22.14 %	8.88 %	6.20 %	2.74 %
1950	34.10 %	22.09 %	8.76 %	6.06 %	2.63 %
1951	32.31 %	20.80 %	8.16 %	5.67 %	2.51 %
1952	31.39 %	19.57 %	6.93 %	4.59 %	1.87 %
1953	33.08 %	20.49 %	7.14 %	4.67 %	1.83 %
1954	31.79 %	19.79 %	6.86 %	4.46 %	1.70 %
1955	32.61 %	20.37 %	7.20 %	4.76 %	1.90 %
1957	32.72 %	20.94 %	7.88 %	5.35 %	2.35 %
1958	34.72 %	21.91 %	7.76 %	5.09 %	2.01 %
1959	34.20 %	21.51 %	7.39 %	4.73 %	1.77 %
1960	32.17 %	20.06 %	6.94 %	4.44 %	1.62 %
1961	31.77 %	19.78 %	6.76 %	4.29 %	1.53 %
1962	32.20 %	19.87 %	6.57 %	4.11 %	1.42 %
1963	32.03 %	19.67 %	6.43 %	3.98 %	1.35 %
1964	31.45 %	19.30 %	6.28 %	3.88 %	1.31 %
1965	30.65 %	18.65 %	5.99 %	3.69 %	1.23 %
1966	31.05 %	18.89 %	5.99 %	3.66 %	1.20 %
1967	31.47 %	19.13 %	5.95 %	3.61 %	1.17 %
1968	31.31 %	19.05 %	5.92 %	3.58 %	1.16 %
1969	31.46 %	19.21 %	6.03 %	3.67 %	1.21 %
1970	30.29 %	18.57 %	5.95 %	3.66 %	1.23 %
1971	30.81 %	18.85 %	5.99 %	3.68 %	1.23 %

1972	30.32 %	18.48 %	5.82 %	3.56 %	1.18 %
1973	29.60 %	18.07 %	5.72 %	3.50 %	1.15 %
1974	28.93 %	17.60 %	5.56 %	3.41 %	1.15 %
1975	29.41 %	17.73 %	5.49 %	3.33 %	1.09 %
1976	29.73 %	17.78 %	5.39 %	3.23 %	1.02 %
1977	30.09 %	18.00 %	5.45 %	3.28 %	1.05 %
1978	27.22 %	16.28 %	4.93 %	2.97 %	0.94 %
1979	26.58 %	15.94 %	4.91 %	3.01 %	1.02 %
1980	25.26 %	15.06 %	4.60 %	2.82 %	0.98 %
1981	24.67 %	14.71 %	4.47 %	2.72 %	0.94 %
1982	24.36 %	14.50 %	4.43 %	2.72 %	0.97 %
1983	24.00 %	14.34 %	4.42 %	2.72 %	0.98 %
1984	23.57 %	14.13 %	4.39 %	2.72 %	1.00 %
1985	23.64 %	14.21 %	4.45 %	2.77 %	1.01 %
1986	23.11 %	13.93 %	4.37 %	2.72 %	0.99 %
1987	23.11 %	13.96 %	4.41 %	2.76 %	1.01 %
1988	22.73 %	13.75 %	4.33 %	2.69 %	0.94 %
1989	21.83 %	13.17 %	4.13 %	2.55 %	0.90 %
1990	22.19 %	13.47 %	4.28 %	2.66 %	0.93 %
1991	22.27 %	13.61 %	4.37 %	2.72 %	0.94 %
1992	23.27 %	14.82 %	5.38 %	3.58 %	1.50 %
1993	25.57 %	16.90 %	6.97 %	4.97 %	2.40 %
1994	26.91 %	17.87 %	7.43 %	5.30 %	2.53 %
1995	26.86 %	17.83 %	7.36 %	5.25 %	2.56 %
1996	27.84 %	18.65 %	7.96 %	5.79 %	3.00 %
1997	29.09 %	19.70 %	8.61 %	6.31 %	3.28 %
1998	27.96 %	18.79 %	7.99 %	5.77 %	2.86 %
1999	28.31 %	19.19 %	8.38 %	6.13 %	3.11 %
2000	30.45 %	21.36 %	10.31 %	7.89 %	4.40 %
2001	26.87 %	17.93 %	7.36 %	5.19 %	2.47 %
2002	28.90 %	20.15 %	9.61 %	7.35 %	4.16 %
2003	29.82 %	21.09 %	10.40 %	8.03 %	4.58 %
2004	31.70 %	22.70 %	11.62 %	9.15 %	5.49 %
2005	37.06 %	28.13 %	16.49 %	13.47 %	8.25 %
2006	28.22 %	18.97 %	7.86 %	5.56 %	2.62 %
2007	28.97 %	19.78 %	8.54 %	6.14 %	2.92 %
2008	27.11 %	18.34 %	7.70 %	5.45 %	2.49 %
2009	26.95 %	17.95 %	7.11 %	4.88 %	2.09 %
2010	27.99 %	18.81 %	7.74 %	5.44 %	2.50 %
2011	28.33 %	19.02 %	7.80 %	5.45 %	2.44 %

Note: Cross-section shares reported in this table are not the same that are used in calculation of top income mobility, as those are calculated on a sample restricted to those with incomes (or residence) *s* years in a row.

Appendix B: Proof of Theorem 2.1

Theorem 2.1:

Theorem 2.1. Let T_1 and T_2 be members of ***T***. Then the following statements are equivalent,

(i) T_1 second-degree downwards dominates T_2

(ii) $\theta_q(a;T_1) > \theta_q(a;T_2)$ for all positive non-decreasing convex function q where $q'(a) = q(a) = 0$.

The proof proceeds via Lemma 1 known from mathematical textbooks:

LEMMA 1. *Let M be the family of bounded, continuous and non-negative functions on* [0,1] *which are positive on* ⟨0,1⟩ *and let g be an arbitrary bounded and continuous function on* [0,1]. *Then*

$$\int g(t)h(t)dt > 0 \quad for\ all\ h \in M$$

implies $g(t) \geq 0 \quad for\ all\ t \in [0,1]$ *and the inequality holds strictly for at least one* $t \in \langle 0,1 \rangle$.

Proof of Theorem 2.1.

Using integration by parts and the fact that $q'(u) = q(u) = 0$, we have that

$$0 < \theta_q(u;T_1) - \theta_q(u;T_2) = \int_u^1 q(s)\,d\,(T_2(s) - T_1(s)) = \int_u^1 q'(s)(T_1(s) - T_2(s))\,ds = \int_u^1 q''(v)\int_v^1 (T_1(s) - T_2(s))\,ds\,dv$$

Thus, if (i) holds then $\theta_q(u;T_1) > \theta_q(u;T_2)$ for all positive non-decreasing convex q.

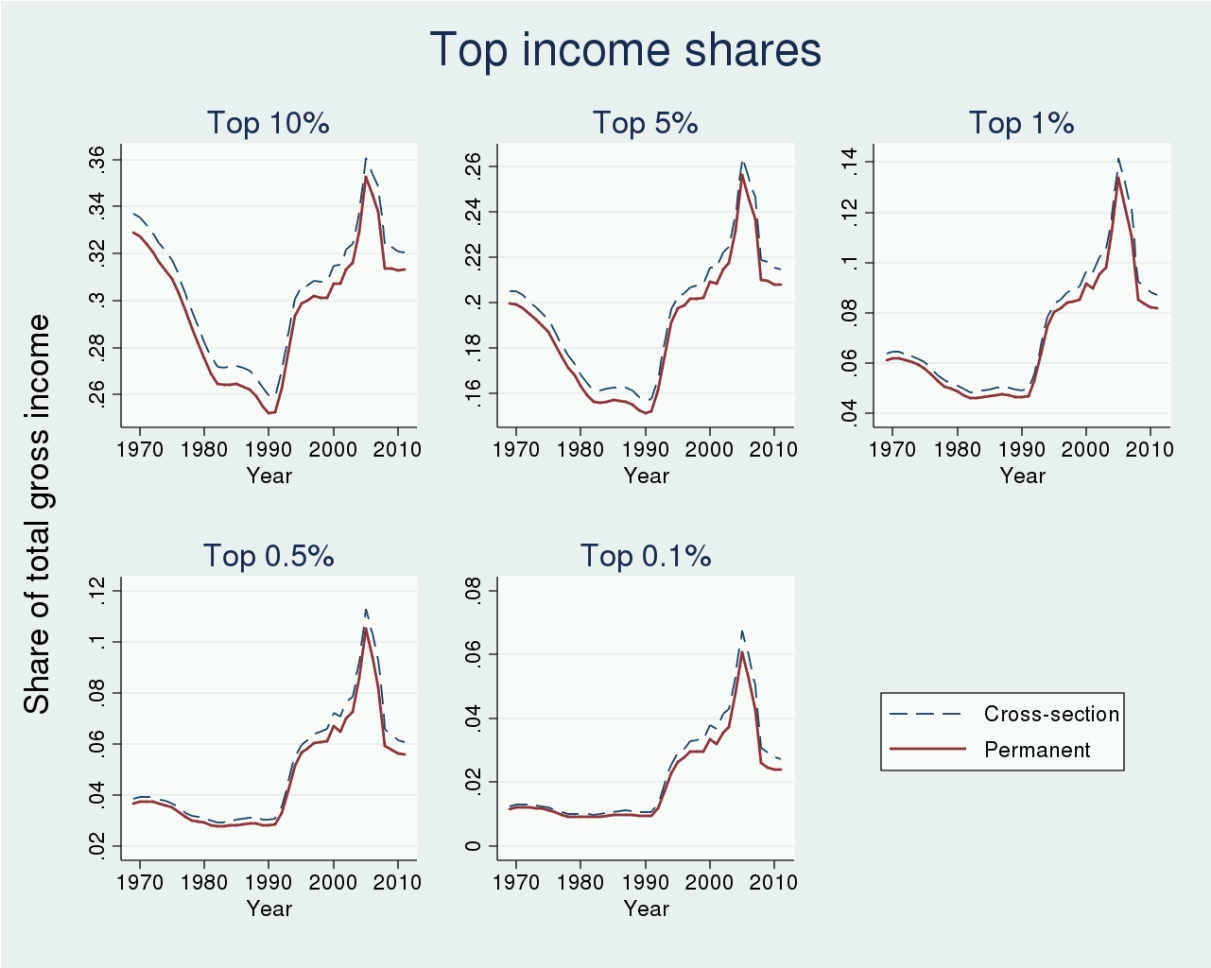
To prove the converse statement we restrict attention to all positive non-decreasing convex q where $q'(u) = q(u) = 0$. Hence,

$$0 < \theta_q(u;T_1) - \theta_q(u;T_2) = \int_u^1 q''(v)\int_v^1 (T_1(s) - T_2(s))\,ds\,dv$$

and the desired result it obtained by applying Lemma 1.

Appendix C : Cross-section and permanent top income mobility, three-year windows

Figure C.1: Cross-sectional and long-term top income shares (three-year averages). 1967-2011



Appendix D: The top income mobility curve for u>0.5

The level of top income mobility given in the figures in the main text is for selected points on the top income mobility curve. We can draw this curve for all values of $u > 0.5$, as is shown in the figures below for selected years. The intersections of the lines to the right in Figure correspond to the crossing of the time trends in Figure 5, which covered the top 10 per cent. To the left of the intersections, covering broadly the range from the median to the top decile, the direction of movement is different. The curve for 1999 lies below those for earlier years and the curve for 2009 above that for 1999 but below those for earlier years for much of the range down to the median.

Figure D.1 Top income mobility curve T of the upper half of the distribution for selected three-year windows Norway 1967-2011

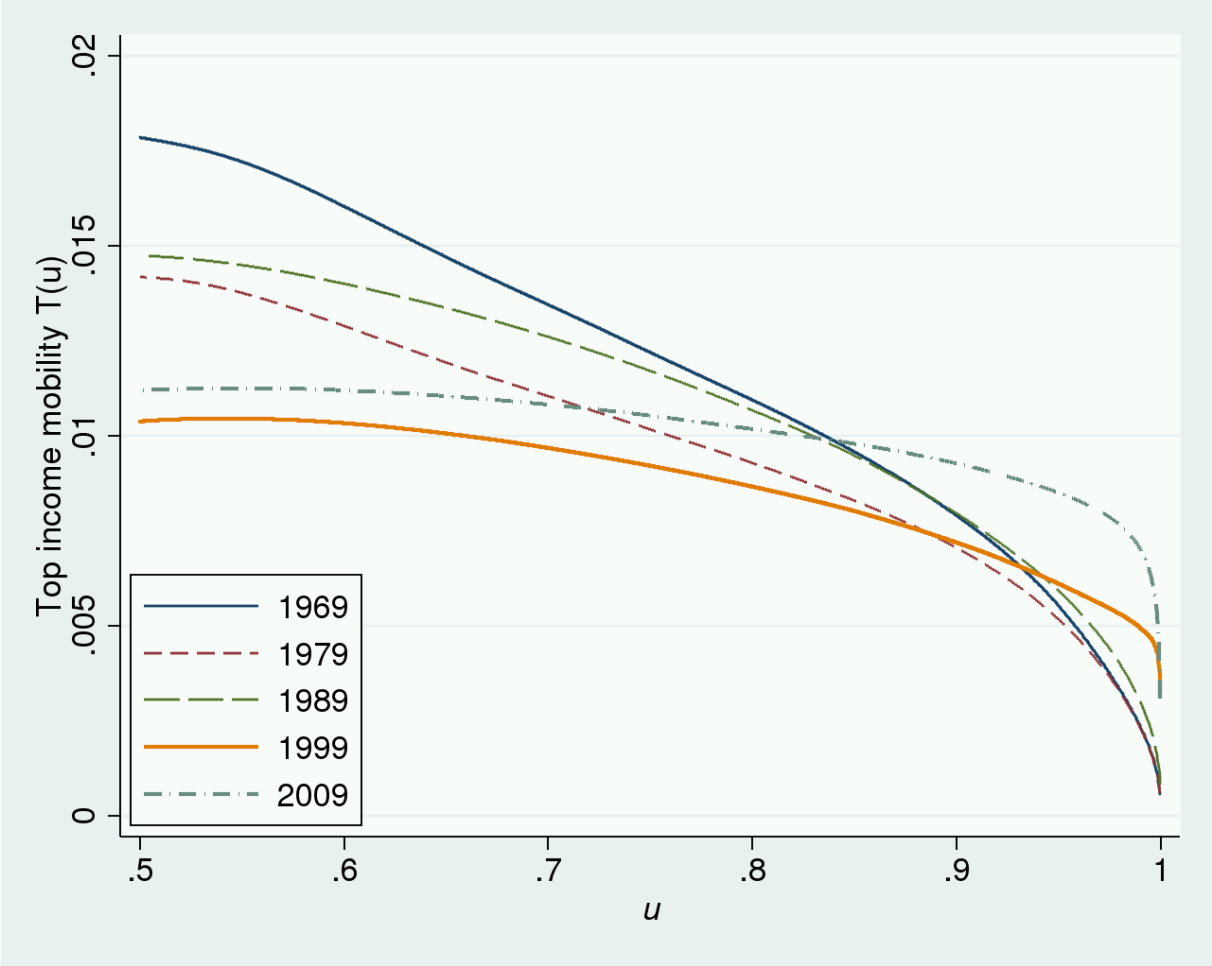
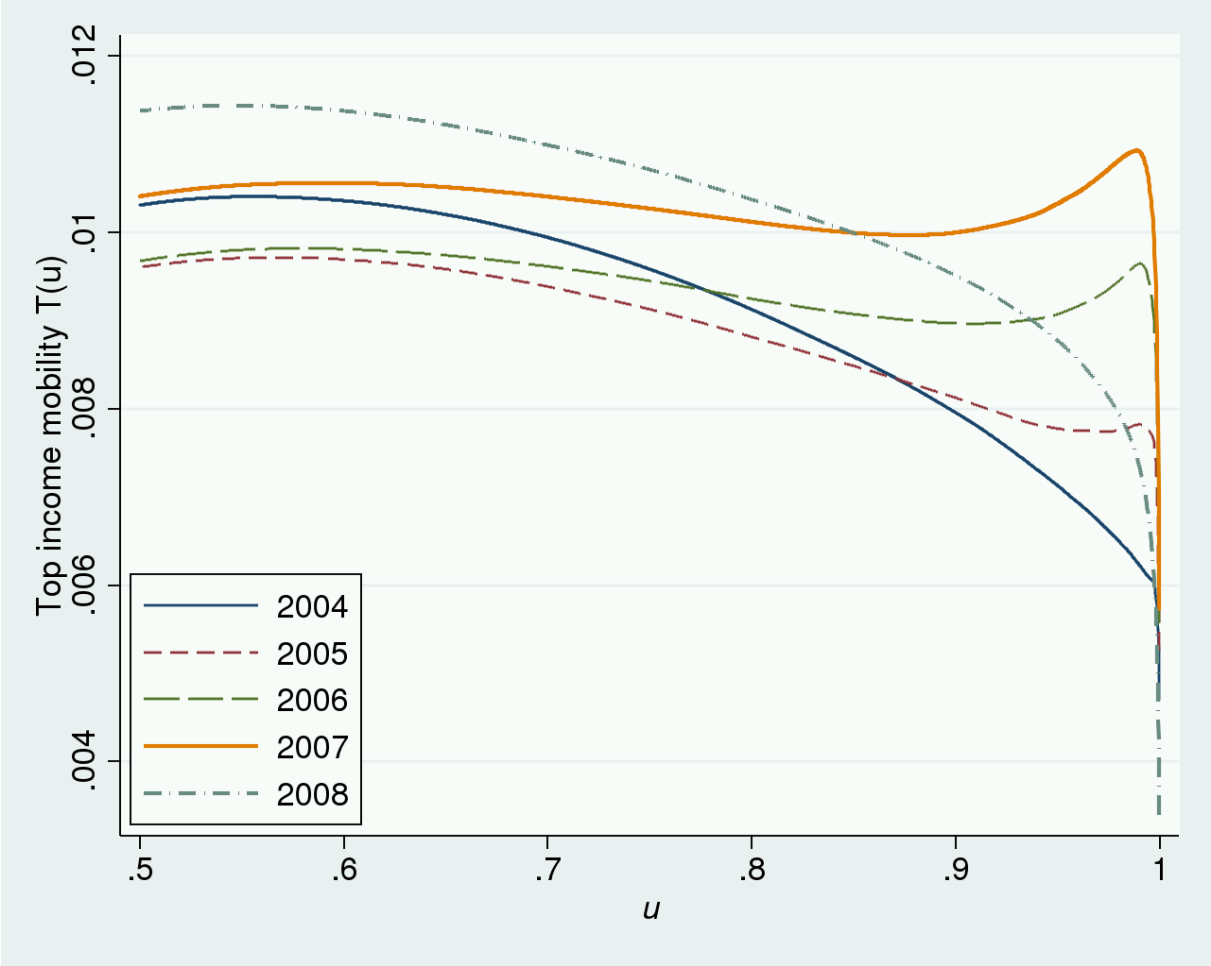


Figure D.2. Income mobility curve (*u>0.5*), three-year windows, Norway 2004-2008



Appendix E:Top income mobility by cohort, additional figures

Figure E.1 Cohorts, top 0.1 % (u=0.999) Norway 1967-2011

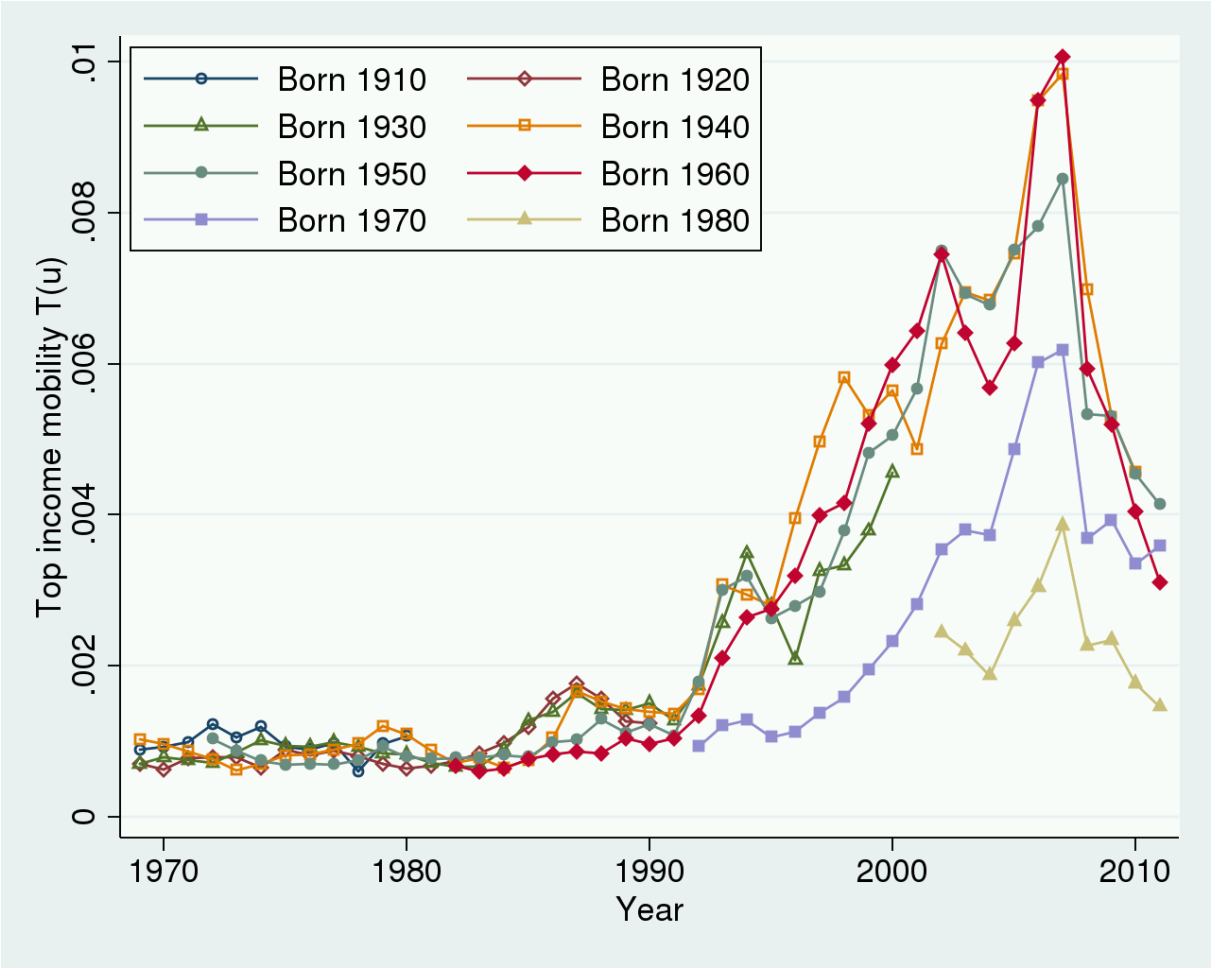


Figure E.2 Top income shares within cohort, top 5% Norway 1967-2011

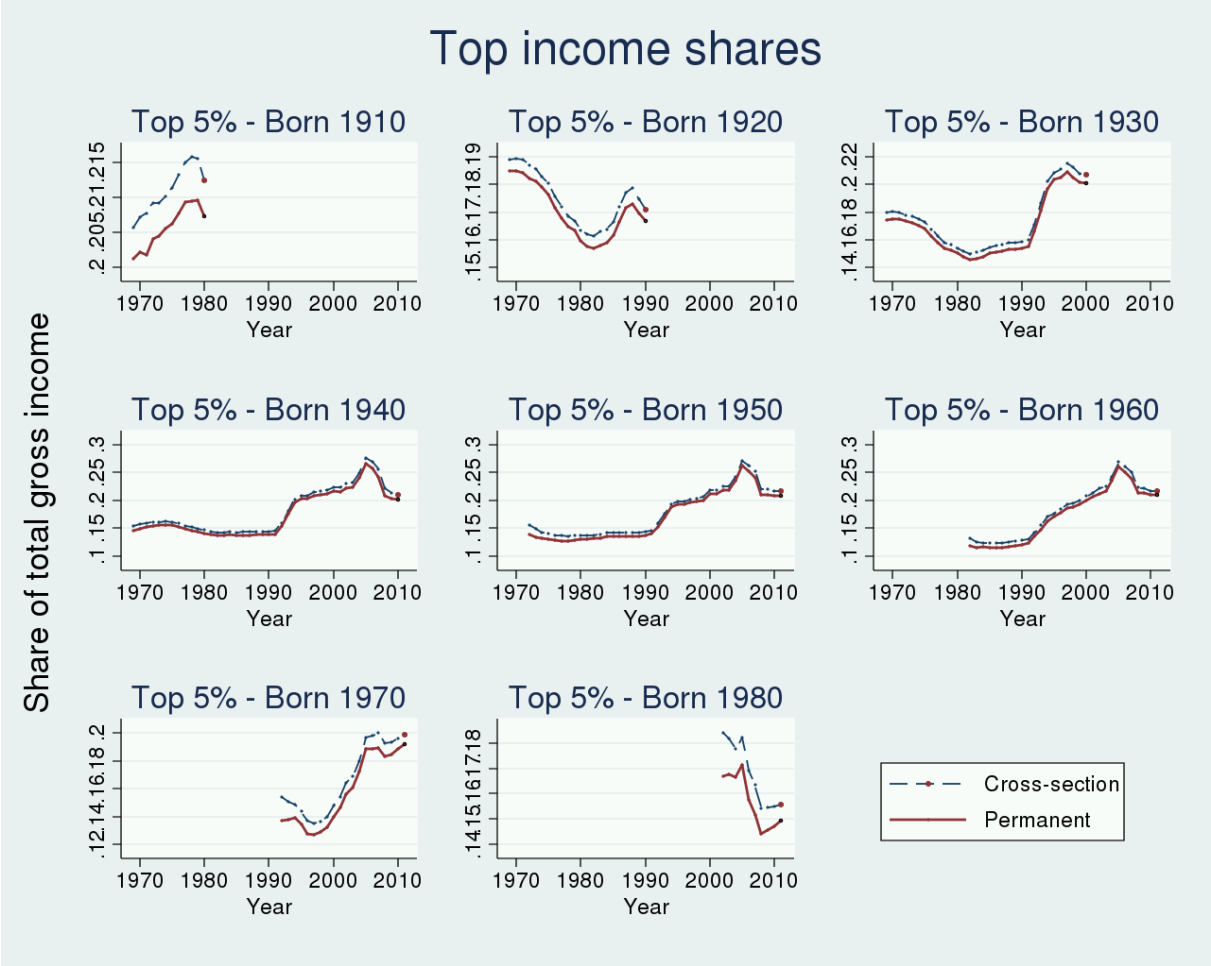
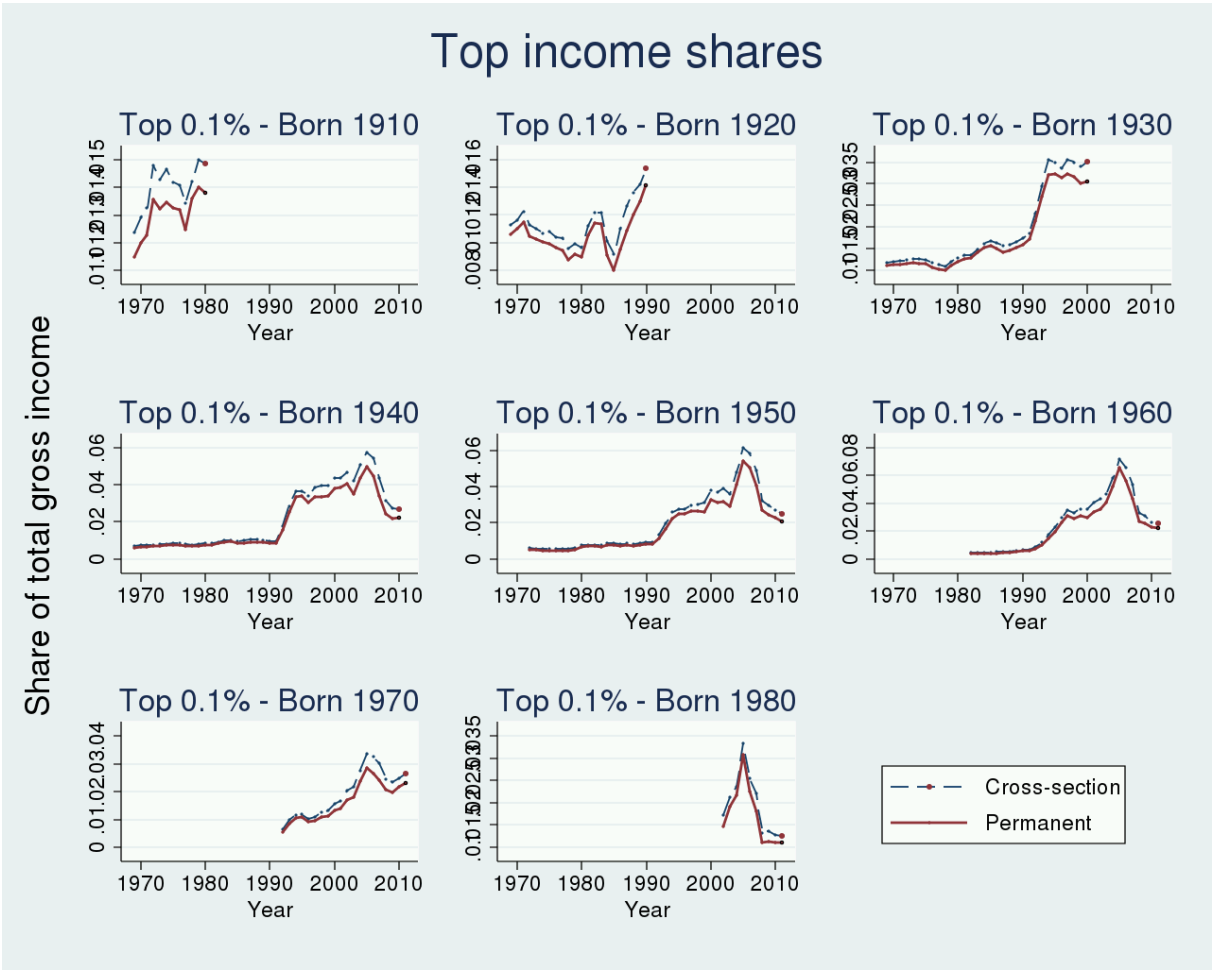


Figure E.3 Top income share within cohort, top 0.1 % Norway 1967-2011



Appendix F: Permanent-income top income shares

The table shows top income shares when incomes are averaged over three and ten years. The year in the left column refers to the end point of the time period.

Table F.1 Permanent income top shares

Year (end of period)	3-year periods					10-year periods				
	Top 10%	Top 5%	Top 1%	Top 0.5%	Top 0.1%	Top 10%	Top 5%	Top 1%	Top 0.5%	Top 0.1%
1969	32.90 %	19.94 %	6.12 %	3.67 %	1.16 %					
1970	32.75 %	19.91 %	6.19 %	3.74 %	1.20 %					
1971	32.41 %	19.74 %	6.18 %	3.75 %	1.21 %					
1972	32.04 %	19.50 %	6.12 %	3.73 %	1.21 %					
1973	31.66 %	19.24 %	6.02 %	3.66 %	1.18 %					
1974	31.29 %	18.98 %	5.91 %	3.60 %	1.17 %					
1975	30.92 %	18.68 %	5.78 %	3.50 %	1.13 %					
1976	30.30 %	18.17 %	5.53 %	3.32 %	1.05 %	29.76 %	17.92 %	5.46 %	3.27 %	1.02 %
1977	29.58 %	17.62 %	5.27 %	3.14 %	0.97 %	29.34 %	17.62 %	5.34 %	3.19 %	0.99 %
1978	28.83 %	17.12 %	5.07 %	3.01 %	0.91 %	28.85 %	17.28 %	5.21 %	3.11 %	0.95 %
1979	28.24 %	16.77 %	4.99 %	2.98 %	0.92 %	28.35 %	16.93 %	5.08 %	3.02 %	0.92 %
1980	27.53 %	16.33 %	4.87 %	2.91 %	0.92 %	27.78 %	16.52 %	4.91 %	2.91 %	0.88 %
1981	26.91 %	15.92 %	4.73 %	2.83 %	0.91 %	27.24 %	16.14 %	4.75 %	2.80 %	0.84 %
1982	26.44 %	15.60 %	4.61 %	2.76 %	0.91 %	26.73 %	15.77 %	4.60 %	2.70 %	0.80 %
1983	26.40 %	15.59 %	4.61 %	2.77 %	0.93 %	26.25 %	15.44 %	4.46 %	2.61 %	0.77 %
1984	26.43 %	15.63 %	4.65 %	2.80 %	0.96 %	25.81 %	15.13 %	4.34 %	2.53 %	0.74 %
1985	26.44 %	15.68 %	4.68 %	2.83 %	0.96 %	25.39 %	14.86 %	4.24 %	2.47 %	0.73 %
1986	26.34 %	15.66 %	4.71 %	2.85 %	0.97 %	25.04 %	14.65 %	4.18 %	2.43 %	0.72 %
1987	26.20 %	15.63 %	4.74 %	2.88 %	0.99 %	24.73 %	14.48 %	4.14 %	2.42 %	0.72 %
1988	25.92 %	15.49 %	4.71 %	2.87 %	0.98 %	24.43 %	14.32 %	4.10 %	2.39 %	0.72 %
1989	25.49 %	15.25 %	4.64 %	2.82 %	0.95 %	24.14 %	14.16 %	4.06 %	2.38 %	0.73 %
1990	25.20 %	15.11 %	4.62 %	2.81 %	0.93 %	23.95 %	14.07 %	4.06 %	2.38 %	0.73 %
1991	25.24 %	15.20 %	4.69 %	2.86 %	0.95 %	23.83 %	14.05 %	4.08 %	2.40 %	0.74 %
1992	26.26 %	16.13 %	5.26 %	3.30 %	1.19 %	23.97 %	14.24 %	4.23 %	2.52 %	0.80 %
1993	27.82 %	17.61 %	6.33 %	4.19 %	1.71 %	24.28 %	14.62 %	4.52 %	2.76 %	0.93 %
1994	29.34 %	19.10 %	7.45 %	5.14 %	2.28 %	24.64 %	15.03 %	4.85 %	3.03 %	1.09 %
1995	29.88 %	19.72 %	8.02 %	5.65 %	2.63 %	25.04 %	15.47 %	5.19 %	3.33 %	1.26 %
1996	29.98 %	19.87 %	8.17 %	5.81 %	2.77 %	25.51 %	15.98 %	5.59 %	3.67 %	1.47 %
1997	30.19 %	20.14 %	8.42 %	6.04 %	2.97 %	26.08 %	16.58 %	6.06 %	4.06 %	1.72 %
1998	30.11 %	20.15 %	8.46 %	6.07 %	2.96 %	26.59 %	17.10 %	6.43 %	4.37 %	1.89 %
1999	30.11 %	20.21 %	8.53 %	6.12 %	2.96 %	27.16 %	17.66 %	6.84 %	4.71 %	2.09 %
2000	30.74 %	20.90 %	9.17 %	6.70 %	3.34 %	27.91 %	18.42 %	7.43 %	5.21 %	2.39 %
2001	30.71 %	20.80 %	8.98 %	6.49 %	3.18 %	28.26 %	18.75 %	7.63 %	5.37 %	2.46 %
2002	31.33 %	21.42 %	9.54 %	7.01 %	3.56 %	28.64 %	19.16 %	7.99 %	5.68 %	2.67 %

2003	31.61 %	21.71 %	9.80 %	7.25 %	3.74 %	28.98 %	19.51 %	8.29 %	5.95 %	2.84 %
2004	32.95 %	23.17 %	11.23 %	8.60 %	4.80 %	29.42 %	19.98 %	8.73 %	6.36 %	3.15 %
2005	35.27 %	25.59 %	13.39 %	10.52 %	6.07 %	30.43 %	21.02 %	9.63 %	7.16 %	3.69 %
2006	34.49 %	24.58 %	12.20 %	9.38 %	5.23 %	30.40 %	20.93 %	9.46 %	6.98 %	3.55 %
2007	33.77 %	23.63 %	11.04 %	8.23 %	4.26 %	30.47 %	20.95 %	9.37 %	6.87 %	3.45 %
2008	31.36 %	20.99 %	8.51 %	5.91 %	2.59 %	30.56 %	20.97 %	9.28 %	6.77 %	3.34 %
2009	31.37 %	20.93 %	8.36 %	5.76 %	2.47 %	30.55 %	20.87 %	9.10 %	6.58 %	3.20 %
2010	31.27 %	20.79 %	8.21 %	5.62 %	2.40 %	30.43 %	20.68 %	8.85 %	6.34 %	3.04 %
2011	31.33 %	20.79 %	8.17 %	5.58 %	2.39 %	30.51 %	20.71 %	8.81 %	6.29 %	3.00 %