Changes in the Structure of Family Income in Canada, 1980-1997
The Effects of Changing Family Structure and Growing Proportion of Recent Immigrants

By Wen-Hao Chen

Family and Labour Studies
Statistics Canada

Ottawa, Ontario
K1A 0T6
Voice: 613-9513807
Facsimile: 613-9515403
Wen-hao.chen@statcan.ca

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Abstract

The market-based family income inequality in Canada has increased between 1980 and 1997, particularly in the 1990s. However, unlike the case in the United States where the increasing inequality was shown from a polarization at the two ends of the income distribution, the growing inequality in Canada was largely associated with a major shift of density from the middle to the lower half of the income distribution. Key possible explanations of disappearing middle class are often associated with the increase in earnings dispersion including skill-biased technological shocks, open economy, the growing correlation of husband and wife earnings, changes in family structure, or increasing low economic performance immigrants. Among possible explanations affecting family income distribution, this paper focuses on the effects of changing family structure and the growing proportion of recent immigrants. The analyses are based on a conditional weighted density estimation developed by DiNardo, Fortin and Lemieux (1996), and data from Survey of Consumer Finance (SCF) 1980-1997 is used.

The results show that the increasing trend of non-traditional forms of family structure had substantial impact on rising family income inequality, explaining one-fifth of the increase in Gini coefficient and one-third of the growth in low-income rate. The impact of growing proportion of recent immigrants on income dispersion was also paramount. It is especially concentrated in the lower half of the distribution, explaining about one-third of the increase in 50-10 and 90-10 ratios, and was responsible for $462 of the decline in median income in this period.

I. Introduction

The increasing income polarization and poverty have been the subject of discussion in many countries. In the United States, the common wisdom of rising inequality has been associated with gains in both the upper and lower portion of the income distribution. In Canada, market-based family income inequality also grew rapidly over time, particularly in the 1990s.[1] However, the growing inequality in Canada was primarily associated with loss from the bottom portion of the income distribution. During the period between 1980 and 1997, the real income index increased only 7 percent for people at the 90th percentile of the income distribution, while it decreased about 40 percent for those at the 10th percentile. In the meantime, low-income rate (calculated as one half of the median) increased about 4.3 percentage points this period despite the declining trend of median income.

What has driven the change of family income structure in Canada? What factors can explain the increase in inequality? The objective of this paper is to understand factors and their contribution to the changes in income distribution and low-income rate. Among possible explanations affecting family income distribution, this paper focuses on effects of changing family structure and the growing proportion of low economic performance of recent immigrants.[2]

Previous Canadian literature has related rising inequality to various factors. For example, McWatters and Beach (1990) provide an overview of contributing factors affecting the distribution of income, including supply-side issues (baby-boom effect,

[1]. The definition of family income throughout this paper is total market income (without government transfers and tax components) from every member in the census family, divided by an equivalence scale that is defined as a square root of family size. Notice that inequality based on post-transfer family incomes has changed very little over time (see also Beach and Slotsve, 1996).

increased female participation, changing family structure, retirement and pensions) and demand-side issues (structural changes and business cycle effects). Yet little is known about the role of the growing proportion of recent immigrants on the increase in inequality. Recent immigrants are very different from their predecessors in terms of quantity and quality. The great volume of immigrants who came in the 1990s more likely came from Asia or developing countries where skills were less transferable. Shifts in skill distribution (e.g., language proficiency or credential recognition) of recent immigrants alter their earnings distribution and possibly affect overall income inequality. The inclusion of the immigration factor in the examination of changing income distribution would help to fill the gap in the existing Canadian inequality literature. Besides, investigating impacts of rising non-traditional families (e.g., lone parent families) continue to be a crucial issue among policy agenda. The scope of government transfers has been changed over time with a declining role in the 1990s. If the increase in single-head families was likely associated with low incomes, more policy interventions may be required.

The analyses rely on a relatively new approach based on the conditional re-weighting procedure developed by DiNardo, Fortin and Lemieux (1996). As noted by Daly and Valletta (2000), this technique has two advantages compared to the standard regression-based decomposition in the existing literature. First, it enables estimation of the entire density of income rather than just mean or quintiles in the standard regression model. Second, it provides greater behavioral content on the results because the counterfactual distributions constructed in this format allow conditional relationship between explanatory factors and a set of other attributes.

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[2]. Recent immigrants are defined as those who have been living in Canada 10 years or less.

The paper is organized as follows. Section II provides a brief literature review on inequality. Section III describes data source and some historical trends in the data. In section IV, the conditional re-weighting decomposition technique applied in this paper will be described. The estimated results are presented in section V, and a conclusion is given in section VI.

II. Factors Affecting Family Income Inequality: A Literature Review

Research on income inequality has been explored in great detail through various perspectives. In the United States, discussions of rising polarization of family income distribution have often focused on the widening male earnings dispersion driven by shifts in the relative demand for skilled workers such as technological changes (Bound and Johnson 1992), fluctuations in the rate of growth of the supply of skilled workers (Katz and Murphy 1992)[3], shifts in industrial composition that are largely associated with trade or economic integration (Murphy and Welch 1991), and changes in institutional settings (Podgursky 1983, Katz and Murphy 1992, and DiNardo, Fortin and Lemieux 1996.) In addition to the earnings disparities, shifts in demographic composition are also among the possible explanations for the increase in family income inequality. For instance, Karoly and Burtless (1995), Burtless (1999), and Daly and Valletta (2000) show that the demographic changes, especially for increasing in single head families, are responsible for a great proportion of the increase in overall inequality in the US. Other studies also indicate that the increase in the female labour supply is largely associated with women whose husbands have relatively high earnings, which would lead to an increase in family

[3]. Argument on the technological change and rising wage inequality is discussed in Card and DiNardo (2002).

income inequality (Juhn and Murphy 1997, and Burtless 1999). For example, Burtless (1999) found that about 13 percent of the rise in overall inequality between 1979 and 1999 in the US can be attributed to an increase in the correlation of husband and wife earned incomes.

Studies of income inequality are also well documented in Canada. On the issue of technological change, Gera, Gu and Lin (2001) show that, at the aggregate level, demand for skilled workers did not rise significantly over 1981 and 1994—the period that technological change was paramount. Although they also show that the variations are very substantial across industrial sectors, skill upgrading at the national level is less evident. Their results implicitly suggest a less role of technological change in rising income inequality. With respect to earnings disparity, Morissette (1995) shows that the increase in earnings inequality in the 1980s not only occurred with changes in earnings but also in conjunction with changes in the distribution of hours worked. Picot (1998) updates the earnings inequality trends in the 1990s and finds that the real wage rates have declined among young Canadians, while the overall inequality has changed little through 1980 and mid-1990. With respect to family income in Canada, early study by Henderson and Rowley (1977) suggests that the decline in family size is one of the major reasons for rising inequality since income variation is much stronger within smaller families. Wolfson (1986) examines the importance of shifting family structure in income inequality. His results suggest that the increasing incidence of lone parent families, reflected by lower fertility rates or rising separation rates, has enhanced the inequality over the period 1965-1983. Studies by Beach (1988) and McWatters and Beach (1990) discuss the changes in family income distribution in relation to the "vanishing" middle

class in the period between the 1960s and 1980s. They examine many possible factors from both supply side and demand side, and conclude that the declining share of middle class is largely associated with the decline in men's participation rate and with the rise in women's participation rate, while effects from other possible factors, such as business cycle or industrial shift, are relatively small. Zyblock (1996) analyzes both demographic and non-demographic factors on the change in family incomes over 1981-1993. His results show that, in either age groups or family types, the within group contribution dominates the between group contribution in the level of overall family income inequality. He also points out that the shift toward lone parent families accounted for nearly 40 percent of the increase in inequality through this period.

In addition to the traditional thoughts of growing earnings disparities and increasing incidence of single head families, this paper also address an important factor—immigrants—in relation to the rising family income inequality in Canada. Recent study by Hou and Picot (2002) show that aggregate low-income rates in Canada increased 2.3 percentage points between 1989 and 1999, and two-thirds was accounted for by the rising low-income rates among immigrants. The effect was even stronger in regions with high immigrant population such as Toronto and Vancouver.

III. Data and Historical Trends

This study used data from the Survey of Consumer Finance (SCF) for 1980-1997. The sample includes individuals age 15 and above in the families, but excludes families whose major income recipients are age 65 years and over because market-based incomes are usually small among elderly families. The definition of family in this study adopts

the concept of "census family", which consists of a married couple or common-law couple without or with unmarried children, or a lone parent with an unmarried child or children.

The major interest in this study focuses on the changes of the distribution of individual economic well-being based on market force alone. To properly measure the well-being of an individual, both monetary and demographic components in a family are considered. Family incomes are measured as annual market incomes including earnings, investment and private transfers but excluding government transfers and tax components. The total family market incomes are further standardized through an equivalence scale in order to adjust demographic components. In this context, equivalence scale is defined as the square root of family size. The use of equivalence scale would reduce part of the inequality that is caused by exacerbation of big size families. In this setting, individuals rather than families are considered as the basic unit of analysis.

To define low-income status, individuals whose equivalent incomes fall below one half of the median equivalent income in a given year are considered as being in low-income. For the decomposition section, data from two peak years--1980, 1989--and one near peak year--1997--are used. The purpose of choosing these three particular years aims to reduce any variations that were due to the business cycle effects. All income measures are expressed in 2000 constant dollars.

Figure 1 displays trends of inequality (as indicated by the 75-25 percentile ratio), as well as low-income rate. No surprisingly, the cyclical effects are very obvious as shown by the two spikes areas representing 1983-84 and 1992-93 recessions, respectively. Focusing on the peak or near-peak years (1980, 1989 and 1997), inequality

displays a growing up trend throughout this period, while low-income rate increased only during the 1990s. Both indices increased substantially in the early 1990s, yet they were never able to return to the previous level despite the economic expansions in the late 1990s.

Figure 2 shows that the increasing inequality was mainly associated with the worse performance of people from the bottom end of the income distribution. The real income in 1997 for people at the 25th percentile was about 15 percent lower than the level in 1980 for people at the same percentile. The situation is even worse for those extremely poor: the real income dropped as much as 40 percent for people at the 10th percentile between 1980 and 1997. On the contrary, people at the top end of the distribution experienced very little change in terms of real income during this period. The real incomes for persons at the 75th and 90th percentile were only 4 and 7 percent, respectively, higher than those at the same positions in 1980. These patterns are very different from those found in the US literature, where polarization is obvious (e.g., Daly and Valletta 2000).

In order to display changes in the entire income distribution, kernel density estimates of the distribution of equivalent income for peak years are shown in Figure 3.[4] Between 1980 and 1997, the distribution widened with hollowing of the middle and density shift to both ends. Density moved to the left is more apparent, suggesting the deterioration of well-being for many individuals. The story is very different when two periods were estimated separately. It is surprising that the change in income distribution in the 1980s was mostly concentrated in the movement from the middle portion to the

[4]. The kernel density is estimated using the "Gaussian" functional form and "optimal bandwidth" (see Silverman 1986 for detail).

upper portion with very little change in the lower portion. On the contrary, much of the density mass shifted to the left in the 1990s, while the change in the upper tail was relatively small.

Figure 4 displays inequality measures for male earnings during this period. The measure includes people with zero earnings. The trend of earnings dispersion was relatively stable in the 1980s and increased notably in the 1990s. Indeed, the rising earnings dispersion possibly resulted from the decline in earnings among individuals in the lower portion of the distribution (as indicated by a declining trend of median) and less likely from gains in the upper portion of individuals. At the aggregate level, it seems that technological changes or trade do not have much support to the changes in income distribution in Canada. Nevertheless, their effects may be very significant within certain groups or industries (Gera, Gu and Lin 2001).

Figure 5 depicts the correlation between husband earnings and wife participation. It shows that the increase in female participation rates has been largely concentrated on women whose husbands have relatively high earnings. Among males whose earnings were right on the top quartile of the distribution, the proportion of working wives increased significantly from .55 in 1980 to nearly .8 in 1997. On the other hand, the proportion of working wives remained relatively stable over time among husbands whose earnings were on the bottom quartile of the distribution. The increasing correlation between husband earnings and wife labour force participation is inclined to increase inequality in family income.

Figure 6 displays the trend of family composition. It shows that the Canadian family structure has been changed with a decline in husband-wife-children families (62%

in 1980 to 55% in 1997), and a corresponding increase in all three other family types: combining 5.1 percentage points increase in single unattached families and lone parent families, and a slight increase (2.1 percentage points) in childless couple families. The movement toward single head families is believable to increase the proportion of low-income families, and therefore tends to increase inequality.

The other notable trend in Canada in the past 20 years is the increasing proportion of recent immigrants and shifts of compositions among them. According to SCF, recent immigrants account for about 25 percent of the total immigrants throughout the 1980s, but their share increased to 33 percent in 1997. Figure 7 shows that new immigrants who came in the 1990s are more vulnerable than their earlier cohorts from the 1980s. In the 1983 recession, the difference in median equivalent income between recent immigrants and population was about $4000, while the gap increased to $15,000 in the 1993 recession. The decline in median income is likely reflected by a relatively weaker attachment to full-time employment among new immigrants in the 1990s (Figure 9). The proportion of full-time employment for recent immigrants stayed very close to the national average (about .64) throughout the 1980s, then plunged quickly in the 1990s and never came back. Of course, the recession in the early 1990s played an important factor in this manner. Many studies (e.g., McDonald and Worswick 1998) have shown that immigrants' rate of earnings assimilation is sensitive to macroeconomic conditions. However, why are immigrants from the 1990s more negatively affected by recession compared to their earlier cohorts from the 1980s? The story behind the macroeconomic conditions is perhaps the change of composition among immigrants. The skill distribution of immigrants in the 1990s likely changed when the Third World countries

(Asia, Middle East, and Africa) replaced Europe and the United States as the major source countries of immigrants. New immigrants in the 1990s are considered as less skilled than earlier cohorts, not necessarily because of the disadvantage in educational attainments but because of problems in terms of credential recognition, language proficiency and perhaps discrimination. Figure 10 shows the proportion of immigrants who speak the official language as their mother tongue. In 1981, over 45 percent of immigrants or recent immigrants spoke the official language as their mother tongue. The percentage declined to 28 percent and 16 percent for immigrants and recent immigrants, respectively, in 1997. To what extent the changes in the compositions of immigrants affect national inequality or low-income rate is the central issue to be examined in this research.

IV. Methodology

The technique for decomposing changes in the density of equivalent income is based upon the "conditional re-weighting procedure" developed by Dinardo, Fortin, and Lemieux (1996)—hereafter called DFL. This technique has also been used by many authors in recent literature (e.g., Valletta 2001, Daly and Valletta 2000, and Chiquiar and Hanson 2002). Basically, it is similar to the famous "Oaxaca-Blinder decomposition." But this procedure is able to estimate the entire conditional distribution, while the Oaxaca-Blinder decomposition only focused on the mean of a distribution. The estimated conditional weights can be combined with sample survey weights to produce an adjusted distribution.

Recall that a standard Oaxaca-Blinder decomposition follows from an income equation:

$$\bar{y}_{97} - \bar{y}_{80} = \hat{\beta}_{97} * (\bar{X}_{97} - \bar{X}_{80}) + \bar{X}_{80} * (\hat{\beta}_{97} - \hat{\beta}_{80}) . \quad (1)$$

The left-hand side is the change in average equivalent income ($\bar{y}$) between 1980 and 1997. It equals to the sum of two components: that due to differences in the mean characteristics ($\bar{X}$) and that due to differences in the returns to these characteristics ($\hat{\beta}$). The first term on the right-hand side of (1) represents a counterfactual that "*what would the average equivalent income have been in year 1997 for individuals with the mean characteristics of the 1980 levels."* Shortcoming of this decomposition is that it only estimates the mean of a distribution and ignores changes, for example, at the tails. Distribution changes other than means (such as quintiles or deciles) are unable to be investigated with this method. To construct counterfactual densities that work with the entire density of incomes, DFL shows that it can be estimated through kernel density estimation to appropriately weighted samples.

$$\hat{f}(y) = \frac{1}{n}\sum_{i=1}^{n} \frac{\theta_i}{h} K(\frac{y - Y_i}{h}) \quad (2)$$

Equation (2) is a kernel density estimate based on a random sample ($Y_1,...,Y_n$) with sampling weights ($\theta_1,...,\theta_n$), h is the smoothing function referred as the bandwidth and K is the kernel function.[5] The choice of h and K may be sensitive to the distribution and has been subject to many discussions in the literature. In the context, the "optimal bandwidth" (Silverman 1986) and Gaussian kernel function are used.

To provide an exposition of this technique, consider a simple binary variable—mother tongue—that equals to 1 if immigrants speak the official language as their mother tongue and zero otherwise. Without controlling other characteristics, we have seen the

proportion of immigrants whose mother tongue is the official language has declined significantly over time (Figure 9). Therefore, the simplest way to impose the earlier distribution of language profile on the current equivalent income distribution is to "upweight" people who speak the official language as their mother tongue by a number that is equal to the percentage decrease in the share of this group over time. Similarly, a possibility to be in the group who speaks the non-official language as the mother tongue has increased. As a result, immigrants in this group will be "downweight" because they are less likely to be observed as such in earlier years than in current.

The "conditional" re-weighting function follows the spirit of the above simple example but further allows us to control other characteristics. To begin with, consider Y is the distribution of equivalent income in 1997, conditional on four explanatory factors—immigrants' full-time employment rate I, immigrants' language and migration duration composition L, family structure S, and other attributes X—to be examined in this context. The distribution of income can be shown as the product of joint densities I, L, S, and X:

$$\begin{aligned} f_t(Y) &= f(Y \mid t_Y = 97, t_{I|L,S,X} = 97, t_{L|S,X} = 97, t_{S|X} = 97, t_X = 97) \\ &= \int\int\int\int f(Y \mid I, L, S, X, t_Y = 97) dF(I \mid L, S, X, t_{I|L,S,X} = 97) dF(L \mid S, X, t_{L|S,X} = 97) \\ &\quad \cdot dF(S \mid X, t_{S|X} = 97) dF(X \mid t_X = 97) \end{aligned} \tag{3}$$

The challenge here is to construct counterfactual densities such that "*what would the density of equivalent income have been in 1997 if immigration factors, family structure, other attributes, but nothing else, had remained the same as in 1980 levels?*"

$$f_t(Y) = f(Y \mid t_Y = 97, t_{I|L,S,X} = 80, t_{L|S,X} = 80, t_{S|X} = 80, t_X = 80)$$

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[5]. See Silverman (1986) for detailed on kernel density estimation.

$$= \int \iiint f(Y \mid I,S,X,t_Y = 97)dF(I \mid L,S,X,t_{I|L,S,X} = 80)dF(L \mid S,X,t_{L|S,X} = 80)$$
$$dF(S \mid X,t_{S|X} = 80) \cdot dF(X \mid t_X = 80) \quad (4)$$

With proper arrangement, the counterfactual density in (4) can be expressed as

$$f_t(Y) = f(Y \mid t_Y = 97, t_{I|L,S,X} = 80, t_{L|S,X} = 80, t_{S|X} = 80, t_X = 80)$$
$$= \int \iiint f(Y \mid I,L,S,X,t_Y = 97)dF(I \mid L,S,X,t_{I|L,S,X} = 97)\frac{dF(I \mid L,S,X,t_{I|L,S,X} = 80)}{dF(I \mid L,S,X,t_{I|L,S,X} = 97)}$$
$$\cdot dF(L \mid S,X,t_{L|S,X} = 97)\frac{dF(L \mid S,X,t_{L|S,X} = 80)}{dF(L \mid S,X,t_{L|S,X} = 97)}$$
$$\cdot dF(S \mid X,t_{S|X} = 97)\frac{dF(S \mid X,t_{S|X} = 80)}{dF(S \mid X,t_{S|X} = 97)} \cdot dF(X \mid t_X = 97)\frac{dF(X \mid t_X = 80)}{dF(X \mid t_X = 97)}$$
$$= \int \iiint f(Y \mid I,L,S,X,t_Y = 97)dF(I \mid L,S,X,t_{I|L,S,X} = 97)dF(L \mid S,X,t_{L|S,X} = 97)$$
$$\cdot dF(S \mid X,t_{S|X} = 97)dF(X \mid t_X = 97) \quad (5)$$
$$\cdot \lambda_{I|L,S,X}(I,L,S,X) \cdot \lambda_{L|S,X}(L,S,X) \cdot \lambda_{S|X}(S,X) \cdot \lambda_X(X)$$

which is equal to the exact density of equivalent income in 1997 times four re-weighting functions: $\lambda_{I|L,S,X}(I,L,S,X)$, $\lambda_{L|S,X}(L,S,X)$, $\lambda_{S|X}(S,X)$, and $\lambda_X(X)$. The new weights (λ) can then be incorporated into the estimation of the kernel density:

$$\hat{f}(y) = \frac{1}{n}\sum_{i=1}^{n}\frac{\theta_i \cdot \lambda}{h}K\left(\frac{y - Y_i}{h}\right) \quad (6)$$

Estimation of Re-weighting Functions

In this subsection, how the re-weighting functions are estimated in each case will be explained in more detail, beginning with the application to immigration factors. As seen in the previous section, labour market performance among immigrants has been deteriorating since 1990. The declining full-time employment rate among immigrants is associated with many factors including observable compositional changes (e.g., shift in mother tongue composition) and some unobservable changes (e.g., credentials,

discrimination or macro conditions). To investigate impacts of immigrants on the change of income distribution, the basic idea is to ask a question such as "*what would the income distribution be if labour market performance (in terms of full-time employment) of immigrants, conditional on other observable characteristics (e.g., age, education, family structure, geography, mother tongue and duration of residency, etc.) had remained at their 1980 levels?"* This counterfactual density represents the overall effects of immigrants on income distribution due to the change in the full-time employment rate. It could be due to any effects that are not controlled here. For example, shift of national origin of immigrants to developing countries might result in more problems on credentials recognition or discrimination, and therefore affect full-time employment probability. Besides, any other changes such as increasing demands for certain skills in favor of (or not in favor of) immigrants, or changes in macro condition are also captured in this category.

In terms of notation, let *I* be a binary variable with value 1 if full-time employment and zero are otherwise.

$$\lambda_{I|L,S,X}(I,L,S,X) = \frac{dF(I \mid L,S,X,t_{I|L,S,X}=80)}{dF(I \mid L,S,X,t_{I|L,S,X}=97)}$$
$$= I\frac{\Pr(I=1 \mid L,S,X,t_{I|L,S,X}=80)}{\Pr(I=1 \mid L,S,X,t_{I|L,S,X}=97)} + (1-I)\frac{\Pr(I=0 \mid L,S,X,t_{I|L,S,X}=80)}{\Pr(I=0 \mid L,S,X,t_{I|L,S,X}=97)} \qquad (7)$$

$\lambda_{I|L,S,X}(I,L,S,X)$ in (7) represents changes in the probability between 1980 and 1997 that a given immigrant defined by characteristics (L,S,X) is observed to engage full-time employment. Every immigrant in the distribution will be either upweighted (if $\lambda_{I|L,S,X} > 1$) or downweighted (if $\lambda_{I|L,S,X} < 1$) in order to adjust full-time employment status to its 1980 level. Estimate of the re-weighting function $\lambda_{I|L,S,X}(I,L,S,X)$ can be

obtained by estimating the conditional probabilities in (7) through a probit model. For non-immigrants, the re-weighting function is set to 1.

In the first decomposition, I hold immigrants' full-time rate at the 1980 level conditional on their mother tongue and migration duration status. Indeed, the proportion of recent immigrants has increased rapidly in the 1990s and fewer of them speak the official language as their mother tongue. It is possible that the economic returns to those who can speak the official language and to those who possess longer Canadian experience were also changing in this period. As a result, I wish to construct a counterfactual density (accounts for interaction effects) that holds constant the language/migration duration composition in addition to the full-time employment rate at their 1980 levels. In a simple framework, immigration population can be divided into four mutually exclusive groups in a given year according to mother tongue (=1 if mother tongue is official language, =0 else) and migration duration (=1 if longer than 10 years, =0 else). The re-weighting function for this factor is then expressed as:

$$\begin{aligned}\lambda_{L|S,X}(L,S,X) &= \frac{dF(L\,|\,S,X,t_{L|S,X}=80)}{dF(L\,|\,S,X,t_{L|S,X}=97)} \\ &= L_1\frac{\Pr(L=1\,|\,S,X,t_{L|S,X}=80)}{\Pr(L=1\,|\,S,X,t_{L|S,X}=97)} + L_2\frac{\Pr(L=2\,|\,S,X,t_{L|S,X}=80)}{\Pr(L=2\,|\,S,X,t_{L|S,X}=97)} \\ &+ L_3\frac{\Pr(L=3\,|\,S,X,t_{L|S,X}=80)}{\Pr(L=3\,|\,S,X,t_{L|S,X}=97)} + L_4\frac{\Pr(L=4\,|\,S,X,t_{L|S,X}=80)}{\Pr(L=4\,|\,S,X,t_{L|S,X}=97)} \\ &= \sum_{c=1}^{4} L_c\frac{\Pr(L=c\,|\,S,X,t_{L|S,X}=80)}{\Pr(L=c\,|\,S,X,t_{L|S,X}=97)}. \qquad (8)\end{aligned}$$

Estimate of the re-weighting in (8) can be obtained through a "multinomial logit" model. Again, the re-weighting function is set to 1 for all non-immigrants.

Similarly, estimate of the conditional re-weighting function for family structure $\lambda_{S|X}(S,X)$ can also be calculated by using multinomial logit again because there are four different family types as described in the text.

$$\lambda_{S|X}(S,X)=\frac{dF(S\mid X,t_{S|X}=80)}{dF(S\mid X,t_{S|X}=97)}=\sum_{c=1}^{4}S_c\,\frac{\Pr(S=c\mid X,t_{S|X}=80)}{\Pr(S=c\mid X,t_{S|X}=97)} \tag{9}$$

Finally, applying Bayes' rule, the conditional re-weighting function for other attributes $\lambda_X(X)$ can be written as:

$$\lambda_X(X)=\frac{dF(X\mid t_X=80)}{dF(X\mid t_X=97)}=\frac{\Pr(t_X=80\mid X)}{\Pr(t_X=97\mid X)}\cdot\frac{\Pr(t_X=97)}{\Pr(t_X=80)}. \tag{10}$$

It is equal to the relative probability of observing people with characteristics X in the 1980 versus the 1997 sample, times the unconditional probabilities of being in either sample. The conditional probabilities can be estimated by probit model, while the unconditional probabilities are simply the population ratio.

Changes in the density of equivalent income between 1980 and 1997 can therefore be modeled based on the following decomposition:

$$\begin{aligned}
f_{97}(Y)-f_{80}(Y)=\;& f_{97}(Y;t_{I|L,S,X}=97,t_{L|S,X}=97,t_{S|X}=97,t_X=97) \\
&-f_{97}(Y;t_{I|L,S,X}=80,t_{L|S,X}=97,t_{S|X}=97,t_X=97) && \text{(i)}\\
&+f_{97}(Y;t_{I|L,S,X}=80,t_{L|S,X}=97,t_{S|X}=97,t_X=97) \\
&-f_{97}(Y;t_{I|L,S,X}=80,t_{L|S,X}=80,t_{S|X}=97,t_X=97) && \text{(ii)}\\
&+f_{97}(Y;t_{I|L,S,X}=80,t_{L|S,X}=80,t_{S|X}=97,t_X=97) \\
&-f_{97}(Y;t_{I|L,S,X}=80,t_{L|S,X}=80,t_{S|X}=80,t_X=97) && \text{(iii)}\\
&+f_{97}(Y;t_{I|L,S,X}=80,t_{L|S,X}=80,t_{S|X}=80,t_X=97) \\
&-f_{97}(Y;t_{I|L,S,X}=80,t_{L|S,X}=80,t_{S|X}=80,t_X=80) && \text{(iv)}\\
&+f_{97}(Y;t_{I|L,S,X}=80,t_{L|S,X}=80,t_{S|X}=80,t_X=80) \\
&-f_{80}(Y;t_{I|L,S,X}=80,t_{L|S,X}=80,t_{S|X}=80,t_X=80) && \text{(v)}
\end{aligned}$$

The five components in the above equation represent the effects of changing "immigrants' full-time employment rate", "immigrants' language/migration duration compositions", "family structure", "other attributes", and "residual" factors, respectively.

Criticism of this approach is often related to its inability to distinguish overlapping effects of different factors. The possibility of a general equilibrium or an endogenous relationship between factors would confound the true contribution of each factor. A simple solution is to perform the same decomposition but in different order sequences and see whether results are robust under a different order. In this paper, reverse-order decomposition is also employed.

V. Results

This section applies the decomposition procedure described above to estimate the contribution of two immigration factors, family structure, other attributes, and residual on the change in equivalent income between 1980 and 1997. Vector of other attributes X includes age, sex, education, province dummies, size of area dummies, and 16 Census Metropolitan Area (CMA) dummies. Thus, effects such as aging population or shift in geographic location would be captured in this category. Finally, factors such as "skill-biased technological shocks", "international trade", "correlation between husband and wife earnings", or other unexplained factors fall into the last category.

Figures 10 to 13 display changes in the density of equivalent income between 1980 and 1997 in decomposition sequence. Each graph adjusted an additional modeled factor to its 1980 levels. The solid line in Figure 10 is the 1997 density of equivalent income, while the dash line represents the counterfactual density that adjusted for the

immigrants' full-time employment rate. It shows that the lower portion of the income distribution would have been narrower slightly if full-time employment rate among immigrants are held constant at 1980 levels. The adjusted distribution moved density from the left tail to the middle, but had virtually no impact on the right tail. Figure 11 further adjusted distribution by holding immigrants' language/migration duration compositions constant at the earlier year level. Changing these two compositions among immigrants had reduced density in the upper middle, with corresponding increase of mass in the lower middle of the distribution. The visual effect became more significant when family structure was added and held constant at the earlier year level (Figure 12). Changing family structure between 1980 and 1997 had caused a uniform shift to the left with more concentration in the lower tail of the distribution. Finally, the effect of changing other attributes is displayed in Figure 13. Effects such as shifts in age structure factor or geographic location had resulted in a notable movement in density from the lower half to the upper half of the distribution.

The quantitative contributions of visual presentations are shown in Table 1. Statistics include changes of a series of dispersion measures, low-income rate, and median income between 1980 and 1997. Over this period, inequality indices and low-income rate based on equivalent income had increased. Overall inequality, as measured by Gini coefficient, increased about 4.3 percentage points. However, the rising inequality is principally concentrated in the lower half of the income distribution. Despite the declining median, the change in 90-50 ratio is less noticeable, but the increase in 50-10 ratio is substantial, suggesting people in the lower end suffered major income loss over this period.

Turning to the contribution of each factor with respect to the changes in these measures, column 1 shows the effect of changing full-time employment rate of immigrants. Overall, it explains 24 percent (26%) of the increase in 90-10 (50-10) ratio, 12 percent of the increase in Gini coefficient, and about 17 percent (or equivalently 0.7 percentage point) of the increase in the low-income rate over this period. The stronger effects on the 90-10 and 50-10 ratios indicate that increasing proportion of non-full time jobs was likely associated with low incomes. Recall that declining full-time rate of immigrants was affected by many unobserved factors. If shift of national origin accounts for most in this category, it is equivalent to say that the increasing immigrants from developing countries were likely associated with low incomes, given all else being equal. Nevertheless, it is not identifiable with this data.

Column (2) further displays the effect of immigrants due to the changes of compositions in mother tongue and migration duration. The proportion of recent immigrants increased significantly in the 1990s and fewer of them speak the official language as their mother tongue. By holding these two components at the 1980 level, it results in a 7 percent of increase in Gini coefficient, 0.5 percentage point growth in low-income rate and $228 decline in median income. The magnitudes are not considerably large in terms of overall changes. However, it is surprising that holding constant the proportion of recent immigrants and mother tongue composition alone could result in changes in inequality as well as low-income rate at the national level. Combining (1) and (2), changes due to immigration factors are substantial. They account for 19 percent of the increase in Gini, 33 percent of the increase in 50-10 ratio, 1.2 percentage points growth in low-income rate, and $462 of the decline in median.

Changing family structure is still dominant among explanatory factors in explaining the change in equivalent income distribution. Column (3) shows that it accounts for 20 percent of the increase in Gini coefficient and 75-25 ratio, and 32 percent (or equivalently 1.4 percentage points) of the growth in low-income rate. Its impact was primarily concentrated in the lower half of the income distribution; it explains 33 percent and 36 percent of the increase in 90-10 and 50-10 ratios, respectively, while only 13 percent of the increase in 90-50 ratio. This suggests that increasing single-head families (lone parents or unattached families) were associated with low-incomes. It is also notable that changes in family structure were also responsible for as much as $755 decline in median over this period.

As for the contribution of other attributes on the inequality measures, column (4) shows the effects are fairly small across all measures except for movement in median income. Actually, factors in this category contributed to inequality in an opposite way. They brought down low-income rate by 0.7 percentage point, and also moved median up by $803 between 1970 and 1997. It is not sure which factor in this category contributed a substantial offset effect in the growing inequality. One possible explanation is the shift in age structure. In 1997, the baby boom cohort had reached their best time of life with substantial accumulation of experience and human capital. It is reasonable to see that increasing proportion of prime-age people propelled the national median upward.

Finally, the contribution of residual factor is considerably large as listed in column (5) of Table 1. More than half of the increase in Gini and low-income rate remain unexplained. The residual effects were even stronger in the upper half of the income distribution compared to dispersions in the lower half. For instance, more than

70 percent of the increase in the 90-50 and 75-50 ratios cannot be explained by any of these four explanatory factors above, while the shares are only 39 percent and 36 percent for the 90-10 and 50-10 ratios, respectively. The relatively large residual effects in the upper tail dispersion preserve discussion of roles for other uncontrolled factors, such as technical, globalization, correlation between husband and wife earnings, or perhaps simply the business cycle, on the changes in equivalent income. Nevertheless, there is no way to distinguish such effects from the residual in this context.

Reverse-Order Decomposition

As mentioned earlier, contributions of explanatory factors may change if there were overlapping effects between factors. Therefore, results from the reverse-order decomposition are also presented in Table 2. Derivation of re-weighting functions for reverse order is described in Appendix A. Generally, all measures display similar patterns as those shown in the primary-order decomposition. The contribution of other attributes with respect to income dispersions (except for lower tail dispersion) remained insignificant even if they were considered as the first in the decomposition. Interestingly, the contribution of 50-10 ratio has increased noticeably, with the expense from immigration factors. It is very likely overestimated because factors such as a geographic shift from rural to urban areas is possibly associated with great inflows of low-performance immigrants who largely reside in cities.

Contributions associated with changes in family structure increased slightly in the reverse-order decomposition, notably in the upper half of the distribution. For instance, changes in family structure accounted for 20 percent of the increase in the 90-50 ratio for

the reverse-order decomposition, while the share was only 13 percent for the primary-order decomposition in which the immigration factors were conditioned. These effects, however, might be overestimated because changing family structure (e.g., increasing single families) was likely associated with the increase in young professional immigrants under the skill-based "independent" immigration visa category. Finally, effects due to changes in immigrants' factors reduced a bit when they were considered the last in the decomposition. Nevertheless, immigration factors were still responsible for 0.8 percentage point of the increase in low-income rate and a notable $376 reduction in median income over this period.

Decomposition breakdown by two periods: 1980-1989 and 1989-1997

Table 3 and Table 4 break down the previous analysis into two periods: 1989-1989 and 1989-1997 representing a peak-to-peak (or near peak) year in the 80s and 90s, respectively. Peak-to-peak years are selected for the purpose of avoiding possible variations due to business cycles. Surprisingly, the increase in overall inequality was principally concentrated in the second period. More than two-thirds of the increase in every inequality measure between 1980 and 1997 took place in the 1990s, and there was no change in low-income rate in the first period. In fact, the entire economy was growing in the 1980s. The slow growth in inequality and a substantial gain in median income ($1441) suggest an overall improvement of economy in the 1980s. The slightly increase of income dispersion in the lower half (50-10 ratio) can be picked up mostly by the changes in family structure. Nevertheless, it is worth noting that the significant gain in median income in this period was mostly associated with residual factors (might be

technical change or more open economy), and part of the growth was actually offset by the immigration factors as well as family structure.

The story changed dramatically in the second period. Nearly 100 percent of the increase in low-income rate between 1980 and 1997 occurred in the 1990s, correspondingly with a significant drop in median income ($1900). Again, residual or unexplained factors dominated other factors in explaining the change in inequality, accounting for more than three-quarters of the increase in most of the measures in this period. Changes in family structure were still contributing an influential role particularly in the lower half of the income dispersions, explaining 25 percent of the increase in 50-10 ratio and 15 percent of the growth in the low-income rate during this period. One different story from the 1990s is that the contribution from immigration factors became noticeable in the decomposition. Immigration factors from (1) and (2) of Table 4 together explained 20 percent of the increase in Gini, and nearly 1 percentage point growth in low-income rate. The sudden increasing impact of immigrants on income distribution is consistent with the historical trend of increasing inflow of recent immigrants in the early 1990s.

It is also worth noting that as much as a $1604 decline in median income and 74 percent (or equivalently 3.1 percentage points) of the increase in low-income rate remained unexplained during this period. Some might relate these to the declining role of government transfers in the 1990s. It is unlikely because government transfers were excluded from the calculation of equivalent income in this study. It is also possible that the overall decline in living standards was just reflecting the effect of a macro condition.

Perhaps the economy in year 1997 was simply not good enough to compare to the economy in 1989 or 1980.

VI. Conclusion

Inequality based on equivalent income in Canada has increased between 1980 and 1997, mainly in the 1990s. SCF data show that inequality was largely associated with gains in the lower half rather than the increase in both ends of the income distribution. What has driven the changes of income structure in Canada? What is the rising income dispersion in relation to the increasing trend of non-traditional families? Do the increasing proportion of recent immigrants and changing compositions of immigrants affect inequality at the national level? What policy implications have we learned from this? The objective of this paper is to provide explanations of factors that affect inequality and low-income in Canada, taking advantage of a new technique developed by DiNardo, Fortin and Lemieux (1996). This procedure provides two relative advantages compared to the conventional regression-based or mean deviation methods in estimating inequality. First, it enables us to focus on the changes of the entire distribution rather than mean or quintiles of a distribution. Second, the results provide more behaviour interpretation because counterfactual densities constructed in this format allow a conditional relationship between explanatory factors and a set of other controls. The analysis first focused on the entire period from 1980-1997, then further divided by two sub-periods 1980-1989 and 1989-1997, which represent one peak-to-peak cycle and one peak-to-near peak business cycle.

During the entire period, each of the four explanatory factors exhibited notable contributions to the increase in inequality. The effects are much stronger in explaining the increase in the lower half of the distribution. They together explained 64 percent and 61 percent of the 50-10 and 90-10 ratio, respectively. But the rising income dispersions in the upper half (e.g., 75-50 ratio) were largely associated with unknown factors.

With respect to the contribution of each factor, the effect of rising non-traditional families is consistent with previous Canadian literature, which would tend to increase income inequality. Conditional on other attributes, changes in family structure were responsible for 20 percent of the increase in Gini coefficient and 1.4 percentage points increase in low-income rate between 1980 and 1997. The impacts were especially salient on the lower half income dispersions, suggesting that increasing single-head families were more likely associated with low incomes. Changes in other attributes had an equalizing effect on the distribution of equivalent income. Its counterfactual effect reduced low-income rate by 0.7 percentage point and pushed the median $800 above. The growing people in the prime age (due to the baby boom population) as well as migration from rural toward urban areas all worked to increase middle point and might explain the equalizing effect in this category.

Turning to the immigration factors, surprisingly they played quite an influential role in explaining income dispersion. Holding constant full-time employment rate of immigrants at the earlier year level would reduce 26 percent of the increase in 50-10 ratio and drop low-income rate by 0.7 percentage point. When proportion of recent immigrants and mother tongue compositions were held constant at the 1980 level, it further explained 0.5 percentage point growth in low-income rate and 7 percent of the

increase in Gini coefficient. Conditional on family structure and other attributes, immigration factors explained about 17 percent (or equivalently 1.2 percentage points) of the increase in low-income rate and were responsible for a $462 decline in median between 1980 and 1997. Nearly all these effects took place in the 1990s—the period that a great inflow of a new type of immigrants occurred.

Finally, it should be noted that a great proportion of the increase in inequality and low-income rate remained unexplained in both periods. It is not certain which unknown factor dominated the inequality trend in Canada in this study. In the US, technological change and open economy are common explanations for the rising inequality or wage polarization. Raw data from SCF do not seem to support this view because the rising wage dispersion among males was not considerably large, and the earnings gain from the upper portion of the distribution was only modest. Although wage disparity might be very substantial within some certain groups or industries, these effects were washed out in the aggregate level. The increasing correlation between husband and wife earnings was not examined in this context. However, raw data do show that there was a significant increase in the proportion of working wives among husbands whose earnings were on the top quartile of the distribution. The increasing families with two high-wage earners might be an interesting issue to pursue in examining family income inequality in the future.

What policy implications will we be focusing on from these results? Decomposition has shown that market-based inequality and low-income rate are highly associated with increasing single-head families and recent immigrants. It raises the role of government transfers as well as social programs. Whom should the welfare target and

what social programs (e.g., career or language training) should be implemented as a priority? Do increasing credit constraints or minimum wages help single-head families and immigrants to improve their market outcome? How do we help skilled-immigrants to get a connection with the host country? Issues such as discounting human capital of immigrants, recognition of foreign credentials, discrimination, and increasing burden of the welfare system need to be taken into account when discussing immigration related policies in the future. Ignoring such issues would lead to a more unequal society and perhaps social exclusion.

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Figure 1: Trends of Inequality and Low-income, Equivalent Market Income

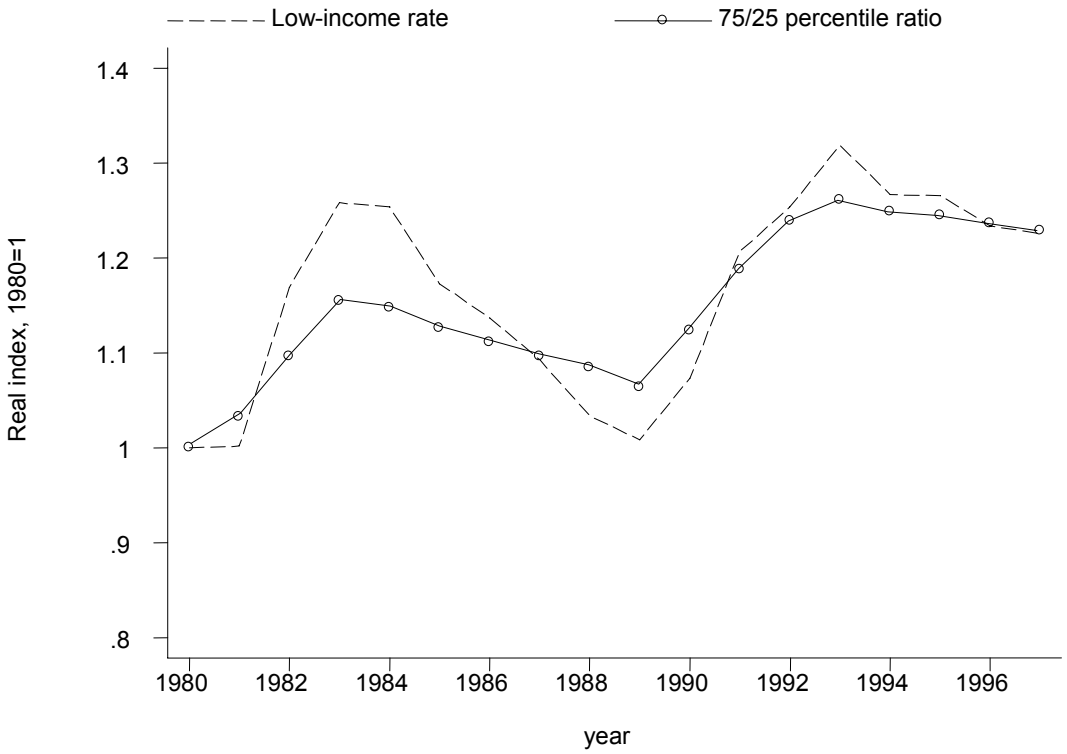

Figure 2: Indexed Equivalent Income by percentile, 1980-1997

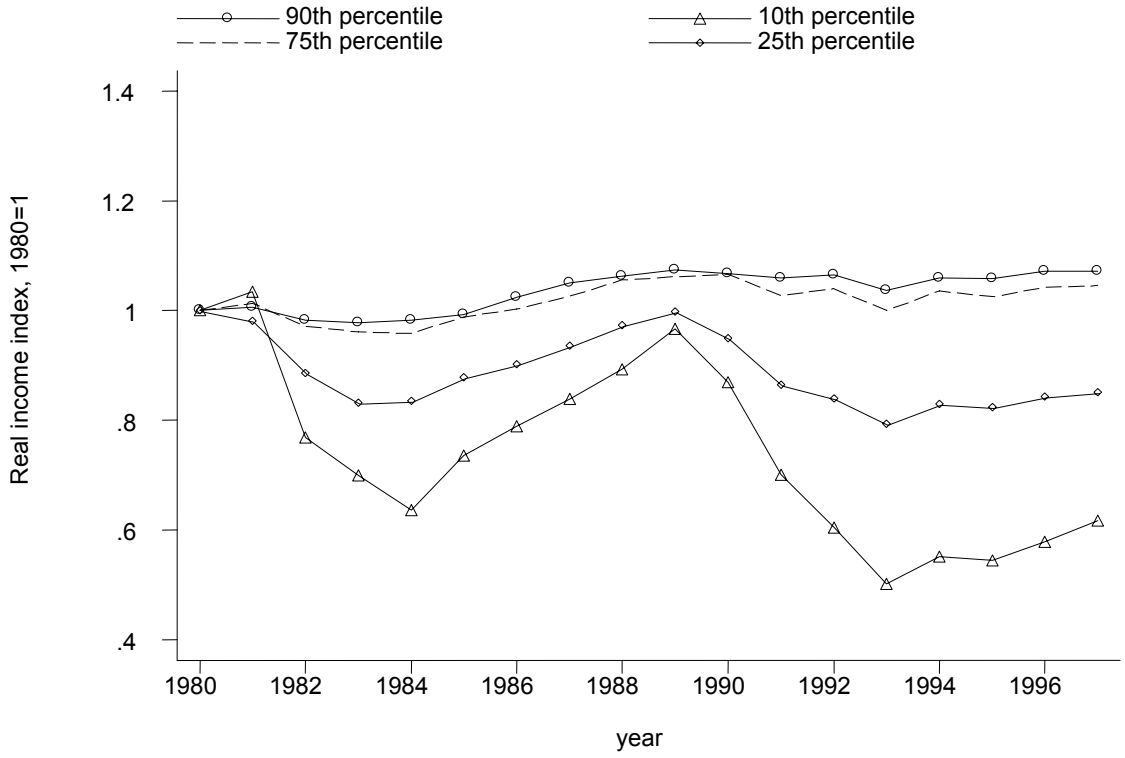

Figure 3: Kernel Density for Equivalent Income

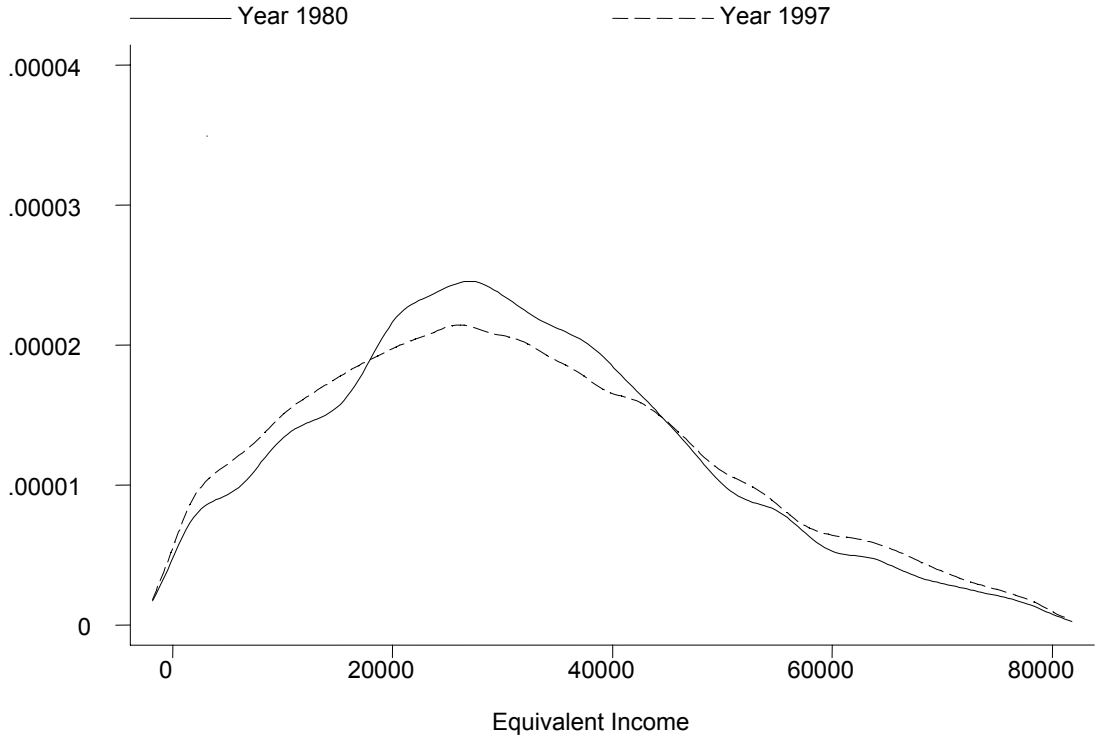

Figure 3A: Kernel Density for Equivalent Income

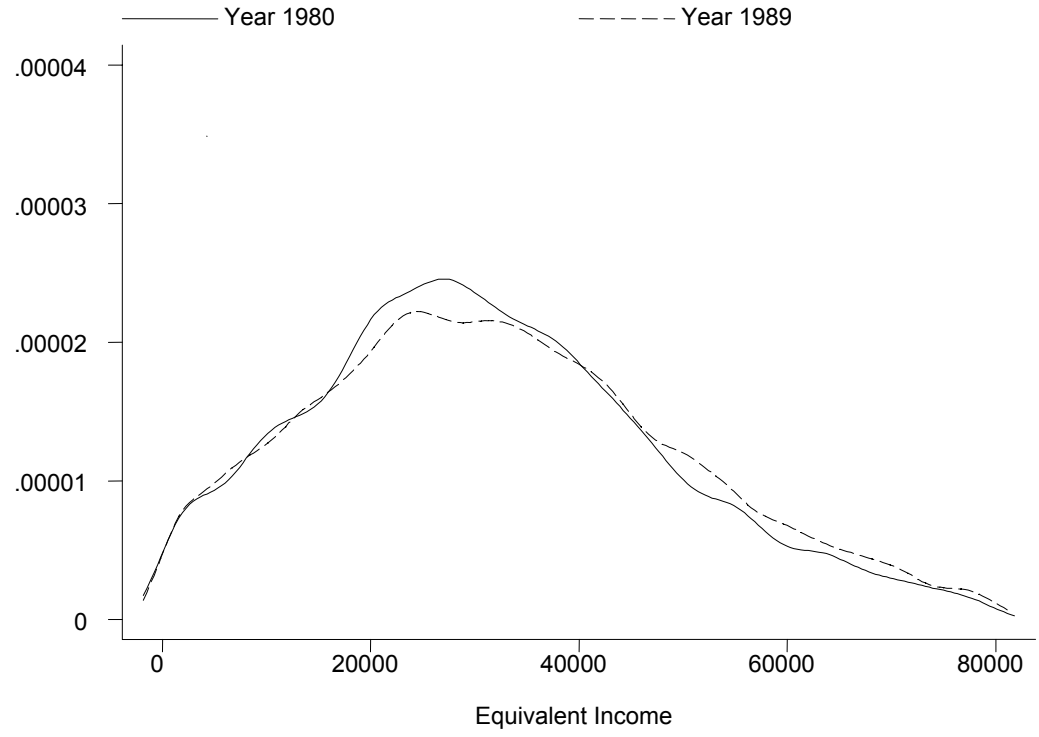

Figure 3B: Kernel Density for Equivalent Income

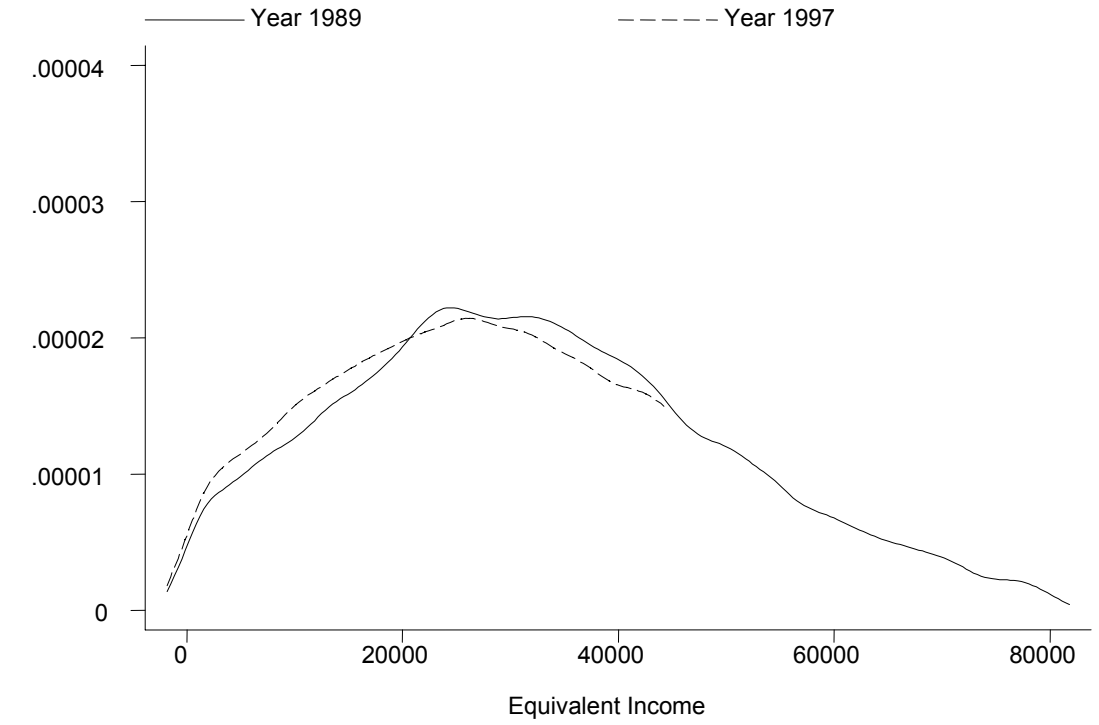

Figure 4: Inequality measures for Male earnings (age 15-64)

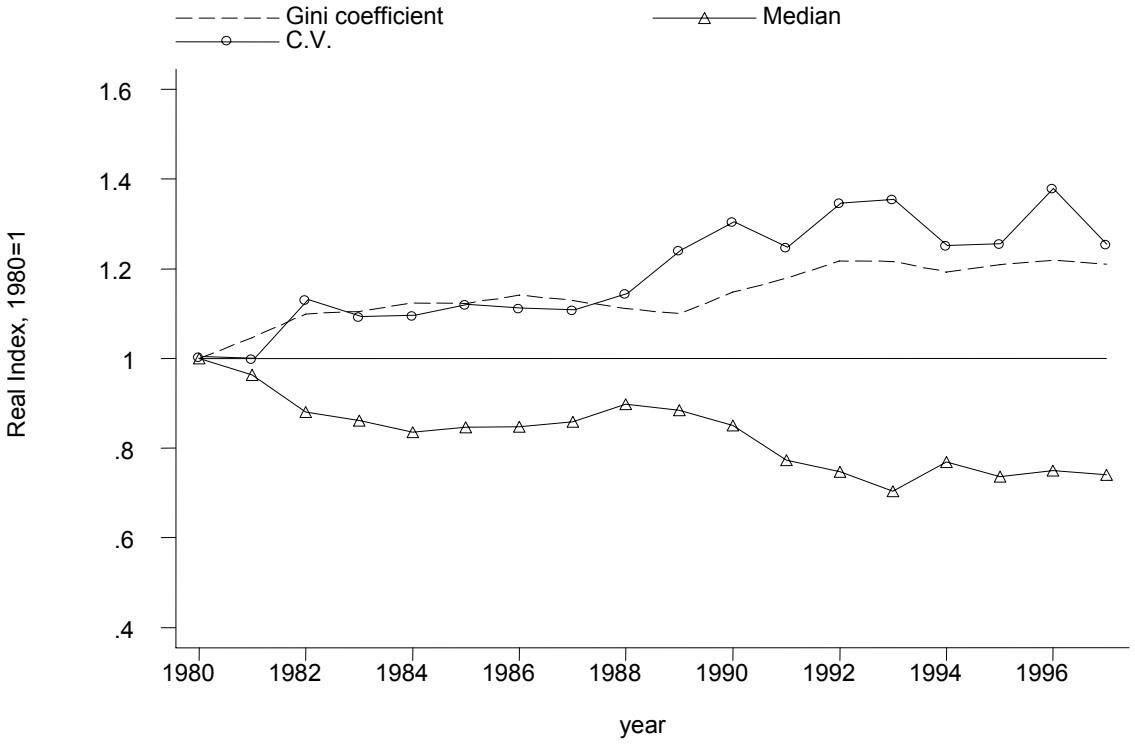

Figure 5: Proportion of working wives by husband's quartile earnings distribution, couple families

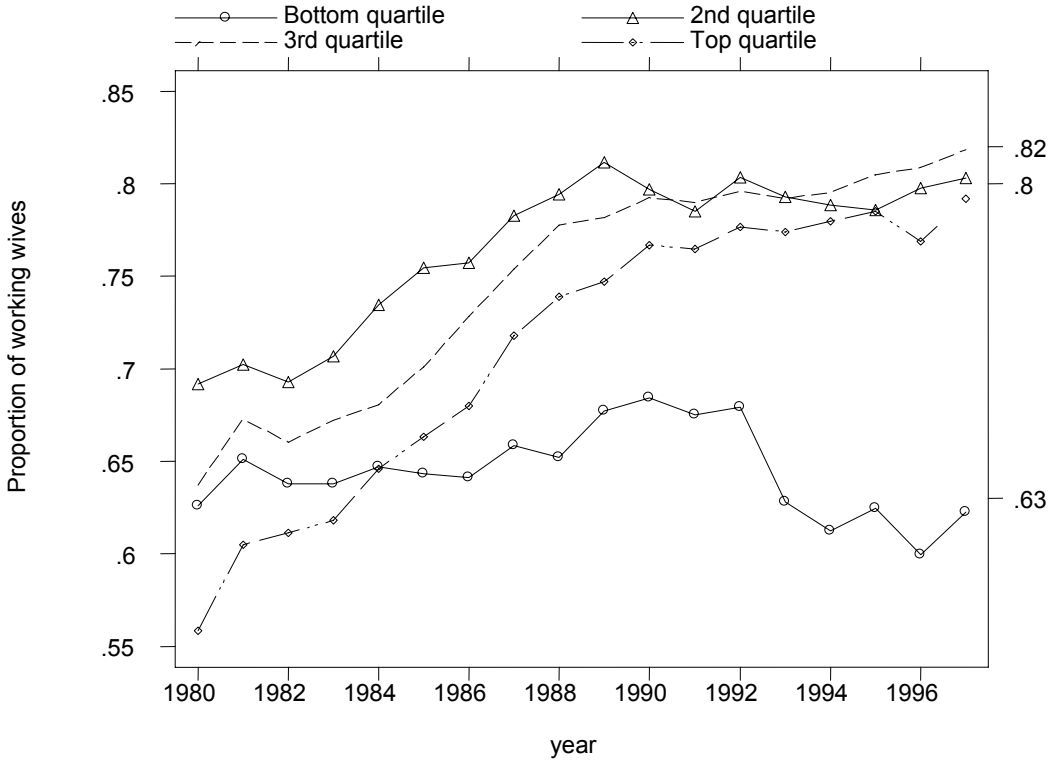

Figure 6: Family Composition

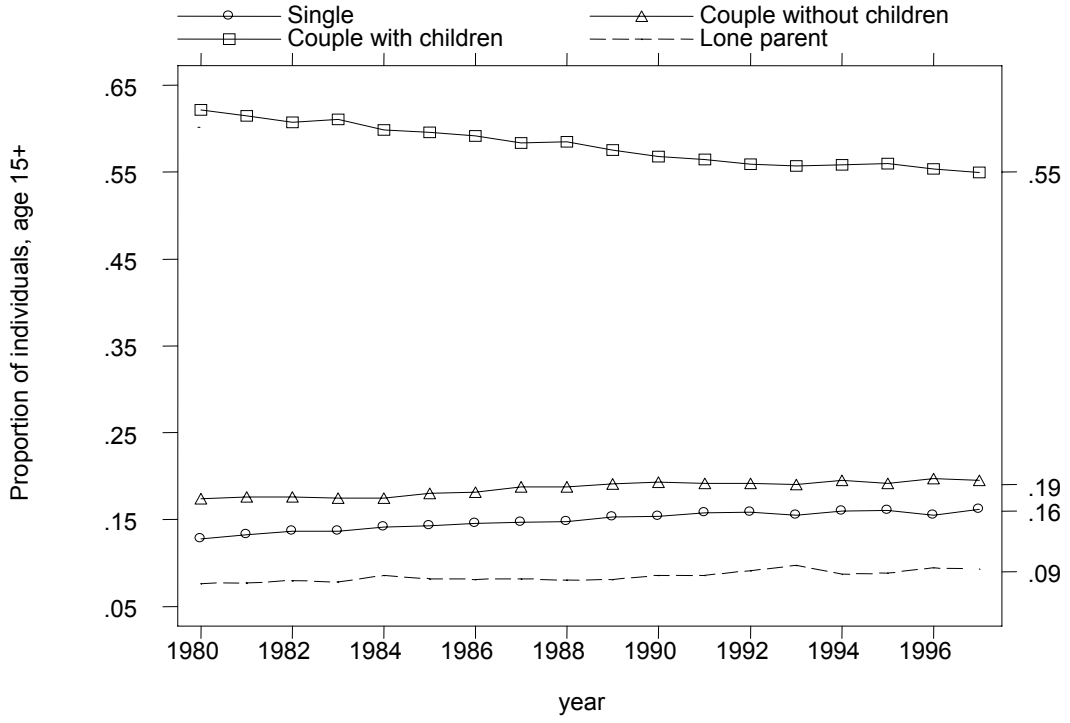

Figure 7: Median Equivalent Market Income, (age 15+)

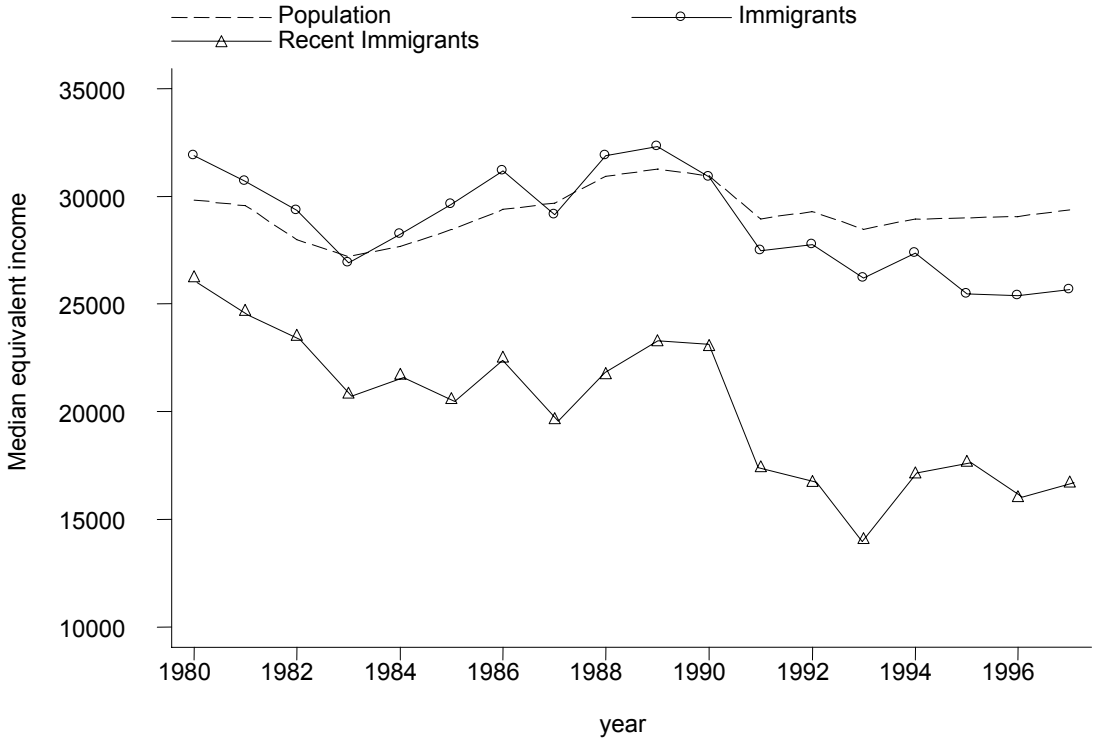

Figure 8: Full-time employment rate, Individuals age 15-64

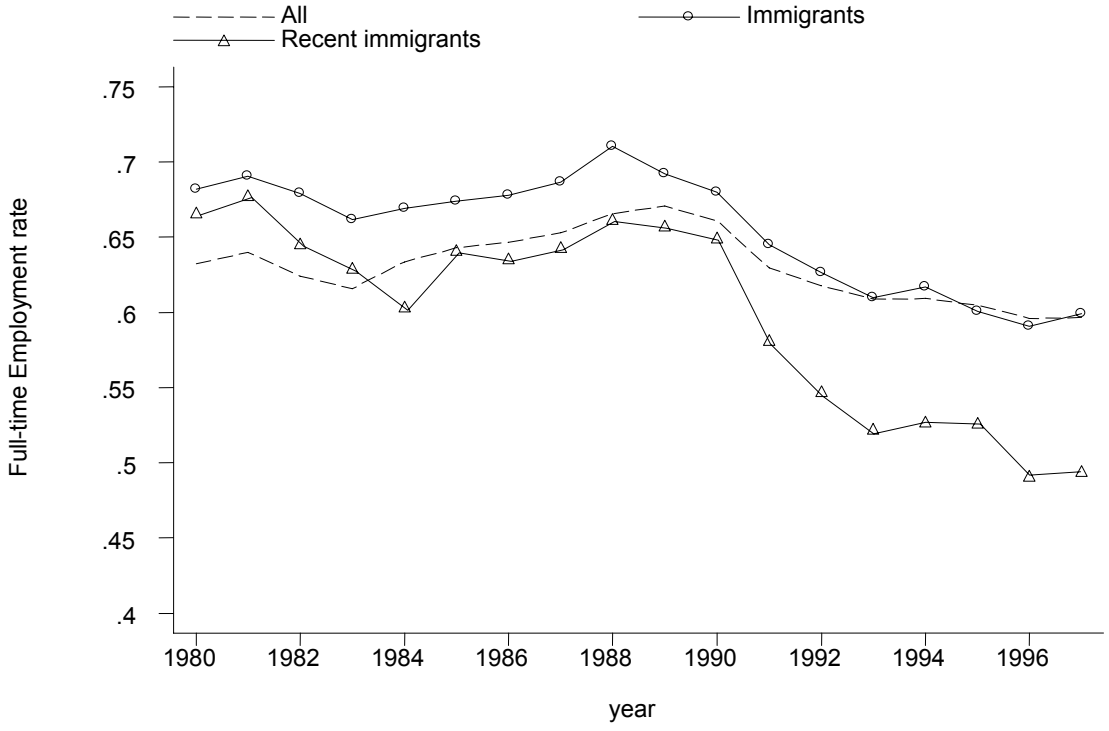

Figure 9: Proportion of immigrants whose mother tongue is English or French

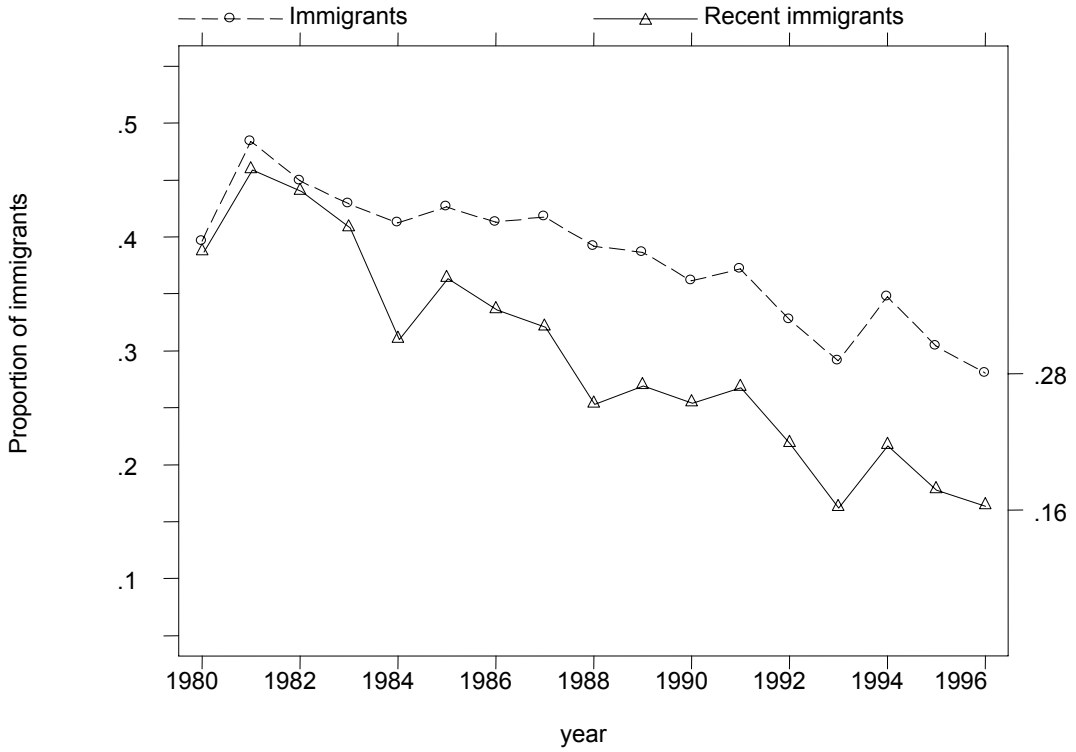

Figure 10: 1997 Equivalent Incomes with 1980 Immigrants' full-time employment

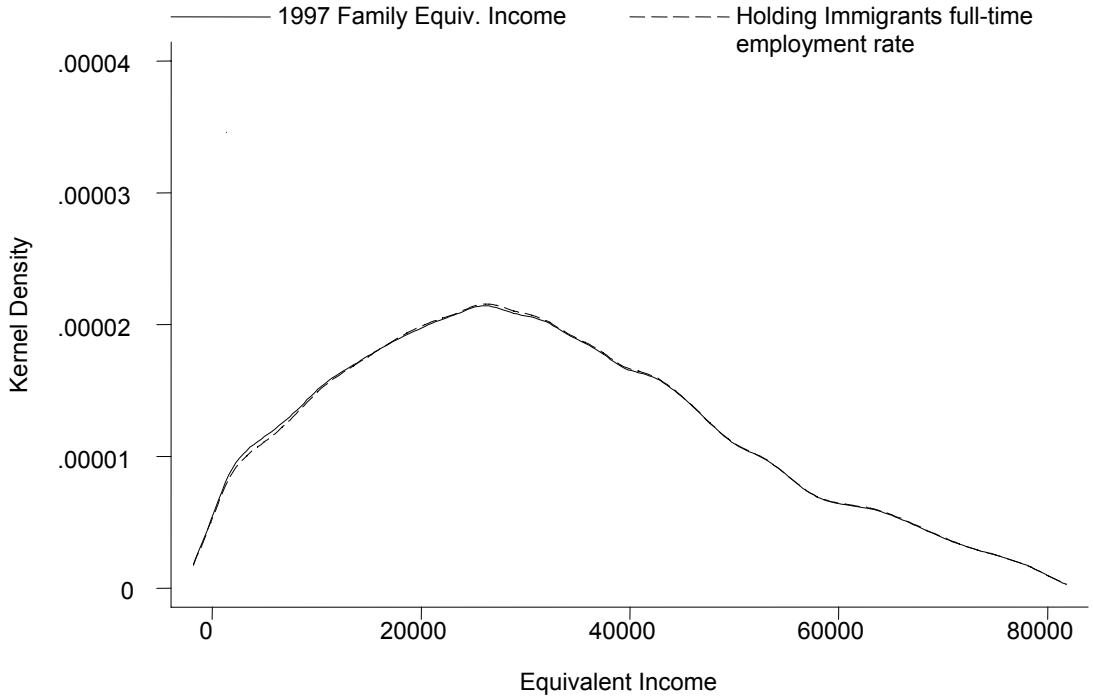

Figure 11: 1997 Equivalent Incomes with 1980 Immigrants' full-time employment, mother tongue and migration duration compositions

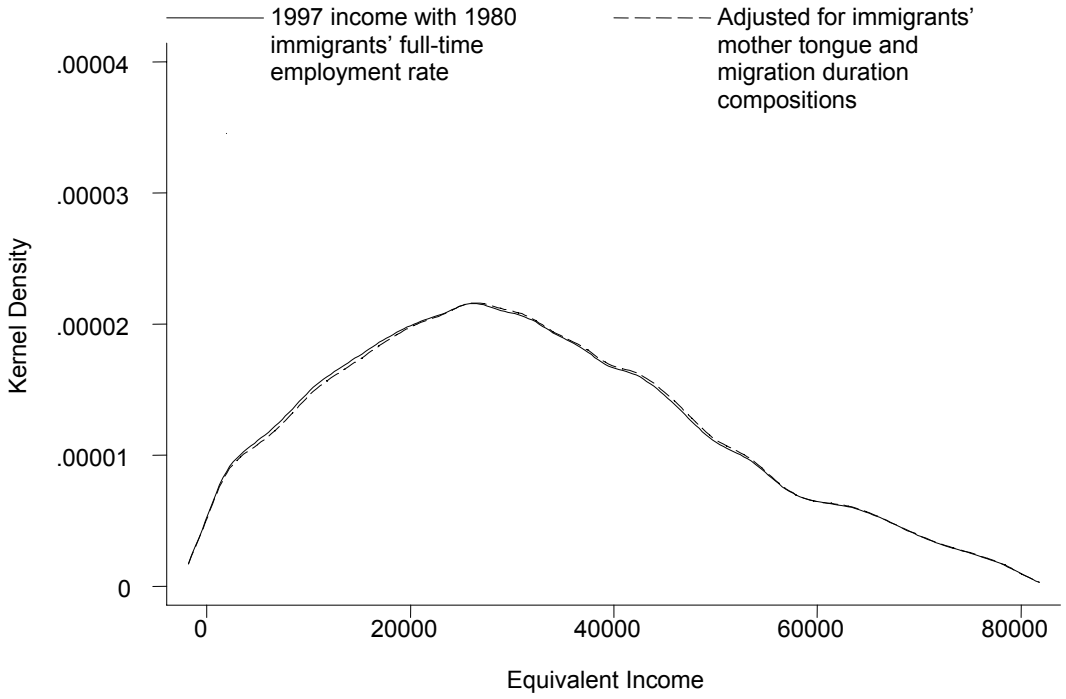

Figure 12: 1997 Equivalent Incomes with 1980 Immigration factors and family structure

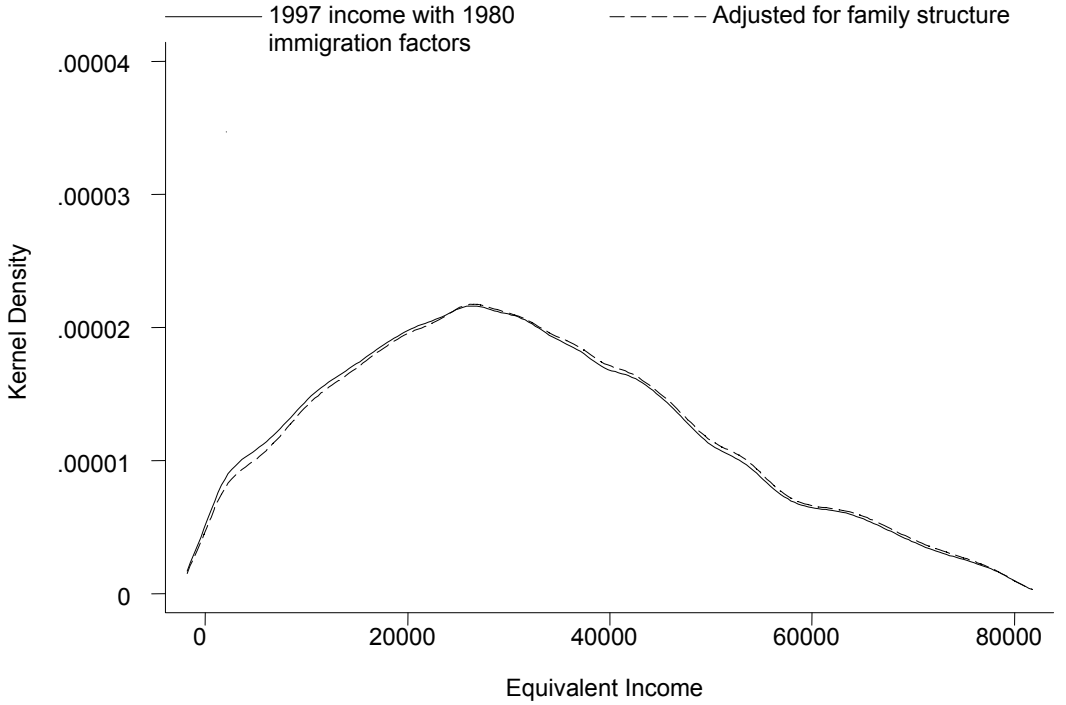

Figure 13: 1997 Equivalent Incomes with 1980 Immigration factors, family structure and other attributes

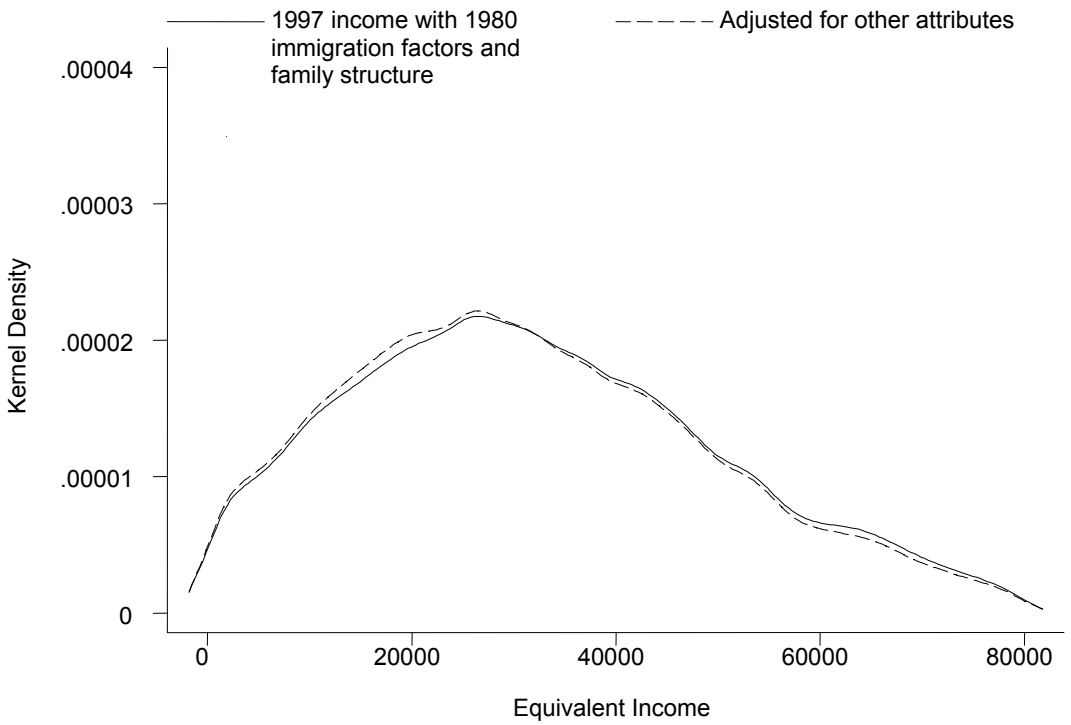

Figure 14: Residual

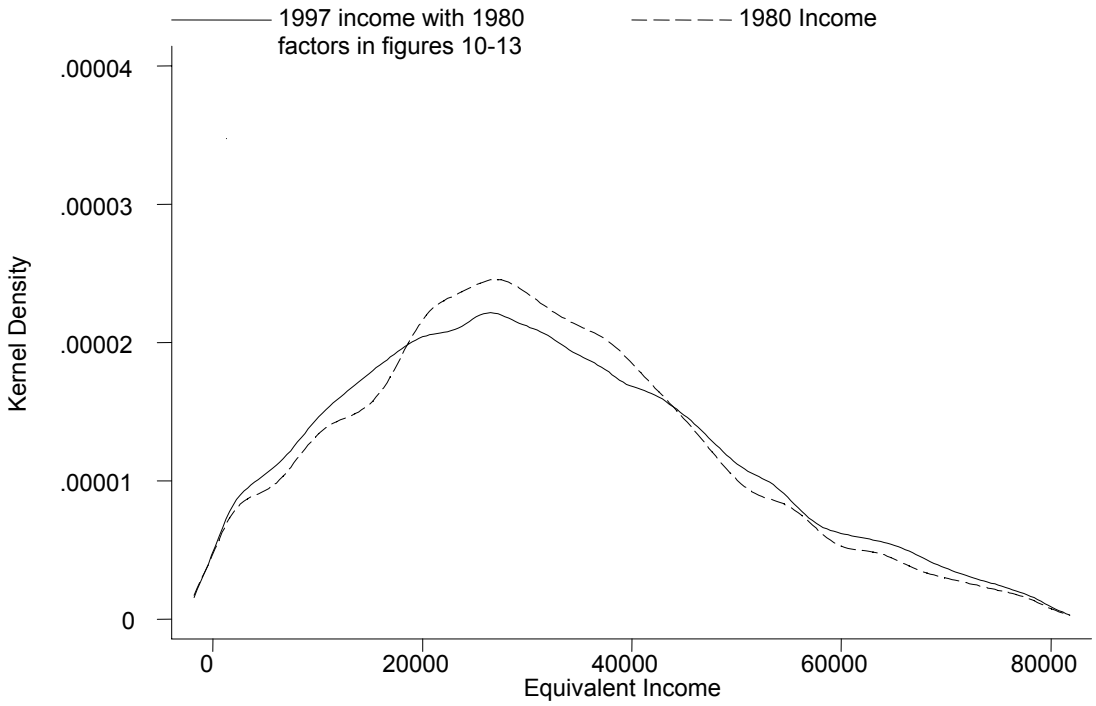

Table 1: Primary-Order Decomposition of Changes in the Distribution of Family Equivalent Income, 1980-1997

Statistics	Total Change	Effect of				
		Immigrant FT rate[1] (1)	Immigrants Lang./dur.[2] (2)	Family Structure (3)	Other Attributes[3] (4)	Residual Factors (5)
Gini	0.042	0.005 (0.12)	0.003 (0.07)	0.008 (0.20)	0.001 (0.03)	0.024 (0.57)
C.V.	0.095	0.009 (0.09)	0.006 (0.07)	0.008 (0.09)	0.020 (0.21)	0.052 (0.55)
90-10	5.384	1.278 (0.24)	0.379 (0.07)	1.789 (0.33)	-0.153 (-0.03)	2.091 (0.39)
90-50	0.169	0.009 (0.06)	0.011 (0.06)	0.022 (0.13)	0.009 (0.05)	0.118 (0.70)
75-25	0.526	0.079 (0.15)	0.027 (0.05)	0.104 (0.20)	-0.034 (-0.07)	0.350 (0.67)
75-50	0.088	0.010 (0.11)	0.005 (0.06)	0.014 (0.15)	-0.008 (-0.09)	0.068 (0.77)
50-25	0.252	0.040 (0.16)	0.012 (0.05)	0.053 (0.21)	-0.014 (-0.05)	0.161 (0.64)
50-10	2.263	0.586 (0.26)	0.154 (0.07)	0.814 (0.36)	-0.095 (-0.04)	0.804 (0.36)
Low-income rate	0.043	0.007 (0.17)	0.005 (0.11)	0.014 (0.32)	-0.007 (-0.15)	0.024 (0.55)
Median	-457.17	-233.65 (0.51)	-228.13 (0.50)	-754.97 (1.65)	802.71 (-1.76)	-43.13 (0.09)

Note: Percent of total variation explained in parenthesis.
1. Effect of immigrants held proportion of full-time working immigrants constant at the earlier year levels.
2. Effect of immigrants held mother tongue and migration duration constant at the earlier year levels.
3. Other attributes are age, sex, province indicators, CMA, sizes of area.

Table 2: Reverse-Order Decomposition of Changes in the Distribution of Family Equivalent Income, 1980-1997

Statistics	Total Change	Effect of				
		Other Attributes[1] (1)	Family Structure (2)	Immigrants Lang./dur.[2] (3)	Immigrants FT rate[3] (4)	Residual Factors (5)
Gini	0.042	0.003 (0.07)	0.010 (0.24)	0.003 (0.07)	0.002 (0.05)	0.024 (0.57)
C.V.	0.095	0.017 (0.18)	0.016 (0.17)	0.005 (0.05)	0.004 (0.04)	0.052 (0.55)
90-10	5.384	0.710 (0.13)	1.961 (0.36)	0.433 (0.08)	0.189 (0.04)	2.091 (0.39)
90-50	0.169	-0.001 (0.00)	0.034 (0.20)	0.010 (0.06)	0.007 (0.04)	0.118 (0.70)
75-25	0.526	0.011 (0.02)	0.118 (0.23)	0.034 (0.06)	0.012 (0.02)	0.350 (0.67)
75-50	0.088	-0.006 (-0.06)	0.019 (0.22)	0.003 (0.03)	0.004 (0.05)	0.068 (0.77)
50-25	0.252	0.014 (0.06)	0.055 (0.22)	0.019 (0.08)	0.003 (0.01)	0.161 (0.64)
50-10	2.263	0.341 (0.15)	0.857 (0.38)	0.186 (0.08)	0.076 (0.03)	0.804 (0.36)
Low-income rate	0.043	-0.002 (-0.06)	0.014 (0.32)	0.004 (0.10)	0.004 (0.08)	0.024 (0.55)
Median	-457.17	441.45 (-0.97)	-479.56 (1.05)	-153.34 (0.34)	-222.59 (0.49)	-43.13 (0.09)

Note: Percent of total variation explained in parenthesis.
1. Other attributes are age, sex, province indicators, CMA, sizes of area.
2. Effect of immigrants held mother tongue and migration duration constant at the earlier year levels.
3. Effect of immigrants held proportion of full-time working immigrants constant at the earlier year levels.

Table 3: Primary-Order Decomposition of Changes in the Distribution of Family Equivalent Income, 1980-1989

Statistics	Total Change	Effect of				
		Immigrant FT rate[1] (1)	Immigrants Lang./dur.[2] (2)	Family Structure (3)	Other Attributes[3] (4)	Residual Factors (5)
Gini	0.013	0.001 (0.06)	0.001 (0.06)	0.004 (0.35)	0.001 (0.09)	0.006 (0.45)
C.V.	0.050	0.000 (0.00)	0.001 (0.03)	0.010 (0.20)	-0.002 (-0.04)	0.041 (0.81)
90-10	0.820	0.047 (0.06)	0.102 (0.12)	0.525 (0.64)	0.021 (0.03)	0.125 (0.15)
90-50	0.048	0.001 (0.02)	0.003 (0.06)	0.003 (0.05)	0.002 (0.04)	0.040 (0.83)
75-25	0.145	0.007 (0.05)	0.010 (0.07)	0.038 (0.26)	0.013 (0.09)	0.077 (0.53)
75-50	0.018	0.001 (0.05)	0.000 (0.01)	0.002 (0.13)	0.002 (0.10)	0.013 (0.72)
50-25	0.080	0.004 (0.05)	0.007 (0.09)	0.024 (0.29)	0.007 (0.09)	0.039 (0.48)
50-10	0.323	0.022 (0.07)	0.046 (0.14)	0.262 (0.81)	0.007 (0.02)	-0.013 (-0.04)
Low-income rate	0.002	0.001 (0.77)	0.003 (1.70)	0.008 (5.10)	-0.003 (-1.64)	-0.008 (-4.94)
Median	1440.59	-44.81 (-0.03)	-84.30 (-0.06)	-333.82 (-0.23)	417.78 (0.29)	1485.74 (1.03)

Note: Percent of total variation explained in parenthesis.
1. Effect of immigrants held proportion of full-time working immigrants constant at the earlier year levels.
2. Effect of immigrants held mother tongue and migration duration constant at the earlier year levels.
3. Other attributes are age, sex, province indicators, CMA, sizes of area.

Table 4: Primary-Order Decomposition of Changes in the Distribution of Family Equivalent Income, 1989-1997

Statistics	Total Change	Effect of				
		Immigrant FT rate[1] (1)	Immigrants Lang./dur.[2] (2)	Family Structure (3)	Other Attributes[3] (4)	Residual Factors (5)
Gini	0.029	0.004 (0.14)	0.002 (0.06)	0.004 (0.14)	0.000 (0.01)	0.019 (0.65)
C.V.	0.044	0.007 (0.16)	0.004 (0.08)	0.004 (0.08)	0.010 (0.23)	0.020 (0.44)
90-10	4.564	1.014 (0.22)	0.192 (0.04)	1.023 (0.22)	-0.094 (-0.02)	2.429 (0.53)
90-50	0.121	0.006 (0.05)	0.016 (0.13)	0.007 (0.06)	0.004 (0.03)	0.089 (0.74)
75-25	0.381	0.062 (0.16)	0.032 (0.08)	0.033 (0.09)	-0.021 (-0.06)	0.276 (0.72)
75-50	0.071	0.006 (0.09)	0.010 (0.15)	0.002 (0.03)	-0.005 (-0.07)	0.057 (0.80)
50-25	0.172	0.033 (0.19)	0.008 (0.05)	0.019 (0.11)	-0.008 (-0.05)	0.120 (0.70)
50-10	1.940	0.469 (0.24)	0.050 (0.03)	0.477 (0.25)	-0.055 (-0.03)	0.999 (0.52)
Low-income rate	0.042	0.006 (0.14)	0.003 (0.07)	0.006 (0.15)	-0.005 (-0.11)	0.031 (0.74)
Median	-1897.76	-163.49 (0.09)	-243.60 (0.13)	-255.18 (0.13)	368.45 (-0.11)	-1603.95 (0.85)

Note: Percent of total variation explained in parenthesis.
1. Effect of immigrants held proportion of full-time working immigrants constant at the earlier year levels.
2. Effect of immigrants held mother tongue and migration duration constant at the earlier year levels.
3. Other attributes are age, sex, province indicators, CMA, sizes of area.

Appendix A: Derivation of reverse-order decomposition

Family equivalent income distribution in reverse-order conditioning sequence can be expressed as

$$f_t(Y) = f(Y \mid t_Y = 97, t_{X|S,L,I} = 97, t_{S|L,I} = 97, t_{L|I} = 97, t_I = 97) \tag{A1}$$
$$= \int\int\int\int f(Y \mid X,S,L,I,t_Y = 97)dF(X \mid S,L,I,t_{X|S,L,I} = 97)dF(S \mid L,I,t_{S|L,I} = 97)$$
$$\cdot dF(L \mid I,t_{L|I} = 97)dF(I,t_I = 97)$$

The counterfactual density of family income in 1997, holding constant "other attributes X", "family structure S", and "immigration factors L, I" at their 1980 levels is:

$$f_t(Y) = f(Y \mid t_Y = 97, t_{X|S,L,I} = 80, t_{S|L,I} = 80, t_{L|I} = 80, t_I = 80)$$
$$= \int\int\int\int f(Y \mid X,S,L,I,t_Y = 97)dF(X \mid S,L,I,t_{X|S,L,I} = 80)dF(S \mid L,I,t_{S|L,I} = 80)$$
$$dF(L \mid I,t_{L|I} = 80)dF(I \mid t_I = 80)$$
$$= \int\int\int\int f(Y \mid X,S,L,I,t_Y = 97)dF(X \mid S,L,I,t_{X|S,I} = 97)\frac{dF(X \mid S,L,I,t_{X|S,I} = 80)}{dF(X \mid S,L,I,t_{X|S,I} = 97)}$$
$$\cdot dF(S \mid L,I,t_{S|L,I} = 97)\frac{dF(S \mid L,I,t_{S|L,I} = 80)}{dF(S \mid L,I,t_{S|L,I} = 97)} \cdot dF(L \mid I,t_{L|I} = 97)\frac{dF(L \mid I,t_{L|I} = 80)}{dF(L \mid I,t_{L|I} = 97)}$$
$$\cdot dF(I \mid t_I = 97)\frac{dF(I \mid t_I = 80)}{dF(I \mid t_I = 97)}$$
$$= \int\int\int\int f(Y \mid X,S,L,I,t_Y = 97)dF(X \mid S,L,I,t_{X|S,L,I} = 97)dF(S \mid L,I,t_{S|L,I} = 97)$$
$$\cdot dF(L \mid I,t_{L|I} = 97)dF(I \mid t_I = 97)$$
$$\cdot \lambda_{X|S,L,I}(X,S,L,I) \cdot \lambda_{S|L,I}(S,L,I) \cdot \lambda_{L|I}(L,I) \cdot \lambda_I(I) \tag{A2}$$

Let us start with the re-weighting function for immigrants' full-time employment factor:

$$\lambda_I(I) = \frac{dF(I \mid t_I = 80)}{dF(I \mid t_I = 97)} = \frac{\Pr(t_I = 80 \mid I)}{\Pr(t_I = 97 \mid I)} \cdot \frac{\Pr(t_I = 97)}{\Pr(t_I = 80)}. \tag{A3}$$

Equation (A3) shows that the re-weighting function for immigration factor is simply equal to the probability of observing a full-time immigrant in the 1980 versus 1997 sample, multiple by the population ratio.

Similarly, re-weighting function adjusts for immigrants' mother tongue and migration duration compositions conditional on full-time employment rate is

$$\lambda_{L|I}(L,I) = \frac{dF(L \mid I, t_{L|I} = 80)}{dF(L \mid I, t_{L|I} = 97)} = \sum_{c=1}^{4} L_c \frac{\Pr(L = c \mid I, t_{L|I} = 80)}{\Pr(L = c \mid I, t_{L|I} = 97)}. \tag{A4}$$

Re-weighting function for family structure, conditional on immigration factors is:

$$\lambda_{S|L,I}(S,L,I) = \frac{dF(S \mid L, I, t_{S|L,I} = 80)}{dF(S \mid L, I, t_{S|L,I} = 97)} = \sum_{c=1}^{4} S_c \frac{\Pr(S = c \mid L, I, t_{S|L,I} = 80)}{\Pr(S = c \mid L, I, t_{S|L,I} = 97)}. \tag{A5}$$

Both re-weighting functions in (A4) and (A5) can be estimated through multinomial logit estimation. Finally, use a simple property, re-weighting function for other attributes $\lambda_{X|S,L,I}(X,S,L,I)$ can be expressed as:

$$\begin{aligned} \lambda(X,S,L,I) &= \lambda(X \mid S,L,I) \cdot \lambda(S \mid L,I) \cdot \lambda(L \mid I) \cdot \lambda(I) \\ &= \lambda(I \mid L,S,X) \cdot \lambda(L \mid S,X) \cdot \lambda(S \mid X) \cdot \lambda(X) \end{aligned} \tag{A6}$$

Rearranging equation (A6) and the $\lambda_{X|S,L,I}(X,S,L,I)$ can be obtained by the product of the complete set of primary-order weights, divided by the product of three reverse conditional weights (A5), (A4) and (A3).

$$\lambda_{X|S,L,I}(X \mid S,L,I) = \frac{\lambda_{I|L,S,X}(I \mid L,S,X) \cdot \lambda_{L|S,X}(L \mid S,X) \cdot \lambda_{S|X}(S \mid X) \cdot \lambda_X(X)}{\lambda_{S|L,I}(S \mid L,I) \cdot \lambda_{L|I}(L \mid I) \cdot \lambda_I(I)} \tag{A7}$$