Evaluating Mobility Between Unmatched Quantiles: The Effects on Generational Mobility of Changes in Family Law in the United States.

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Abstract

This paper addresses the intergenerational mobility question by examining the role of family structure in the transmission of educational attainment within a family using the one percent Integrated Public Use Microsample Series (IPUMS) of the decennial Census for the decades 1970 and 1990. We first introduce mobility indices and tests which examine the proximity of the transition matrix to that which would pertain in the perfectly mobile state. Unlike existing transition matrix based mobility indices, these indices and tests can be employed when the transition matrix is not square, and when the transition matrix is between states that are defined multivariately or more generally when the quantiles of the marginal states are unmatched. Using educational attainment as a proxy for permanent income for children and both educational attainment and income as proxies for parents, the tests indicate that mobility significantly increased, both in the population as a whole and within intact parent and single parent sub-populations, over the period. Within the single parent group there was much less evidence for significant mobility change for children from exogenous single parent families than for children from endogenously single parent families, which accords with theoretical predictions. There is also some evidence of convergence between intact and single parent groups, suggesting that there is a trend towards equal opportunity for children of intact and endogenously single parent families.

Keywords: intergenerational mobility, joint custody, educational attainment, family structure

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During the 1970's and 1980's substantial changes in family law and practice were introduced in the United States in part to improve the life chances of children in single parent custodial situations relative to children in intact marriages. In the spirit of an equal opportunity imperative the intent was to bring about an increase in material support and paternal involvement in the development of children in divorced and separated parent situations[1] bringing them closer to parity with children in other circumstances. In effect the changes were intended to increase intergenerational mobility, to make the life chances of children less dependent upon the nature of the parental arrangement under which they found themselves. The extent to which such objectives have been achieved has fostered much public and academic debate elsewhere in the realms of health, education and income policy. Evaluating the attainment of such objectives involves analyzing the nature of transition, the way in which the outcomes in one state or generation are subsequently morphed into the outcomes of another. The degree of mobility relates to the extent to which the transition is "unstructured" (the two states are independent) whereas immobility corresponds to higher degrees of dependence. These notions of mobility are of interest to a broader congregation. In addition to generational income mobility (Corak (2004), Dworkin (1981), Roemer (1998), Roemer (2002), Roemer (2004), Roemer et al. (2003)) and dynastic poverty (Kanbur and Stiglitz (1986)), the fields of growth empirics (Quah (1996)), social mobility (Treiman and Ganzenboom (1990)) and Industrial Organization (Boyle and Sorensen (1971)) all have interests in the issue of evaluating the nature of transition.

In the study of intergenerational income mobility attention has been focused on the interpretation of the regression coefficient (β) of log child income when adult (y) on log income of the corresponding parent (x) (Solon (2004)). In effect that literature interpreted β as a mobility index building upon Becker and Tomes (1979) to create a rich class of models which highlight the many forces, both public and private, determining the value of β. The literature inferred mobility (equal opportunity) as $\beta \to 0$ and immobility (unequal

[1] There is evidence to support the view that the changes were effective in this regard.

opportunity) as $\beta \rightarrow 1$. Mobility interpretations of β are to some extent limited by its connection to the correlation coefficient ρ_{yx} $\left(\beta = \rho_{yx}\left(\frac{\sigma_y}{\sigma_x}\right)\right)$, and that statistics ability to reflect dependence, they are further circumscribed by the degree to which the y and x relationship is homogeneously linear across all income strata[2]. However if the degree of dependence is the issue and the setting is not homogeneous, the transition matrix between the common quantiles of the marginal distributions $f(x)$ and $f(y)$ can be more informative as to the nature of the dependence. This has given rise to the application of techniques derived from Markov Chain processes and the development of mobility indices, some based upon the nature of the transition matrix directly, some based upon other concepts[3]. With complete mobility the columns of the transition matrix would be identical (corresponding to independence between parent and child outcomes) with complete immobility the leading diagonal would equal 1 (see for example Dearden et al. (1997) and Blanden et al. (2004)). When the quantiles or categories of $f(x)$ and $f(y)$ match or are common, such an analysis is straightforward, but when they are not, it is not. Here more general transition processes are contemplated which do not readily lend themselves to a Markov chain interpretation since the data of necessity does not present in terms of the common quantiles of two single variables.

Our interest is the role of parental income and educational attainment in the development of human capital in their offspring. We wish to learn whether or not different parental arrangements imply different types of transmission process and to examine how these relationships have changed in response to changes in family custodial law and practice through the 1970's and 1980's in the USA. This involves the analysis of transitions between such un-

[2] As an index β would not prove very effective if immobility were just confined to the lowest income group for example. Indeed there are dangers with interpreting zero correlation with perfect mobility, imagine a deterministic world (perfectly immobile) where below a certain parental income there is an exact negative relationship between parent and child outcomes whereas above that income there is an exact positive relationship between parent and child outcomes, an appropriately balanced sample would yield 0 correlation with an inferred perfect mobility for what is a completely deterministic state.

[3] Bartholemew (1982), Blanden et al. (2004), Chakravarty (1995), Dearden et al. (1997), Hart (1983), Maasoumi (1986), Maasoumi and Zandvakili (1996), Prais (1955), Shorrocks (1978), have all produced mobility indices many of which are discussed in Maasoumi (1996).

matched states. For example consider the transition from a parent's educational attainment to their child's educational attainment when the child's education has not been completed. Parent and child educational attainment categories will differ and, since they are discrete, they do not fit conveniently into common quantile representations which conform with standard transition matrix analysis. More generally when both parental educational and income status are morphed into a child's academic achievement, the possibility of matching quantiles is even more remote. Here indices and tests are proposed and implemented that can deal with these situations but which may also be applied in standard matched marginal quantile structures.

While this analysis is couched in terms of intergenerational academic attainment it can have an intergenerational income transition interpretation. For the latter, following Solon's model, one would wish to link the child's permanent income at a particular age with that of its parents at that same age. Given permanent income cannot be observed directly instruments have to be used in its place. Typically current income or earnings of the parent and child when adult (sometimes adjusted for the point in the life-cycle at which it is observed) are employed (See for example Aaronson and Mazumder (2005)). Here the instruments used are the educational attainment of the child (in terms of the grade it has attained at a given age) which is related to the educational attainment and income of its parent(s) construing the variates as proxies for the permanent income of the corresponding generations. Such a formulation may be rationalized by recourse to the returns to education literature (see Blundell et al. (2006) and Heckman and Krueger (2003) for example) which highlights the extent to which education influences the permanent income (and mobility thereof) of future generations, from the equal opportunity literature (Roemer (2004)) which argues that parental educational attainment – rather than income – is a better proxy for the influences that impact upon the preferences and tastes of children and from the Heckman and Kruger debate (see Heckman and Krueger (2003)) wherein, crudely put, Heckman favors parental education as having a primary determining role whereas Kruger favors financial constraints as having the primary role[4]. Here both parental permanent income and innate abilities (proxied for in an unidentifiable manner by their educational attainment and current income) are admitted as channels through which current generations influence future generations in a dynastic sense. The within family endowment and enhancement of human capital is heir specific (mobility reducing) as opposed to publicly provided education which is heir indifferent (mobility increasing).

The role of the family type[5] is investigated in this process by identifying three broad categories of family, two parent (referred to as "Intact") families and two types of single parent family namely "Exogenously" single and "Endogenously" single. An exogenously single parent is one whose spouse has deceased whereas an endogenously single parent is one where the parents have separated or divorced, the latter being a consequence of choice whereas the former is (hopefully!) not. In the United States throughout the 80's a trend in child custody law and dispute resolution emerged where previous societal preference (as expressed by its laws) for maternal custody changed toward one with less gender based bias, this was coupled with a gradual trend toward joint custody awards in dispute resolution. Following Rasul (2006), Leo (2006) found supporting empirical evidence, that such changes not only affect the investments in children in endogenously single parent families but also influence the corresponding behavior of intact families. Indeed such changes may also affect the probability of divorce or separation given that they change partner's expectations about the likelihood of custody of offspring in the future. Here the idea that different family types may correspond to different blueprints by which the location in the permanent income distribution of its offspring can be influenced is examined. The nature of this influence is explored in the context of parent-child educational achievement and family income data from the United States for cohorts of 15, 16, 17 and 18 year olds in 1970 and 1990.

[4]There is a considerable literature on the impact of parental income and education on a child's education conveniently summarized in Chevalier et al. (2005).

[5]Bjorklund et al. (2004) consider family structure in terms of family size, gender mix and birth order of children, here we focus on the parental structure of the family and leave family size, gender, and ethnicity issues for further research.

Notions of mobility and how they may be indexed and tested in the context of more general structures than matched marginal distributions is discussed in Section 1. Section 2 relates the changes in custodial law and practice that took place during the two sample periods and discusses how those changes could affect mobility. Section 3 reports the results and section 4 draws some conclusions. Broadly speaking changes in custodial law and practice do appear to have significantly increased mobility.

1. Testing for and Measuring Mobility Between Unmatched States

Let $f(y)$ be the distribution of a characteristic in the ultimate state and let $f(x)$ be the distribution of a characteristic in the initial state, the issue to be addressed is the relationship between the two distributions, i.e. the extent to, and manner in, which y and x are related. More specifically, is there a notion of causality whereby x to some extent influences y? Consider $f(x, y)$, the joint distribution of x and y where $f(y)$ and $f(x)$ are the respective marginal distributions, at one extreme there is a sense of no relationship, or mobility, when $f(y, x) = f(y)f(x)$ and the initial state has no influence on the ultimate state. At the other there is a deterministic environment or immobility, whereby $y = h(x)$ where $h(.)$ is a monotonic function. Partitioning y and x into k mutually exclusive and exhaustive regions where $p(y)$ and $p(x)$ are respectively vectors of the marginal probabilities of falling into those regions such that $p(y) = p(x)$, we are interested in the elements of the square "transition" matrix T defined by $p(y) = T(y, x)p(x) = J(y, x)M(x)^{-1}p(x)$ where $J(y, x)$ is a square matrix of joint probabilities. T is the matrix formed by the product of the two square matrices in the following system of equations:

$$\begin{bmatrix} p_1(y) \\ p_2(y) \\ \vdots \\ p_k(y) \end{bmatrix} = \left\{ \begin{bmatrix} p_{11}(y,x) & p_{12}(y,x).. & p_{1k}(y,x) \\ p_{21}(y,x) & p_{22}(y,x).. & p_{2k}(y,x) \\ \vdots & \vdots & \vdots \\ p_{k1}(y,x) & p_{k2}(y,x).. & p_{kk}(y,x) \end{bmatrix} \begin{bmatrix} p_1(x) & 0.. & 0 \\ 0 & p_2(x).. & 0 \\ \vdots & \vdots & \vdots \\ 0 & 0.. & p_k(x) \end{bmatrix}^{-1} \right\} \begin{bmatrix} p_1(x) \\ p_2(x) \\ \vdots \\ p_k(x) \end{bmatrix}$$

Thus T is a matrix of conditional probabilities i.e. $T = \left\| \frac{p_{ij}(y,x)}{p_j(x)} \right\|$, $i, j = 1, .., k$ familiar in the convergence literature (Quah (1996)).

1.1. *Mobility Tests*

Our interest centers on the properties of the elements of T. When x and y are independent (parent's outcome does not affect child's outcome) the elements of J will be given by $p_{ij}(y, x) = p_i(y)p_j(x)$ and T will be of the form:

$$T = \begin{bmatrix} p_1(y) & p_1(y) & .. & p_1(y) \\ p_2(y) & p_2(y) & .. & p_2(y) \\ : & : & :: & : \\ p_k(y) & p_k(y) & .. & p_k(y) \end{bmatrix}$$

The test of the null "T has identical columns" is the standard contingency table or independence test based upon the matrix J. Alternatively when $y = h(x)$ the relationship becomes deterministic, in the case of $h(x)$ being monotonic non-decreasing T becomes the identity matrix (J is a diagonal matrix with $p(x)$ as the diagonal vector) and the hypothesis of dependence can be examined via a Wald test on J for example.

Practically it may not possible to partition X and Y spaces in such a way that $p(x) = p(y)$, the notion of transition still exists but it is no longer between commonly defined quantiles. The miss-alignment (or $p(y) \neq p(x)$) can occur for several reasons, simply that the set of possible partitions results in such a case (indeed the dimensions of $p(y)$ and $p(x)$ may be different in which case T is no longer square) or because $p(y) = p(z, w)$ or $p(x) = p(u, v)$, that is to say the two states are not conformably defined. Independence can still be examined via a contingency table test which implies the columns of the possibly non-square, but definitely miss-aligned, transition matrix are equal.

To examine proximity to complete dependence the corresponding J and T matrices can be constructed from the marginals, just as in the case of independence or contingency table tests.

For example imagine that x is partitioned at x_1 and x_2 (where $x_2 > x_1$) and y is partitioned at y_1, y_2 and y_3 (where $y_1 < y_2 < y_3$) furthermore suppose $F(y_1) < F(x_1) < F(y_2)$ and $F(y_2) < F(x_2) < F(y_3)$, where $F(.)$ are the corresponding cumulative marginal densities. Then the joint density matrix J_{Imm} can be shown to be of the form:

$$J_{Imm} = \begin{bmatrix} F(y_1) & 0 & 0 \\ F(x_1) - F(y_1) & F(y_2) - F(x_1) & 0 \\ 0 & F(x_2) - F(y_2) & F(y_3) - F(x_2) \\ 0 & 0 & 1 - F(y_3) \end{bmatrix}$$

In this case T_{Imm}, the corresponding transition matrix, will be of the form:

$$T_{Imm} = \begin{bmatrix} \frac{F(y_1)}{F(x_1)} & 0 & 0 \\ \frac{F(x_1)-F(y_1)}{F(x_1)} & \frac{F(y_2)-F(x_1)}{F(x_2)-F(x_1)} & 0 \\ 0 & \frac{F(x_2)-F(y_2)}{F(x_2)-F(x_1)} & \frac{F(y_3)-F(x_2)}{1-F(x_2)} \\ 0 & 0 & \frac{1-F(y_3)}{1-F(x_2)} \end{bmatrix}$$

Just as T with identical columns corresponds to the null of complete independence, a T of the form T_{Imm} corresponds to the null of complete dependence (notice again the columns sum to one). Examining the coherence of this hypothesis with the data is not so straightforward as examining independence, largely because of the problem of null cells (the analogue to the contingency table test would have zero divisors in some cells) however the likelihood ratio for the non-null cells could be computed or a Wald test could be performed.

1.2. Mobility Indices

Tests for mobility seldom answer questions like "has society become more mobile?". To address such issues mobility indices are needed and several have been proposed for the standard aligned transition matrix case. $Trace(T)$ (which is criticized for ignoring the offdiagonal elements of T[6]), $|T|\frac{1}{n-1}$ (criticized for attaining perfect mobility with just 2 rather than all common columns), and the second largest eigenvalue of T have all been used as mobility indices. Note that they all correspond to measures of the extent to which J represents independence between y and x, all depend upon square transition matrices and none could be used in the miss-aligned case we consider. However the χ^2 test statistics introduced above could also be used as indices in the miss-aligned case, the problem with them is that they do not fit conveniently into the unit interval, one of the desirable properties for mobility indices outlined in Shorrocks (1978). However the extent to which dependence or independence accords with the data can be just as well indexed by an overlap measure given by:

$$OV = \sum_i \sum_j \min\left(p_{ij}^o, p_{ij}^e\right)$$

Where p^o corresponds to the observed cell probability and p^e corresponds to the expected cell probability under the null hypothesis (be it independence or dependence). This measure forms a very natural index since it reflects the proximity of the data to the mobility (immobility) hypothesis of interest. When the data completely conform to the hypothesis of interest $OV = 1$, otherwise $0 \leq OV < 1$.

OV_{Ind}, the independence based index, is easily calculated, p_{ij}^o is simply the observed cell sample proportions and p_{ij}^e is the product of the corresponding empirical marginal proportions. An attractive feature of these indices is that they can be readily applied when the transition matrices are not square and can be implemented in multivariate domains[7]. In addition they appear to have asymptotically normal sampling distributions[8], conveniently

[6]Blanden et al. (2004) constructed an immobility index based upon the sum of leading diagonals and their adjacent cells.

[7]For example given an initial state defined by w and x with joint density $f(w,x)$ and an ultimate state defined by y and z with joint density $g(y,z)$ with a joint density of all characteristics given by $h(w,x,y,z)$ then the mobility index is of the form $\int\int\int\int \min[h(w,x,y,z),(f(w,x)g(y,z))]dwdxdydz$.

[8]The distribution of OV_{Ind} can be shown to be asymptotically normal by noting that, under the null of independence, both p_{ij}^o and p_{ij}^e are normal with means p_{ij} and variances $\frac{p_{ij}(1-p_{ij})}{n}$ and, following results in Daganzo (1980) based on Clark (1961), $\min(p_{ij}^o, p_{ij}^e)$ will also be normal, and OV_{Ind}, being a sum of such terms, will also be asymptotically normal. Anderson et al. (2005) provides a small Monte Carlo exercise supporting normality of the index.

facilitating inferences about trends toward independence or dependence over time. Notice that these indices can be more focused concentrating on a subset of cells that relate to particular features of interest. So for example mobility amongst the poor could be examined by specifying a null in which only independence with respect to the poor is entertained so that the mobility of the i'th subgroup can be considered in terms of:

$$OV_i = \sum_{j=1}^{k} \min\left(\frac{p_{ij}}{p_{i.}}, p_{.j}\right)$$

Where $p_{i.}$ and $p_{.j}$ are marginal row and column probabilities respectively.

1.3. Alternative Overlap Measures of Mobility

For mobility indices one could use OV_{Ind} (OV with independence as a null hypothesis) or $1 - OV_{Dep}$ (OV with complete dependence as a null hypothesis). However it turns out that they are not the same thing, indeed the distinction illuminates the theoretical issue of what it is the notion of mobility is trying to capture. The independence based notion of mobility cannot be a polar extreme to complete immobility as defined by $T = I$ in the aligned case. The structure of a J that would present no overlap with J_{Imm} would have 0's in the non-zero cells in J_{Imm} and non-zero's in the zero cells in J_{Imm}. In this polar extreme to complete immobility all of the agents in a given quantile in the initial state leave it for another quantile in the second state. This is an "everybody change" transition, the biblical Kingdom of Heaven scenario where "the first shall be last and the last shall be first", which interprets complete mobility as the maximum aggregate movement. In the case of an independence based notion of mobility, some of the agents in each quantile in the initial state remain there in the second state so that independence is somewhere between these polar extremes of no movement and maximal movement. That is to say Complete (Independence) Mobility and Complete (Dependence) Immobility are not the same opposite extremes as are Complete (Maximal Movement) Mobility and Complete (Minimal Movement) Immobility.

We thus have two notions of mobility and, for the sake of clarity the latter two will be referred to as Maximal Movement and Minimal Movement indices. Note that Complete Maximal Movement corresponds to two non-independent states just as much as Complete Minimal Movement does.

For this reason using OV_{Ind} as a mobility index would not satisfy the Immobility axiom discussed in Shorrocks (1978) whereas OV_{Dep} would. On the other hand if independence is to be construed of as perfect mobility $1 - OV_{Dep}$ would not satisfy the Perfect Mobility axiom discussed in Shorrocks (1978). Other "desirable" properties for Mobility indices have been enunciated (see for example Maasoumi (1996)). Population Symmetry (permutations of the agent outcome vectors yield the same Mobility index), Population Replication Invariance (a replication of an outcome vector yields the same mobility index) and Scale Invariance (a scale transformation of the outcome vectors yields the same mobility index) are all satisfied by the indices presented here. Continuity (the degree of mobility varies continuously with continuously variable outcome vectors) is only satisfied for a sufficiently fine partition of the outcome space. Decomposability is not satisfied by this index (the weighted sum of the min function of the sub distributions is not generally the min function of the weighted sum of the sub distributions). The question of which mobility index to use depends upon the issue at hand and which notion of mobility is relevant. Here the extent to which child outcomes are independent of family background is at issue and independence based mobility measures are appropriate.

2. Changes in Custodial Law and the Impact on child investments by family type: Existing theories and evidence

In the United States throughout the 80's a trend in child custody law and dispute resolution emerged where previous societal preference (as expressed by its laws and dispute resolution practices) for maternal custody arrangements changed toward one with less gender based bias coupled with a gradual trend toward joint custody awards in dispute resolution.

This is exemplified by the fact that before 1980, only 4 states acknowledged joint custody as a possible arrangement in custody awards. However, by 1990, only 14 states had not incorporated joint custody arrangements in their legislation. The force of this statutory amendment may be noted from the surge in joint custody awards in California (from 2.2% in 1979 to 13% in 1981 (Maccoby and Mnookin (1994)), and Wisconsin (from 2.2% in 1980-81 to 14.2% in 1991-92 (Brown et al. (1997)).

All this had occurred in the midst of the No-Fault divorce revolution of the 1970s, when states permitted the petition for divorce without concurrence between the spouses, unilateral divorce, nor the burden of prove of fault. Its effect on both marriage and divorce rates and consequent child wellbeing has been examined extensively. Brinig and Buckley (1998b), Friedberg (1998), Gruber (2004) and Méchoulan (2005), found that divorce rates rose in its wake. Consequently, this lack of marital attachment reduced marriage rates, educational attainment and labor market attachment in the cohorts that grew up in its shadow (Gruber (2004); Rasul (2003)). However, the merits of unilateral divorce, or divorce in general, were realized in lower domestic violence and suicide rates related to marriage (See Stevenson and Wolfers (2000)). From our perspective there could also be a composition effect within the intact marriage group with a reduction of the proportion of "unhappy" partner investors in the intact state.

The implications of differing custody arrangements for a non-custodial parent's willingness to make child custody payment was examined by Weiss and Willis (1985). They argued that proximity within a marriage overcomes free-rider problems associated with marital public goods such as investment in the children. However, in the divorce state, these investments are non-verifiable inducing a lack of willingness to make child support payments. They argue that if visitation costs are not prohibitive, conditional transfers in return for visitation rights would result in Pareto improvements for all parties involved. It follows that a regime shift towards joint custody that aims at encouraging parental involvement in the divorce state should engender better child outcomes in a post maternal preference state among children of endogenously single (divorced and separated) parent families. Brinig and Buckley (1998a) had found an increase in child support receipts among states which adopted joint custody. Del Boca and Ribero (1998) found evidence of greater private transfers among joint custody families in the divorce state. Our results support these previous findings.

Rasul (2006) extended this analysis to intact families, by examining the consequences of situations where investments cannot be ex ante specified (which is predominantly the case in practice as courts are traditionally unwilling to intervene in disputes within a marriage (Weitzman (1985)). In his model couples decide upon the share of custody (measured in a continuum) in the event of divorce and make non-verifiable investments in their children, ultimately the private gains to marriage are realized and the couple choose whether or not to divorce. For each partner in the marriage, personal returns to investment in the child increase with the level of custody. Changing the level of custody entitlement increases the returns to investment for one partner and reduces it for the other but raising the share of custody to a spouse in the divorce state does not trivially mean that spouses investment will be raised. Principally, there are two opposing mechanisms with respect to investments in children and custody. As child quality is assumed to be a public good in both divorce and intact states, allocating custody to a high valuation spouse raises that spouse's incentive to invest during marriage, which raises both spouses' expected payoff. However, own returns to investment is raised with more of own custody. This creates three distinct sets of spouses for whom optimal custodial arrangements would differ. At the extremes are spousal relationships described by sole custodial arrangements in the divorce state. Here the spouse with the higher valuation for child quality obtains custody and the relationship between investment custody for her is positive, and negative for the parent with the lower valuation. Only for spousal relationships where joint custody is optimal would this relationship be positive for both parents.

To understand the transition from the status quo of maternal preference, and using the above arguments, the move to joint custody may see several possible outcomes, depending on the joint distribution of spousal valuations across the population. It should be acknowledged that where there are strong differences between parents in the valuation of the child sole custody is still generally awarded. Thus if relationships are characterized by higher relative valuations for children by mothers, the regime shift would not yield any appreciable change in custodial arrangements, and hence child outcomes. Similarly if the father values the children more freeing up custodial choice would also increase aggregate investment in the child compared to the status quo (though evidence from Maccoby and Mnookin (1994) suggests this is the least likely scenario). However where parents value child quality similarly the signing of aggregate child investment (and hence quality changes) becomes ambiguous. Essentially if the mother's reduction in child investment is greater than the father's increase, and evidence from Lundberg et al. (1997) suggests it could be, changes in child custody laws away from maternal preference toward joint custody preference would lower child quality within extant marriages.

Leo (2006) develops a model which demonstrates that changes in custodial arrangements not only affect the investments in children in Endogenously single parent families but will also influence the corresponding behavior of intact families. Leo (2006) found empirical evidence that these changes in custodial arrangements did affect the investments in children in both Endogenously single parent and intact families. The results suggest that the regime shift toward joint custody altered parental incentives leading to a reduction in investment in children of intact families, but increased post separation involvement of the male partner in child rearing responsibilities raising investments in children in Endogenous single parent families. Investment in children in Exogenously Single Parent environments will be unaffected by the policy change, thus the outcomes for such families provide us with a sort of control for the social experiment as it were[9]. Since generally speaking the children of intact families are advantaged relative to the children from single parent households the net impact of the policy change is one of equalization which would promotes mobility and equal opportunity.

In summary studies by both Brown et al. (1997) and Maccoby and Mnookin (1994)

[9]Strictly speaking it is not a pure control since the distribution of characteristics in exogenous single parent families is not the same as that of endogenous single parent families prior to the policy change.

suggest that there are significant increases in incidences of joint custody arrangements. If the proportion of families characterized by similar parental valuations is indeed significant, there would be changes in the outcomes among children of intact families as suggested by Rasul (2006) and Leo (2006). Nonetheless, the sign of the impact remains ambiguous. If the withdrawal of investment by the mother is greater than the corresponding increase among fathers, we should see a fall in child outcomes, while the reverse would yield an increase in child outcomes. This aspect of the regime shift has largely been ignored, and will be addressed here. The point is that intergenerational mobility could change both within the family types of intact and endogenously single parent families (but not exogenously single parent families) as well as across all family types.

3. Application and Results

The one percent Integrated Public Use Microsample Series (IPUMS) of the decennial Census for the decades 1970 and 1990 is used to analyse the change in public policy with respect to custodial law and practice that occurred in the intervening period. Human capital development will be measured by educational attainment at a given age where attainment is measured by the completed grade level. Let q be the probability of transiting to the next grade, we posit a model $q = q(y, e, x)$ where y is family income, e refers to the educational attainment of the parents and x to a set of variables describing the family type (e.g. two parent family, single parent family {widowed, divorced}, non-working mother etc.). Essentially $q(.)$ corresponds to a production function blueprint for each family type which converts a family's genetic endowments and current income into the child's academic achievement as measured by grade attainment. In our empirical analysis the academic achievement of 15, 16, 17 and 18 year old cohorts is the subject of investigation. Child attainment and adult incomes and attainments were each partitioned into 4 categories, the appendix reports the breakpoints and a sketch of potential attainment distributions for different cohorts. The distributions differ considerably by age cohort with means and variances increasing with age essentially increasing the chance of a lack of overlap with age.

[Table 1]

The mobility indices for the population at large are reported in Table 1. Recall that the index is a measure of the proximity of the empirical joint distribution to that which would be observed under an independence hypothesis, note that the index though usually very close to 1, is always significantly different from complete mobility and generally diminishes with cohort age.

Intergenerational mobility literature associates perfect mobility with independence between the parent status and child outcome which can be examined via Contingency Table Tests. These tests for the transmission of parental attainment into child attainment and for the transmission of parental income into child attainment were performed based upon a 4×4 partitions in each case. The results are reported in Table 2 and essentially indicate some degree of independence for 15 year olds (in the single parent and two parent Child Grade – Parent Income comparisons in 1990 and in all the Exogenous Endogenous Single Parent comparisons except for the Child Grade – Parent Grade Endogenous Single parent 1990 comparison) however independence is rejected for all other age cohorts in all comparisons.

This clear dependence may have been generated because of dependent changes in the underlying conditioning variables, investigating the structure of $J(y,x)M(x)^{-1}$ is thus of interest. First the question of whether or not the transition matrices are common across the family type is considered, the standard Pearson common samples test is employed in this case[10] and uniformly rejects common transition matrices for all two parent-single parent and Exogenous-Endogenous single parent comparisons for all cohorts. To illustrate its use, the Overlap Test for examining the same issue is reported in Table 3. Under the null of common transition matrices the test statistic should equal 1, under the alternative it will be less than one. As may noted the same conclusions may be drawn from the Pearson two sample test.

[Table 2]

[10] The results are not reported here for space reasons but can be obtained from the authors on request.

[Table 3]

Thus different family types appear to possess different transition mechanisms[11]. Two questions are now of interest, has the nature of the transmission matrix structurally changed over the 1970-1990 period (reflecting changes in custody law and practice), and to what extent are the columns of the matrix identical (parental outcomes and child outcomes are independent)? These issues can be addressed with one test, namely one which checks to see whether or not the mobility index has changed and by noting the direction of change. Note that the mobility index is simply a measure of the extent to which the unrestricted joint density overlaps with the joint density defined by the marginal probabilities under independence (which may be thought of as the objective of the policy exercise).

Since we have established that the transition matrices differ across family types the independence hypothesis can be structured two ways. We can think of greater mobility within the family type, thus asking the question "Has the policy increased mobility within the family type?" or we can think of greater mobility in terms of the population independence structure thus asking the question "Has the policy increased mobility in terms of the populations independence structure?". The within family type formulation is reported in Table 4 and the population independence structure is reported in Table 5. These tests are performed separately for child attainment-parental attainment and child attainment and parental income comparisons (in both cases these correspond to the analysis of 4×4 miss-aligned transition matrices). However an attraction of this technique is that we can examine whether child attainment is jointly independent of parental educational attainment and parental income. This corresponds to an analysis of a 4×16 transition matrix, the results of which are reported in Table 6.

[Table 4]

This table presents a "within family type" analysis addressing the question of whether or

[11] Although the above comparisons between two parent and single parent transition mechanisms found them to be significantly different, note the increase in the Overlap indices for all age groups. Anderson and Leo (2005) using stochastic dominance tests found evidence that the educational attainment gap between these two groups of children to have narrowed significantly.

not mobility has increased relative to the norm for that family type. All family types with the exception of exogenously single households experienced an increase in mobility (equality of opportunity) for age cohorts 16 through 18 though there is little evidence of mobility changes for 15 year olds. The result for 15 year olds is not surprising given the measure is progress through high school, there is little variability across 15 year olds attainments and hence little opportunity to observe substantive change. It is interesting to note that with one exception (17 year old cohort 1990 Intact family) Education-Education indices are always lower than Education-Income indices favouring the Heckman view of the world that parental education rather than income is the determining factor.

[Table5]

This table presents a "relative to the population" analysis addressing the question of whether or not mobility has increased relative to the norm for the population. Put another way it addresses the question has the joint distribution of parent child outcomes become more like that in the general population under the hypothesis of independence. Notice that in this instance the overlap measures for all single parent Education-education comparisons are substantially lower than the corresponding entries in the own subgroup comparisons in Table 4. As is evident, all family types with the exception of exogenously single households experienced an increase in mobility (equality of opportunity) for age cohorts 16 through 18.

[Table 6]

Table 6 presents the results of the analysis of the joint dependence of a child's attainment on its parent's income and attainment. The analysis has been performed both on the basis of subgroup income quartiles and population income quartiles. Overall the overlap measures are much lower than with the partial attainment-attainment and attainment comparisons of Tables 4 and 6. As may be noted, there is little qualitative difference between the two sets of results for intact families however subgroup and population comparisons for the single parent groups vary substantially. Again mobility has significantly increased in all cases under both quartile bases for the 16 to 18 year old cohorts with much weaker evidence for such a change in the Exogenous Single Parent households.

Finally from a "Dynastic Poverty" perspective it is of interest to examine the sources of mobility by income group. Table 7 presents the subgroup mobility measure for all four income quartiles for each year for 18 year olds (16 and 17 year age cohorts yield very similar results though 15 year old cohort yields no discernable differences).

[Table 7]

In both observation year's mobility is lowest in the 1^{st} and 4^{th} income quartiles which evidently make the biggest contribution to the lack of mobility. In all quartiles mobility has increased over the two decades and it has done so most substantially in the 1^{st} and 4^{th} quartiles.

4. Conclusions

Indices and tests have bee proposed for examining notions of mobility between the quantiles of two distributions which permit analysis when the quantiles are unmatched. In the process alternative notions of independence mobility and maximal movement mobility have been enunciated and exemplified. The indices have considerable intuitive appeal since they can be directed specifically to the notion of mobility that is of interest in a given context and are easily extended to multivariate environments. They also have well defined distributions which permit the "statistical significance" of changes in the value of the index. While they do not satisfy all of the desirable properties of such indices called for in Shorrocks (1978) and Maasoumi (1996) they satisfy a good many of them and have the added attraction of being readily employable in circumstances in which current transition based indices are not. Extension to the general case of examining the extent to which $f(u, v, w, x, y, z) = f(u, v, w)f(x, y, z)$ for all values of u, v, w, x, y, z in the context of kernel techniques is the subject of further research.

Using data drawn from the 1 percent Integrated Public Use Microsample Series (IPUMS) of the decennial Census for the decades 1970 and 1990, the independence based mobility index was employed to study intergenerational mobility. Motivated by results in Rasul (2006) and Leo (2006), demonstrating that changes in custodial law and practice changes levels of parental investments in children in both intact and separated family situations (but not in widowed single parent situations), the issue addressed is how intergenerational mobility responded to the change in public policy that occurred between 1970 and 1990 in the United States. In the case of the young, educational attainment was a proxy for permanent income, in the senior generation educational attainment and current income were proxies for permanent income. The indices and tests indicate that mobility significantly increased, both in the population as a whole and within intact parent and single parent sub populations, over the period. Within the single parent group there was much less evidence for significant mobility change for children from exogenous single parent families than for children from endogenously single parent families which was again consistent with theoretical predictions and evidence from Anderson and Leo (2005).

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Appendix 1: Description of Data Used

The data is derived from the one percent Integrated Public Use Microsample (IPUMS) of the decennial Census for 1970 and 1990. All the samples used are unweighted. We include all 50 states and the District of Columbia. The sample is restricted to households with children born in contiguous U.S., Hawaii, and Alaska. We also restrict attention to families as a single household unit and eliminated extended households. We also excluded from our sample, all household made up of never married individuals, but who do have children of their own. This is a fast increasing sub-group whose dynamics may not be the same as children born into a traditional family environment. However, unwed mothers as a increasingly common phenomenon may be rare for our sample since children between the ages of 15 to 18 in 1990 would have been born in the early half of the 1970s.

Families who have single parents due to exogenous reasons, were retained in the sample because they are not subject to the custody laws, and hence can act as a control group against children of families with single parents due to separation or divorce. We do not distinguish between children living with stepparents, that is families where one parent had a previous marriage, from children living with their birth parents. This is because the census questions identifying stepparents were changed for the 1990 sample. It is likely that those identified in 1990 as stepparents would have been considered birth parents in preceding years.

We retain only children between the compulsory schooling ages of 15 to 18. Since compulsory schooling ages end for all states by 18, considering children after 18 may confound the results, due to emancipation.

Appendix 2. Quantile Break Points

Cohort	Quantile Grade Break Point ($\leq$)
15 years old	1 2 4
16 years old	3 4 5
17 years old	4 5 6
18 years old	5 6 7
Parental Grade Breaks	3 6 7

1970 Income quartile breakpoints, Incidence and Proportion in Sample.

Parental Type	Student Age Cohort			
	15 Years Old	16 Years Old	17 Years Old	18 Years Old
Two Parent	26.272499	26.442000	26.611500	25.933500
	37.289999	37.459499	37.628999	37.120499
	51.019501	51.189001	51.866998	51.019501
	27210 (0.8692)	25543 (0.8619)	23839 (0.8618)	17590 (0.8604)
Single Endogenous	7.2884998	6.949500	7.6275001	7.288499
	13.729500	13.729500	14.068500	13.729500
	21.187500	22.204500	22.543501	21.526501
	2309 (0.0738)	2205 (0.0744)	1926 (0.0696)	1421 (0.0695)
Single Exogenous	6.610499	6.610499	6.610499	6.949500
	13.729500	13.729500	13.390500	13.390500
	25.255501	24.238501	23.899500	23.221500
	1786 (0.0571)	1888 (0.0637)	1898 (0.0686)	1432 (0.0700)

1990 Income quartile breakpoints, Incidence and Proportion in Sample.

Parental Type	Student Age Cohort			
Age	15 Years Old	16 Years Old	17 Years Old	18 Years Old
Two Parent	28.000000	27.903999	29.000000	28.741200
	42.000000	41.990000	43.000000	42.759198
	59.000000	59.000000	60.172001	60.000000
	23932 (0.8188)	23118 (0.8129)	22431 (0.8035)	18677 (0.7959)
Single Endogenous	8.147999	8.644000	8.819999	9.326000
	16.520599	17.208599	17.423599	18.000000
	27.000000	27.792999	28.741199	29.248600
	4365 (0.1493)	4360 (0.1533)	4433 (0.1588)	3806 (0.1622)
Single Exogenous	6.514999	6.300000	6.472000	6.500000
	14.225000	15.000000	14.900000	14.392000
	25.811001	27.000000	26.746000	26.299999
	932 (0.0319)	961 (0.0338)	1052 (0.0377)	983 (0.0419)

It is perhaps interesting to note the substantial change in the single endogenous parent income distributions over the 20 year period relative to the other family types. This is perhaps best indicated by the increased value of the median and the widening inter-quartile range. Indeed single exogenous parent distribution appears to have barely changed at all over the 20 year period.

Appendix 3. Child attainment distributions by age cohort.

In sketching the potential distributions of child attainment distributions for each age cohort it has to be acknowledged that not everyone starts school in the year that they were 14, unfortunately in the data set the admission birth month cutoff varies across jurisdictions and information is not available for specific students. However for simplicity assume that births to be uniformly distributed throughout the year and that everyone starts in grade 1 who were age 14 before θ of the year had elapsed. Then the corresponding cohort grade attainment distributions would look like:

Age	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
15	$1\text{-}q$	q			
16	$\theta(1\text{-}q)^2$ $+(1\text{-}\theta)(1\text{-}q)$	$2\theta q(1\text{-}q)$ $+(1\text{-}\theta)q$	θq^3		
17	$\theta(1-q)^3$ $+(1-\theta)(1\text{-}q)^2$	$3\theta q(1\text{-}q)^2$ $+2(1\text{-}\theta)q(1\text{-}q)$	$3\theta q^2(1\text{-}q)$ $+(1\text{-}\theta)q^2$	θq^3	
18	$\theta(1\text{-}q)^4$ $+(1\text{-}\theta)(1\text{-}q)^3$	$4\theta q(1\text{-}q)^3$ $+3(1\text{-}\theta)q(1\text{-}q)^2$	$6\theta q^2(1\text{-}q)^2$ $+3(1\text{-}\theta)q^2(1\text{-}q)$	$4\theta q^3(1\text{-}q)$ $+(1\text{-}\theta)q^3$	θq^4

For cohorts 16 and above this model projects an expected cohort age grade attainment of $1+q(\theta(age-14)+(1-\theta)(age-15))$ with a variance of $q(1-q)(\theta(age-14)+(1-\theta)(age-15))$, for the age $=15$ cohort the expected cohort age grade attainment is $1+q$ with a variance of $q(1-q)$. The essential point being that expected values and variances both grow with cohort age and the potential for attainments to vary and the relationship between child and parent outcomes to vary increases with cohort age.

Table 1. Population Mobility Indices Characteristics.

Year	Comparison	Cohort			
		15	16	17	18
1970	Grade-Grade Mobility	0.9938	0.9214	0.9207	0.9095
	Grade-Income Mobility	0.9918	0.9428	0.9391	0.9285
	Sample Size	31305	29636	27663	20443
1990	Grade-Grade Mobility	0.9915	0.9644	0.9466	0.9494
	Grade-Income Mobility	0.9941	0.964	0.9548	0.9528
	Sample Size	29229	28439	27916	23466

Table 2. χ^2 Independence Tests and Upper Tail Probabilities.

Year	Age	Single Parent Families				Two Parent Families			
		Grade-Grade		Grade-Income		Grade-Grade		Grade-Income	
1970	15	29.63	(0.0005)	31.28	(0.0003)	129.99	(0.0000)	99.57	(0.0000)
	16	301.46	(0.0000)	146.68	(0.0000)	2448.89	(0.0000)	944.32	(0.0000)
	17	355.26	(0.0000)	190	(0.0000)	2013.35	(0.0000)	1159.26	(0.0000)
	18	275.2	(0.0000)	105.76	(0.0000)	1442.91	(0.0000)	908.1	(0.0000)
1990	15	43.76	(0.0000)	19.68	(0.0200)	77.49	(0.0000)	17.91	(0.0362)
	16	208.88	(0.0000)	105.59	(0.0000)	815.94	(0.0000)	481.36	(0.0000)
	17	379.87	(0.0000)	140.58	(0.0000)	992.04	(0.0000)	557.17	(0.0000)
	18	307.35	(0.0000)	184.32	(0.0000)	1059.11	(0.0000)	489.7	(0.0000)
Year	**Age**	**Endogenously Single**				**Exogenously Single**			
		Grade-Grade		**Grade-Income**		**Grade-Grade**		**Grade-Income**	
1970	15	17.28	(0.0445)	12.77	(0.1732)	18.63	(0.0286)	19.76	(0.0195)
	16	185.16	(0.0000)	88.66	(0.0000)	131.05	(0.0000)	65.44	(0.0000)
	17	170.32	(0.0000)	87.51	(0.0000)	205.12	(0.0000)	91.41	(0.0000)
	18	153.99	(0.0000)	80.43	(0.0000)	136.67	(0.0000)	39.12	(0.0000)
1990	15	29.5	(0.0005)	12.08	(0.2087)	20.74	(0.0139)	9.49	(0.3930)
	16	159.63	(0.0000)	83.6	(0.0000)	50.15	(0.0000)	30.09	(0.0004)
	17	269.76	(0.0000)	97.47	(0.0000)	107.23	(0.0000)	53.42	(0.0000)
	18	293.95	(0.0000)	143.52	(0.0000)	46.45	(0.0000)	39.5	(0.0000)

Table 3. Common Transition Matrices Overlap Test (OV) and t statistic for H_o: OV ≥ 1.

Year	Age	Two Parent-Single Parent				Endogenous-Exogenous Comparison			
		Grade-Grade		Grade-Income		Grade-Grade		Grade-Income	
1970	15	0.7552	(33.9711)	0.9634	(11.6301)	0.8895	(11.1835)	0.9734	(5.2465)
	16	0.7502	(34.2760)	0.9148	(18.1277)	0.8892	(11.2545)	0.9336	(8.5079)
	17	0.7731	(31.0984)	0.9162	(17.3542)	0.9011	(10.2438)	0.9241	(8.8591)
	18	0.7696	(27.1120)	0.8931	(17.1419)	0.9026	(8.7706)	0.9401	(6.7389)
1990	15	0.8071	(32.1909)	0.9804	(11.6301)	0.8749	(10.4810)	0.9694	(4.9205)
	16	0.8323	(29.5230)	0.9504	(15.0301)	0.8759	(10.5633)	0.9498	(6.4808)
	17	0.8231	(30.7779)	0.9419	(16.7330)	0.8633	(11.6016)	0.9214	(8.5164)
	18	0.835	(27.1120)	0.9316	(16.7330)	0.8613	(11.2171)	0.9707	(4.8596)

Table 4. OV Mobility Indices (relative to population subgroup), Standard Normal Difference Tests and lower tail probabilities for H_0: $OV_{1970} - OV_{1990} \geq 0$

Family Type	Relation	Cohort	1970	1990	"z"	F(z)
Single Parent	Education-Education	15	0.9893	0.9864	1.2688	0.8978
		16	0.9085	0.9485	-7.3529	0.0000
		17	0.8922	0.9348	-7.0749	0.0000
		18	0.8866	0.9316	-6.4686	0.0000
	Education-Income	15	0.9852	0.9865	-0.5080	0.3057
		16	0.9289	0.9568	-5.7123	0.0000
		17	0.9144	0.9556	-7.7571	0.0000
		18	0.9267	0.9349	-1.3574	0.0873
Intact Family	Education-Education	15	0.9942	0.9919	3.1614	0.9992
		16	0.9278	0.9676	-19.9637	0.0000
		17	0.9287	0.9501	-9.7002	0.0000
		18	0.9197	0.9548	-13.7797	0.0000
	Education-Income	15	0.9933	0.9967	-5.5889	0.0000
		16	0.9485	0.9645	-8.6658	0.0000
		17	0.9433	0.9555	-6.0106	0.0000
		18	0.9360	0.9605	-10.5160	0.0000
Single Parent Endogenous	Education-Education	15	0.9896	0.9855	1.4522	0.9268
		16	0.9087	0.9541	-6.5628	0.0000
		17	0.9032	0.9379	-4.5260	0.0000
		18	0.8724	0.9311	-6.0182	0.0000
	Education-Income	15	0.9893	0.9853	1.4474	0.9261
		16	0.9285	0.9546	-4.1295	0.0000
		17	0.9292	0.9562	-4.0809	0.0000
		18	0.9127	0.9374	-2.9284	0.0017
Single Parent Exogenous	Education-Education	15	0.9839	0.9844	-0.1056	0.4580
		16	0.9087	0.9205	-1.0765	0.1409
		17	0.8781	0.9021	-2.0239	0.0215
		18	0.8868	0.9364	-4.3375	0.0000
	Education-Income	15	0.9783	0.9755	0.4701	0.6809
		16	0.9248	0.9327	-0.7779	0.2183
		17	0.9123	0.8790	2.7771	0.9973
		18	0.9358	0.9350	0.0817	0.5326

Table 5. OV Mobility Indices (Relative to Population Independence Structure), Standard Normal Difference Tests and lower tail probabilities for H_0: $OV_{1970} - OV_{1990} \geq 0$.

Family Type	Relation	Cohort	1970	1990	"z"	F(z)
Single Parent	Education-Education	15	0.7878	0.8421	-6.6932	0.0000
		16	0.7514	0.8428	-10.8878	0.0000
		17	0.7609	0.8294	-7.9953	0.0000
		18	0.7486	0.8395	-9.3721	0.0000
	Education-Income	15	0.9672	0.9838	-5.0744	0.0000
		16	0.9007	0.9458	-8.0426	0.0000
		17	0.9026	0.9376	-6.0179	0.0000
		18	0.8858	0.9264	-5.7645	0.0000
Intact Family	Education-Education	15	0.9675	0.9635	2.4233	0.9923
		16	0.9286	0.9628	-16.791	0.0000
		17	0.9308	0.9517	-9.5941	0.0000
		18	0.9363	0.9636	-11.8873	0.0000
	Education-Income	15	0.9909	0.9914	-0.6061	0.2722
		16	0.942	0.9637	-11.3605	0.0000
		17	0.9392	0.9527	-6.4489	0.0000
		18	0.9343	0.9531	-7.7538	0.0000
Single Parent Endogenous	Education-Education	15	0.7982	0.8591	-6.168	0.0000
		16	0.7644	0.8576	-8.8979	0.0000
		17	0.7623	0.849	-7.8202	0.0000
		18	0.7547	0.8583	-8.128	0.0000
	Education-Income	15	0.9645	0.9848	-4.7402	0.0000
		16	0.8987	0.9452	-6.3779	0.0000
		17	0.8899	0.9386	-6.0961	0.0000
		18	0.8788	0.9282	-5.1347	0.0000
Single Parent Exogenous	Education-Education	15	0.7727	0.7601	0.731	0.7676
		16	0.7359	0.7701	-2.0189	0.0217
		17	0.7579	0.741	1.0109	0.8440
		18	0.7397	0.7619	-1.2397	0.1075
	Education-Income	15	0.9625	0.9869	-4.1709	0.0000
		16	0.9005	0.9424	-4.1083	0.0000
		17	0.9061	0.8671	3.1424	0.9992
		18	0.8864	0.9212	-2.8971	0.0019

Table 6. Joint Parental Income and Attainment OV Mobility Indices, Standard Normal Difference Tests and lower tail probabilities for H_0: $OV_{1970} - OV_{1990} \geq 0$.

Family Type	Quantile Basis	Cohort	1970	1990	"z"	F(z)
All Families		15	0.9899	0.9872	3.1668	0.9992
		16	0.9184	0.9547	-18.0598	0.0000
		17	0.915	0.9427	-12.7097	0.0000
		18	0.9071	0.9403	-12.9996	0.0000
Single Parent	Subgroup	15	0.7783	0.8317	-6.4472	0.0000
		16	0.7644	0.8346	-8.3973	0.0000
		17	0.7726	0.8347	-7.3673	0.0000
		18	0.769	0.8536	-8.9989	0.0000
	Population	15	0.5089	0.5869	-7.5444	0.0000
		16	0.5113	0.5974	-8.352	0.0000
		17	0.5118	0.5987	-8.3184	0.0000
		18	0.504	0.6004	-8.2133	0.0000
Intact Family	Subgroup	15	0.9579	0.9598	-1.0744	0.1413
		16	0.9006	0.9319	-12.522	0.0000
		17	0.8975	0.9201	-8.4497	0.0000
		18	0.8895	0.9197	-9.7627	0.0000
	Population	15	0.9204	0.9052	6.0486	1.0000
		16	0.8701	0.8852	-5.1026	0.0000
		17	0.8662	0.8736	-2.3475	0.0095
		18	0.861	0.8676	-1.834	0.0333
Single Parent Endogenous	Subgroup	15	0.7749	0.8488	-7.2131	0.0000
		16	0.7617	0.8512	-8.4803	0.0000
		17	0.7744	0.8583	-7.7152	0.0000
		18	0.7632	0.8702	-8.5472	0.0000
	Population	15	0.4786	0.5857	-8.3765	0.0000
		16	0.4914	0.5955	-8.0159	0.0000
		17	0.5011	0.5971	-7.0729	0.0000
		18	0.4898	0.6032	-7.3393	0.0000
Single Parent Exogenous	Subgroup	15	0.7461	0.7275	1.0401	0.8508
		16	0.7437	0.7295	0.8086	0.7906
		17	0.7547	0.7115	2.524	0.9942
		18	0.7582	0.7308	1.5137	0.9350
	Population	15	0.5379	0.5614	-1.1657	0.1219
		16	0.5284	0.5856	-2.9145	0.0018
		17	0.5185	0.5716	-2.7797	0.0027
		18	0.5174	0.5546	-1.8028	0.0357

Table 7. Income Subgroup Mobility Index.

		$\sum_{j=1}^{k} \min((\frac{p_{ij}}{p_{i.}}), p_{.j})$
Quartile i=1	1970	0.8674
	1990	0.908
Quartile i=2	1970	0.9887
	1990	0.9972
Quartile i=3	1970	0.9486
	1990	0.9659
Quartile i=4	1970	0.9093
	1990	0.9404