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Income Mobility and Welfare

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Abstract

This paper develops a framework for the quantitative analysis of individual income dynamics, mobility and
welfare. Individual income is assumed to follow a stochastic process with two (unobserved) components,
an i.i.d. component representing measurement error or transitory income shocks and an AR(1) component
representing persistent changes in income. We use a tractable consumption-saving model with labor income
risk and incomplete markets to relate income dynamics to consumption and welfare, and derive analytical
expressions for income mobility and welfare as a function of the various parameters of the underlying income
process. The empirical application of our framework using data on individual incomes from Mexico provides
striking results. Much of measured income mobility is driven by measurement error or transitory income shocks
and therefore (almost) welfare-neutral. A smaller part of measured income mobility is due to either welfare-
reducing income risk or welfare-enhancing catching-up of low-income individuals with high-income
individuals, both of which have economically significant effects on social welfare. Decomposing mobility into
its fundamental components is thus seen to be crucial from the standpoint of welfare evaluation.

I. Introduction

Individual income dynamics characterize society in important ways. The degree to which individuals move across different sections of the income distribution is often summarized by one parameter, income mobility. Indeed, income mobility is probably the single most important indicator of individual income *dynamics* used in public policy discussions.[1] Income mobility is important as it informs us about the opportunities afforded by society to escape one's origins.[2] At the same time, mobility may also be driven by variability in incomes that reflect the risk to which individuals are exposed in the economy.[3] In this paper, we develop an analytical framework for the estimation and welfare-theoretic evaluation of individual income dynamics that takes into account these different drivers of income mobility. In addition, we provide an application of our framework using individual income data from Mexico that yields striking results: Much of measured income mobility is driven by measurement error or transitory income shocks and therefore (almost) welfare-neutral. A smaller part of measured income mobility is due to either welfare-reducing income risk or welfare-enhancing catching-up of low-income individuals with high-income individuals, both of which have economically significant effects on social welfare. Decomposing mobility into its fundamental components is thus crucial from the standpoint of welfare evaluation.

The literature on income mobility has often focused on two important questions: the quantitative/empirical measurement of the extent and nature of the change in individual incomes and, separately, the social-welfare-theoretic evaluations of such changes.[4] Two methodological issues have arisen in this area. First, the parametric formulations used in the

[1]In a developing country context, see, for example, a flagship publication of the World Bank in 2012, "Economic Mobility and the Rise of the Middle Class," that focuses on the income mobility in Latin America. For the US, the New York Times article "Harder for Americans to Rise From Lower Rungs," by Jason deParle (Jan 04,2012) describes the importance of economic mobility for the upcoming presidential election.

[2]See, for instance, Shorrocks (1978), Lillard and Willis (1978a), Atkinson, Bourguignon and Morrison (1992), Danziger and Gottschalk (1998) and Benabou and Ok (2001a, 2001b).

[3]See again Atkinson, Bourguignon and Morrison (1992).

[4]For the former, see Lillard and Willis (1978), Shorrocks (1978b), Geweke, Marshal and Zarkin (1986), Conlisk (1990) and Fields and Ok (1996). For the latter, see, Atkinson (1983), Markandya (1982, 1984), Atkinson, Bourguignon and Morrison (1992), Dardononi (1993), and Gottschalk and Spolaore (2002). Additionally, the discussion over suitable social (income) mobility measures (indices), which may be used to evaluate mobility given the pattern of individual income changes in society, constitutes a very well researched area that has generated a number of important contributions in recent years. See Fields and Ok (1999) for a survey discussion.

measurement of income changes are not easily used as inputs to the quantitative welfare-theoretic analysis, thereby constituting a problematic gap between these two literatures. Furthermore, as the literature has often pointed out, the measurement of dynamic income changes is itself confronted by (at least) the following two problems. First, income data are subject to measurement error and, second, a significant proportion of the observed income changes may be simply temporary in nature - resulting, typically, in an overestimation of the relevant mobility in income (Lillard and Willis (1978) Solon (2001), Luttmer (2002), Fields et al (2003), Glewwe (2004), Antman and McKenzie (2007)). This is also important from the perspective of welfare analysis, as measurement error has no effect on workers' welfare and transitory shocks to income are perhaps easily smoothed out, resulting in very small welfare effects. In addition, welfare analysis is confronted by an additional challenge. Since individual utility is postulated as taking consumption rather than income as its argument, its direct valuation requires reliable data on individual consumption levels, which are often unavailable for developing countries. To use the more easily available data on incomes, a theoretical framework is required that translates the estimated income dynamics into consumption changes taking into account the institutional constraints individual agents face.

In this paper, we develop a tractable analytical framework to study income mobility that provides a close link between the welfare theory and the empirical methodology used in the measurement of the income dynamics, thereby helping to bridge the gap between these literatures. At the same time, this framework overcomes many of the methodological problems that we have just discussed. We note, at the outset, that our focus is on income mobility within individual lifetimes (intra-generational mobility). We postulate (Section II) that individuals face a stochastic income process that is highly parameterized, but, following much of the literature, is sufficiently elaborate to distinguish between changes in income resulting from trend growth and other predictable factors and changes in income that are unpredictable. The unpredictable part of income change, in turn, has two components, one first degree autoregressive (AR(1)) component reflecting persistent shocks to income and another component that is i.i.d and captures transitory shocks and measurement error in the income data. We show how income mobility, measured in relation to the correlation of incomes over time,[5] relates to the various parameters of the underlying income process.

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[5]Specifically, we use a quite basic and familiar measure, the Hart Index, which is the complement of the correlation between the logarithm of incomes over times (see Hart (1981) and Shorrocks (1993)). As

We also discuss how these parameters can be estimated using individual income data and econometric techniques that exploit both the longitudinal and repeated cross-section features of our data set on individual incomes from Mexico (Sections III-V).[6]

Finally, we use a tractable consumption-saving model with labor income risk and incomplete markets (Section VI) that yields closed-form solutions for equilibrium consumption and welfare as a function of the preference and income parameters. This theoretical framework, based on the work of Constantinides and Duffie (1996) and Krebs (2007), focuses on the persistent component of labor income and abstracts from the i.i.d component, an abstraction motivated by results in the literature demonstrating that workers can effectively self-insure against transitory income shocks, as we have already mentioned.[7] One of the main insights of this literature is that in equilibrium consumption responds one-for-one to permanent income shocks.[8] In this paper, we exploit this property of equilibrium consumption to derive an explicit formula for social welfare as a function of the underlying income parameters.

The analytical framework we develop in this paper has the merit of linking income dynamics, income mobility and social welfare in a simple and transparent manner − allowing for a clearer analytical and quantitative discussion of these interrelated concepts, and specifically the role of income variability, than has generally been possible in the past. We discuss in detail how different determinants of measured income mobility may have quite different

Fields and Ok (1996) discuss, however, the literature has recently made important advances in studying the "multi-faceted concept" of mobility and a number of different theoretical measures, each capturing a different aspect of mobility have been introduced. We have no contribution to make to this discussion and simply use the Hart Index as our basic measure of mobility.

[6]For an interesting exercise which compares results on poverty vulnerability (the propensity to move into poverty) obtained using panel data on incomes with those obtained from repeated cross-sections instead and finds that model parameters recovered from pseudo-panels approximate reasonably well those estimated directly from a true panel, see Bourguignon, Goh and Kim (2006)

[7]See, for example, Aiyagari (1994), Heaton and Lucas (1996), and Levine and Zame (2002) and Section III for further discussion of the issue of transitory income shocks. Clearly, in the case of measurement error there is even more compelling reason to neglect the i.i.d. component in the welfare analysis. We should also note that while we consider self-insurance against persistent income shocks, we do not model any alternative schemes that may provide insurance against variations in persistent income. We believe this characterization to be closer to that of developing economies, but this analysis would be relevant in any contexts where such (social) insurance schemes are absent.

[8]Moreover, Krebs (2007) shows that even in the case of persistent, but not necessarily permanent, income shocks (AR(1) process with auto-correlation coefficient less than one) consumption still responds one-for-one to income shocks if there are costs of financial intermediation that generate a sufficiently large spread between borrowing rate and lending rate.

implications for welfare. Specifically, we show that the auto-correlation coefficient of the AR(1) process (the catching-up parameter) measures "good mobility" in the sense that a reduction in this parameter increases both mobility and welfare. In contrast, social welfare is (almost) unaffected by measurement error or transitory income shocks even though mobility increases with the variance of the i.i.d. component of labor income. Finally, the variance of persistent income shocks (income risk) increases mobility, but decreases social welfare. This implies that two societies with the same initial distribution of income and the same level of measured income mobility and aggregate growth may experience quite different social welfare changes depending upon the different combinations of the underlying income parameters.

We present a quantitative implementation of our framework that underscores the importance of decomposing income dynamics into its components, as we have discussed. Specifically, an application using data on individual incomes from Mexico yields striking results. Most of measured income mobility is driven by measurement error or transitory income shocks and therefore (almost) welfare-neutral, and only a small part of measured income mobility is due to either welfare-reducing income risk or welfare-enhancing catching-up of low-income individuals with high-income individuals. However, despite the small mobility effects, (idiosyncratic) persistent income risk has significant negative effects on social welfare – eliminating or insuring it would generate welfare gains that are equivalent to an increase in lifetime consumption by about 10 percent even if workers are only moderately risk-averse (log-utility).[9] Eliminating the catch-up of low income individuals with high income individuals yields a loss in social welfare of similar magnitude. Decomposing mobility into its fundamental components is thus seen to be crucial from the standpoint of welfare evaluation.

II. Income and Mobility

II.1. Income Process

Consider a large number of workers indexed by i. For notational ease, we focus on one cohort of workers who enter the labor market for the first time in period $t = 0$ so that $t = 0, 1, \ldots$ stands for both calendar time and age (experience) of the worker. Let y_{it} stand for the labor income of worker i in period t. Following a longstanding tradition in micro-econometrics,

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[9]In comparison, for the same preference parameters, Lucas (2003) computes welfare cost of aggregate consumption fluctuations in the US that are two orders of magnitude smaller. Thus, even though our estimates of persistent income risk seem small when measured mobility is the yardstick, their welfare effect is large indeed.

we postulate that the log of y_{it} is a random variable that is the sum of two components, a persistent component, ω_{it}, and a transitory component, η_{it}.[10] In addition, we set the mean of lny_{it} to μ. In short, we have:

$$log \, y_{it} = \omega_{it} + \eta_{it} + \mu \, . \tag{1}$$

The persistent component, ω_{it}, follows an AR(1) process

$$\omega_{i,t+1} = \rho\omega_{it} + \epsilon_{i,t+1} \, , \tag{2}$$

where ρ is a parameter measuring the persistence of shocks. The term ϵ denotes a stochastic innovation to labor income, which we assume to be i.i.d. over time and across individuals. We further assume that the transitory component of labor income, η_{it}, is i.i.d. over time and across individuals. Moreover, η_{it} and $\epsilon_{i,t+n}$ are uncorrelated for all t and n. All random variables are normally distributed so that labor income is log-normally distributed. More specifically, we assume that $\epsilon_{it} \sim N(0, \sigma_\epsilon^2)$, $\eta_{it} \sim N(0, \sigma_\eta^2)$, and $\omega_{i0} \sim N(0, \sigma_{\omega_0}^2)$.

Equations (1) and (2) together imply that:

$$ln \, y_{it} = \rho^t\omega_{i0} + \sum_{n=0}^{t-1}\rho^{t-n-1}\epsilon_{i,n+1} + \eta_{it} + \mu \, . \tag{3}$$

Thus, labor income in period t is determined by initial condition, ω_0, and stochastic changes, the latter being represented by the transitory shocks, η, and permanent shocks, ϵ. From (3) and our assumptions about ϵ, η, and ω_0 it follows that expected labor income is $E[lny_{it}] = \mu$ and labor income uncertainty before ω_{i0} is known is given by

$$var[lny_{it}] = \begin{cases} \rho^{2t}\sigma_{\omega_0}^2 + \sigma_\eta^2 + \frac{1-\rho^{2t}}{1-\rho^2}\sigma_\epsilon^2 & if \, \rho \neq 1 \\ \sigma_{\omega_0}^2 + \sigma_\eta^2 + t\sigma_\epsilon^2 & if \, \rho = 1 \end{cases} . \tag{4}$$

As we have mentioned earlier, our study examines income mobility within individual lifetimes, i.e., intra-generational income mobility.[11] From (2), the parameter ρ measures persistency of income and thus $(1-\rho)$ measures the extent to which individuals with low levels

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[10]See Gottschalk and Moffitt (1994) and Carroll and Samwick (1997) for similar specifications and Baker and Solon (2003) for a detailed discussion.

[11]For recent work on intra-generational mobility, see Antman and McKenzie (2007), Cuesta and Pizzolitto (2010), Dang et. al. (2011), and Cruces et. al (2011).

of income "initially" will catch up with individuals with high income. In our context, the "initial" period corresponds to the time of entry into the work force after the completion of formal education. Since labor income may vary initially for equivalent individuals, catching-up in this context measures the extent to which individuals with initially low incomes catch up to those with initially high incomes.[12] In the terminology of the growth literature, it measures convergence.[13]

II.2. Mobility

As noted in the introduction, our empirical measure of income mobility between 0 and t, which we denote by m_t, is the Hart index, defined as the complement of the correlation in (log) incomes at 0 and t (see Shorrocks (1993)):

$$
\begin{aligned}
m_t &= 1 - corr(lny_{i0}, lny_{it}) &(5)\\
&= 1 - \frac{cov(lny_{i0}, lny_{it})}{\sigma_{lny_{i0}}\sigma_{lny_{it}}} \,,
\end{aligned}
$$

where we have used the notation $\sigma_{lny_{i0}} = \sqrt{var[lny_{i0}]}$ and $\sigma_{lny_{it}} = \sqrt{var[lny_{it}]}$. Using our income specification from the previous section, we find the following expression for the co-variance:

$$
\begin{aligned}
cov(lny_{i0}, lny_{it}) &= cov(\omega_{i0} + \eta_{i0}, \rho^t\omega_{i0} + \sum_{n=0}^{t-1} \rho^{t-n-1}\epsilon_{i,n+1} + \eta_{it} + \mu) &(6)\\
&= \rho^t\sigma_{\omega_0}^2
\end{aligned}
$$

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[12]In this theoretical section, our discussion relates to initial income differences and subsequent mobility between ex-ante identical individuals. In our discussion of empirical methodology and in our empirical application to Mexican data, we will study mobility between observationally equivalent individuals. That is to say, we examine income differences and mobility in residual income after conditioning for the standard determinants of income such as education and experience.

[13]To see this, suppose $\rho < 1$. In this case, we have convergence towards the "steady state": $E[lny_{it}|\omega_{i0}] \to \mu$. Let $\Delta_0 = lny_{i0} - \bar{d}$ be the initial distance from the steady state and $\Delta_t = lny_{it} - \bar{d}$ be the distance in period t. We can then define the time, T, it takes to get halfway towards the steady state, which is simply the solution to $\Delta_T/\Delta_0 = 1/2$. Using the expression for Δ_T and Δ_0, it is straightforward to see that T is increasing in ρ for $\rho < 1$, that is, an increase in ρ reduces the speed of convergence.

Using (3) and (6), we find the following expression for income mobility:[14]

$$
m_t = \begin{cases} 1 - \dfrac{\rho^t \sigma_{\omega_0}^2}{\sqrt{\sigma_{\omega_0}^2 + \sigma_\eta^2}\sqrt{\rho^{2t}\sigma_{\omega_0}^2 + \sigma_\eta^2 + \frac{1-\rho^{2t}}{1-\rho^2}\sigma_\epsilon^2}} & if \ \rho \neq 1 \\[4mm] 1 - \dfrac{\sigma_{\omega_0}^2}{\sqrt{\sigma_{\omega_0}^2 + \sigma_\eta^2}\sqrt{\sigma_{\omega_0}^2 + \sigma_\eta^2 + t\sigma_\epsilon^2}} & if \ \rho = 1 \end{cases}
\tag{7}
$$

Equation (7) defines income mobility as a function of the parameters of interest, σ_ϵ^2, σ_η^2, and ρ. It is straightforward to show that mobility is increasing in the volatility parameters σ_ϵ^2 and σ_η^2. This is intuitive as an increase in the variance of income shocks increases the variability of individual incomes, lowering the correlation between incomes across time, thus increasing mobility.

Importantly, income mobility is decreasing in ρ if either t is small and $\sigma_{\omega_0}^2 < \sigma_\eta^2 + \sigma_\epsilon^2$ or t is large and $\sigma_{\omega_0}^2 < \sigma_\epsilon^2/(1-\rho^2)$:

$$
\frac{\partial m_t}{\partial \sigma_\epsilon^2} > 0 \quad , \quad \frac{\partial m_t}{\partial \sigma_\eta^2} > 0 \quad , \quad \frac{\partial m_t}{\partial \rho} < 0 \ .
\tag{8}
$$

Intuitively, any increase in ρ increases income persistence, reducing the catching-up effect and therefore reducing mobility. Note that both conditions $\sigma_{\omega_0}^2 < \sigma_\eta^2 + \sigma_\epsilon^2$ and $\sigma_{\omega_0}^2 < \sigma_\epsilon^2/(1-\rho^2)$ are satisfied in our empirical application (see section V).

III. Econometric Implementation

The discussion in the preceding sections has described how the different parameters of the income process ($\sigma_{\omega_0}^2$, σ_ϵ^2, σ_η^2 and ρ) affect mobility. To get to a quantitative assessment of these linkages, we turn next to the methodology and data used to estimate these parameters.

III.1. Estimation

We continue to assume that log labor income, $ln \ y_{it}$, is specified as in (1). We further assume that the deterministic mean component, μ, depends on $x_{it} = (x'_{it}, z_{it})$, where z_{it}

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[14]For $\rho < 1$, the ω-process has a stationary distribution. If we choose as initial distribution this stationary distribution, the ω-process becomes stationary with $\sigma_{\omega_t}^2 = \sigma_{\omega_0}^2 = \sigma_\epsilon^2/(1-\rho^2)$. In this case the mobility expression (7) reduces to $m_t = 1 - \rho^t/\left(1 + \sigma_\eta^2/\sigma_\epsilon^2\right)$.

denotes the age of worker i in year t and x'_{it} is vector of observable individual characteristics beyond age (education, education^2, gender). We also make the functional form assumption $\mu_t(x'_{it}, z_{it}) = \lambda_t + \lambda(x') \cdot x'_{it} + \sum_z \lambda(z) \delta(z_{it})$, where λ_t is a constant that varies by calendar time period (thus absorbing the effects of macroeconomic factors such as aggregate productivity growth and aggregate economic fluctuations on income), $\lambda(x')$ is a vector of coefficients for the vector of worker characteristics x', and $\delta(z_{it})$ are age-dummies. Thus, log labor income can be written as:

$$lny_{it} = \lambda_t + \lambda(x') \cdot x_{it} + \sum_z \lambda(z)\delta(z_{it}) + v_{it} \qquad (1')$$

$$v_{it} = \omega_{it} + \eta_{it} .$$

Equation (1') resembles a typical Mincer specification for labor income for which the residual, v_{it}, is the sum of two unobserved stochastic components, ω_{it} and η_{it}. As in Carroll and Samwick (1997), we first use equation (1') to estimate the residuals v_{it} and then use these estimated residuals to estimate, in a second step, the parameters of interest. As noted above, this implies, importantly, that our mobility measure relates to residual income v rather than unconditional income lny.

For notational simplicity, assume that all individuals i "are born" in period $t = 0$, so that t and z simultaneously stand for age of the individual and calendar time. Equations (1) and (2) which describe our labor income process imply that the the change in residual income variance with age is given by:

$$Var[v_{iz}] = var[(\omega_{iz} + \eta_{iz})]$$

$$= \sigma_\eta^2 + \rho^{2z}\sigma_{\omega_0}^2 + \frac{1 - \rho^{2z}}{1 - \rho^2}\sigma_\epsilon^2 \qquad (4')$$

(4') links the changes in cross sectional residual income variances over for any age cohort z with our parameters of interest. Unfortunately, however, (4') is not sufficient to separately identify $\sigma_{\omega_0}^2$ and σ_ϵ^2 since, as can be seen from the expression on the right hand side, both evolve at the same rate with z. We therefore also use the covariance restriction,

$$cov(v_{iz}, v_{i,z+1}) = cov((\omega_{iz} + \eta_{iz}), (\omega_{i,z+1} + \eta_{i,z+1}))$$

$$= \rho^{2z+1}\sigma_{\omega_0}^2 + \frac{1 - \rho^{2z}}{1 - \rho^2}\rho\sigma_\epsilon^2 \qquad (6')$$

to achieve identification of all four parameters. Notice that (4') requires, on the left hand side, estimates of the cross-sectional variance of residual income for each age group z, while (6') requires that we use the panel dimension of our data set to estimate the covariances in individuals' residual incomes v_{iz} over time. Thus, our estimation strategy exploits both the panel dimension and the repeated cross sections available in the data set. As in Caroll and Samwick (1997), we use residual income data at the individual level to obtain unbiased estimators of the terms on the left hand side of (4') and (6'). Specifically, v_{iz}^2 and $v_{iz}v_{i,z+1}$ serve as as individual level "observations" of the variance and covariance terms on the left hand sides of (4') and (6') respectively. We estimate our system of two equations ((4') and (6')) using a simultaneous, non-linear, seemingly unrelated regressions model (NLSUR) (as described in Gallant, 1975 and Amemiya, 1983). This permits the estimation of the two non-linear equations, with the cross-equation restrictions implied by the common parameters, simultaneously and achieves additional estimation efficiency by combining information from both equations (Davidson & MacKinnon, 2004).[15]

IV. Data

Using the estimation methodology described in the preceding section, we estimate income mobility parameters using individual income data from Mexico. Specifically, the individual income data are taken from the Encuesta Nacional de Empleo Urbano (ENEU, Mexican National Urban Employment Survey) which was conducted by the Instituto Nacional de Estadistica, Geografia e Informatica (INEGI, National Institute of Statistics, Geography and Information), the primary statistical agency in Mexico, and the Secretaria del Trabajo y Prevision Social (STPS, Secretariat of Labor and Social Security), Mexico's Labor Ministry.

Until recently, the ENEU was the primary survey instrument for collecting earnings and employment data in Mexico. The survey is sampled to be representative geographically and by social strata (see INEGI 2000). The basic sampling unit is the dwelling. Demographic information is collected on the household (households) occupying each dwelling. Subsequently, an employment questionnaire is administered for each individual aged 12 and above in the household on position in the household, level of education (years of schooling), age and sex

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[15]See also Davidson and MacKinnon (2004) for a through discussion of the asymptotic equivalence between estimates obtained using a non-linear-least-squares methodology and the generalized method of moments.

as well as standard measures related to participation in the labor market: occupation, hours worked, employment conditions, search and earnings. Importantly, the ENEU is constructed as a rotating panel, where individuals are surveyed every quarter for a total of five quarters.[16] Worker earnings include overall earnings in the individual's principal occupation from fixed salary payments, hourly or daily wages, piece-meal work, commissions, tips and self employment earnings. The ENEU, in its modern form, has employed a consistent survey instrument from 1987 to 2004; it is thus one of very few long-running surveys with a panel dimension in the developing world. In our study, we are able to use this 18 year span comprising a total of 72 quarters of data.[17]

We note that while the ENEU survey records employment information on all members of the household above 12 years old, for younger workers employment is generally transient and time is often divided among schooling, unpaid support to the household and paid work. Similarly, much later in life, work again becomes more transient. In our analysis, we focus on individuals between the ages 20 and 65.

V. Results

As discussed in the previous section, our estimation methodology proceeds in two steps. As in Carroll and Samwick (1997), we first use individual data to estimate a Mincer earnings regression. In a second step, the residuals from the Mincer regression are used to estimate income mobility parameters using (4') and (6'). Table 2 reports the estimates from the first stage earnings regression using the ENEU data described in the preceding section. Our estimates are consistent with earlier findings in the literature. Specifically, earnings increase, but at a decreasing rate, with education. Further, earnings increase with potential experience (age) up until the age of 44 after which they decrease again. Males appear to earn 31 percent more than women, conditional on the other covariates.[18]

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[16]In each round of the rotating panel, the questionnaire records absent members, adds any new members who have joined the household, and records any changes in schooling that have taken place. If none of the original group of household members is found to be living in the dwelling unit in the follow-up survey, the household is recorded as a new household. The interviewers do not track households that move, so they leave the panel. Rates of attrition are comparable to other developing countries (See Antman and McKenzie, 2007).

[17]Since 2004, the ENEU has been replaced by the Encuesta Nacional de Ocupacion y Empleo (ENOE, Survey of Occupation and Employment) in 2005. Unfortunately, however, the ENOE instrument differs from ENEU in important ways that make it impossible to match the surveys with confidence.

[18]For robustness we have also run alternate earnings specifications, allowing for both more and less tem-

We use next the residuals from the earnings regression, v_{it}, to construct individual level "observations" of income variances v_{it}^2 and covariances $v_{it}v_{i,t+1}$,[19] that are to be used on the left hand side of equations (4') and (6') to estimate the income mobility parameters. The age profile of the constructed variance and covariance measures are indicated in Figures 1 and 2, which are generated by regressing the two variables respectively on a complete set of age and time dummies and then plotting the former against age (see Deaton and Paxson, 1994, for a similar exercise). Consistent with equations (4') and (6'), the accumulation of persistent shocks, σ_ϵ^2, as age increases, gives both relationships an upward slope, albeit at rates differing by a factor of ρ.

Estimation results from the joint estimation of (4') and (6'), as described in the previous section, yield the parameter estimates listed in Table 3. The first column presents the results using the full sample, while the second column provides results obtained using data from just those households that enter the sample in the first quarter of each year. Our estimates of the income mobility parameters are also in line with those obtained previously in the literature. The autoregressive component, ρ, is estimated to be 0.977, which suggests that persistent shocks to income experienced by any individual i will indeed last a long time. The estimated variance of transitory shocks to income $\sigma_\eta^2 = 0.202$, is significantly larger than the variance of persistent shocks to income $\sigma_\epsilon^2 = 0.015$. This is not surprising given that the transitory shocks in our specification subsume measurement error in income, which we expect to be quite large in our data set.[20] Finally, the estimated variance in initial incomes, $\sigma_{\omega_0}^2 = 0.104$. As the results in the second column indicate, the estimates are not appreciably different with the restricted sample of households who enter the survey in just the first quarter of each year.

Given our estimates of the income parameters, we can use expressions (7) to analyze mobility patterns. In particular, we can compute how much the individual parameters contribute to overall mobility. Table 4 shows that mobility in residual income across 1 year is 0.67 and it increases as the span of measurement increases to 10 years (0.76), and 25 years (0.84). The reasons behind the surprisingly high 1 year mobility level, and relatively

poral variation, by allowing all parameters to vary in each time period, and separately by constraining even the constant to be invariant across periods (unlike in the specification reported on in Table 2, which includes year fixed effects). The results do not change appreciably.

[19]Note that v_{t+1} denotes individual i's residual one year (four quarters) after t

[20]See Antman and McKenzie (2007) for a discussion of measurement error and mobility using this data.

modest increases thereafter become clearer in the next rows which set to zero each of the key parameters and calculate the resulting change in mobility. Notice, first, that 1-year mobility falls by a full 90 percent if we set σ_η^2, which represents transitory shocks and measurement error to zero. As we have noted earlier, our analysis proceeds under the understanding that individuals can largely smooth such transitory shocks through own savings and these shocks are therefore limited welfare impact. By contrast, "bad mobility" σ_ϵ^2 due to risk and "good" mobility due to convergence, ρ) account for roughly 1 percent each across 1 year.[21]

The relative impact of these parameters clearly changes as we increase the span over which we are measuring mobility. At 25 years, setting transitory shocks to zero reduces mobility by a still large, but much reduced by 23 percent (as transitory shocks are, by definition, transitory and mobility over this duration is driven to a greater extent by the cumulative effect of persistent shocks experienced by individuals over this period). By contrast, mobility due to persistent risk accounts for 7.4 percent and due to convergence, to 8.6 percent. Having identified which parameters have the largest influence on measured mobility, we now turn to their relative contribution to welfare.

VI. Welfare Analysis

The voluminous literature on consumption and saving with individual income risk and incomplete insurance markets has generated a number of insights.[22] One important insight is that workers can effectively self-insure against transitory income shocks through borrowing or own saving, and that the effect of these shocks on equilibrium prices and quantities are relatively small.[23] A second important insight of this literature is that very persistent or fully permanent income shocks have substantial effects on consumption and welfare even if individual households have own savings, but no or only limited access to insurance markets. Indeed, when labor income is the main source of income and labor income shocks are highly persistent, we would expect that consumption responds (almost) one-for-one to labor income shocks. This point has been made more formally by Constantinides and Duffie (1996) and

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[21]Note that since mobility is highly non-linear in its underlying parameters, measured mobility does not decompose additively into its component parts.

[22]See, for example, Heathcote, Storesletten, and Yaron (2009) for a recent survey.

[23]See, for example Aiyagari (1994) and Heaton and Lucas (1996) for quantitative work and Levine and Zame (2002) for a theoretical argument. Kubler and Schmedders (2002) show that welfare cost of "transitory" labor income shocks are non-negligible, but the labor income process they consider has $\rho = 0.5$.

Krebs (2007) using dynamic general equilibrium exchange models with incomplete markets. Constantinides and Duffie (1996) only consider the case in which income follows a random walk ($\rho = 1$), but Krebs (2007) also analyzes an extension with $\rho < 1$ and costs of financial intermediation that introduce a spread between the borrowing rate and the lending rate. In this section, we discuss the main ideas and results of the model analyzed in Krebs (2007).

VI.1. Consumption

The model features long-lived, risk-averse workers with homothetic preferences who make consumption/saving choices in the face of uninsurable income shocks. Workers' preferences over consumption plans, $\{c_{it}\}$, allow for a time-additive expected utility representation with one-period utility function of the CRRA-type, where in this paper we confine attention to the log-utility case (degree of relative risk aversion of 1):

$$U(\{c_{it}\}|\omega_{i0}) = E\left[\sum_{t=0}^{\infty} \beta^t ln c_{it}|\omega_{i0}\right] . \tag{9}$$

Workers maximize expected lifetime utility subject to a sequential budget constraint that allows them to transfer wealth across periods through saving (or borrowing). The model is an exchange economy with endogenous interest rate (general equilibrium).

In order to apply the equilibrium characterization result of Krebs (2007), we need to introduce three modification of the labor income process (1). First, we abstract from ex-ante heterogeneity and time-effects: $\mu_t(x_{it}) = \mu$. For simplicity, we set $\mu = 0$ so that the mean of labor income (aggregate labor income) is normalized to one (see below). Second, measurement error should not enter into the worker's budget constraint, and the part of η that represents measurement error should therefore be omitted. Further, as we have argued before, the part of η that is due to true income shocks is expected to have only small effects on equilibrium consumption and welfare. To simplify the analysis, we neglect these small effects of transitory income shocks and set $ln y_{it} = \omega_{it}$, where $\{\omega_{it}\}$ is an AR(1) process as in the previous section. Third, the distribution of the innovation term, ϵ, and the distribution of initial income, ω_0, include a mean-adjustment: $\epsilon \sim N(-\sigma_\epsilon^2/2, \sigma_\epsilon^2)$ and $\omega_0 \sim N(-\sigma_{\omega_0}^2/2, \sigma_{\omega_0}^2)$. This adjustment is necessary to ensure that σ_ϵ^2 and $\sigma_{\omega_0}^2$ can be interpreted as uncertainty parameters (see below).[24]

---

[24]The main part of the analysis in Krebs (2007) deals with the random walk case, but the Appendix

Our specification of the labor income process implies that

$$
\begin{aligned}
E[y_{i,t+1}|I_t] &= y_{it}^{\rho} \\
var[y_{i,t+1}|I_t] &= e^{\sigma_\epsilon^2} - 1 \\
E[y_{i0}] &= 1 \\
var[y_0] &= e^{\sigma_{\omega_0}^2}
\end{aligned}
\tag{10}
$$

where I_t denote the information available at time t. Thus, increases in either σ_ϵ or σ_{ω_0} increase the variance of labor income without any change in the (conditional) mean – they lead to a mean-preserving spread. In other words, the two parameters measure risk/uncertainty.[25]

If $\rho = 1$ and labor income follows a random walk, then the equilibrium interest rate will adjust so that individual workers will optimally decide to set consumption equal to labor income (see Constantinides and Duffie (1996) and Krebs (2007) for details). If ρ is not equal to one, but not too far away from one, then a sufficiently large difference in the borrowing and lending rate (cost of financial intermediation) will ensure that in equilibrium households still choose to set consumption equals labor income (see the Appendix of Krebs (2007) for details). In short, in equilibrium we have $c_{it} = y_{it}$, that is, consumption and labor income move one-for-one.

VI.2. Mobility and Welfare

Using $c_{it} = y_{it} = \omega_{it}$ and the income specification discussed above, we can evaluate the expected lifetime utility (9) of an individual with initial income ω_{i0}. Taking the expectation over ω_{i0} yields social welfare, W, where we assume that each individual household is assigned equal weight in the social welfare function. In other words, social welfare is the expected lifetime utility from an *ex ante* point of view when the initial condition, ω_0, is not yet known

---

discusses the extension to labor income shocks that are not fully permanent. The labor income process specified in the Appendix of Krebs (2007) is equivalent to an AR(1) process with an innovation term that has finite support, which rules out the case of a normal distribution. One way to apply the results of Krebs (2007) to the present analysis is to truncate all normal distributions at an arbitrarily large point, and to think of all equilibrium results as approximate results for which the approximation error can be made arbitrarily small.

[25]The n-period ahead variances, $var[y_{i,t+n}|I_t]$, in general depend on σ_ϵ^2 for $n \geq 2$ if $\rho < 1$. We can correct for these "higher-order" effects without essentially changing the main results of the paper. More precisely, a modified version of the welfare formula (.), which adjusts for the change in mean income, yields quantitative results that are very close to the results reported here. Details are available on request.

(veil of ignorance). More formally, we have

$$
\begin{aligned}
W &= E\left[\sum_{t=0}^{\infty}\beta^t lnc_{it}\right] \tag{11} \\
&= E\left[E\left[\sum_{t=0}^{\infty}\beta^t lnc_{it}|\omega_0\right]\right] \\
&= E\left[-\frac{\beta}{(1-\beta)(1-\beta\rho)}\frac{\sigma_\epsilon^2}{2}+\frac{1}{1-\beta\rho}\omega_0\right] \\
&= -\frac{\beta}{(1-\beta)(1-\beta\rho)}\frac{\sigma_\epsilon^2}{2}-\frac{1}{1-\beta\rho}\frac{\sigma_{\omega_0}^2}{2}
\end{aligned}
$$

The formula (11) shows how social welfare depends on the various income parameters and the preference parameter β. In particular, (11) shows that an increase in uncertainty, either about initial conditions or about future labor market conditions, will reduce social welfare. Further, an increase in ρ increases uncertainty about lifetime income, and therefore reduces welfare:

$$
\frac{W}{\partial\sigma_{\omega_0}^2}<0 \ , \ \frac{W}{\partial\sigma_\epsilon^2}<0 \ , \ \frac{W}{\partial\rho}<0 \tag{12}
$$

In order to express welfare changes in economically meaningful units, we calculate the corresponding change in consumption in each period and possible future state that is necessary to compensate the worker for the change in uncertainty. For example, suppose we compare two economies, one with income parameters $(\sigma_{\omega_0}^2,\sigma_\epsilon^2,\rho)$ and one with income parameters $(\hat\sigma_{\omega_0}^2,\hat\sigma_\epsilon^2,\hat\rho)$. We then define the consumption-equivalent welfare change, Δ, of moving from $(\sigma_{\omega_0}^2,\sigma_\epsilon^2,\rho)$ to $(\hat\sigma_{\omega_0}^2,\hat\sigma_\epsilon^2,\hat\rho)$ as

$$
E\left[\sum_{t=0}^{\infty}\beta^t ln\left(c_{it}(1+\Delta)\right)\right]=E\left[\sum_{t=0}^{\infty}\beta^t ln\hat c_{it}\right] \ , \tag{13}
$$

where c is consumption in the first economy and $\hat c$ is consumption in the second economy. Using the definition (13) and the welfare formula (11), we find:

$$
\begin{aligned}
\ln(1+\Delta) &= \frac{\beta}{(1-\beta\hat\rho)}\frac{\hat\sigma_\epsilon^2}{2}+\frac{(1-\beta)}{(1-\beta\hat\rho)}\frac{\hat\sigma_{\omega_0}^2}{2} \\
&\quad -\frac{\beta}{(1-\beta\rho)}\frac{\sigma_\epsilon^2}{2}-\frac{(1-\beta)}{1-\beta\rho}\frac{\sigma_{\omega_0}^2}{2}
\end{aligned} \tag{14}
$$

As mentioned before, measurement error and transitory shocks have (almost) no effect on welfare. In contrast, the effect of the other two mobility parameters, σ_ϵ and ρ, turn out be quite substantial. For example, based on the welfare formula (14) and an annual discount factor of $\beta = 0.96$, a value that is standard in the macro-economic literature (for example, Cooley and Prescott, 1995), we find that removing all "bad mobility", $\sigma_\epsilon^2 = 0$, leads to a welfare gain of about 12 percent of lifetime consumption. Using the same discount factor, the welfare cost of removing all "good mobility", $\rho = 1$, is equal to 8 percent of lifetime consumption, again a significant welfare effect. Finally, removing both "good" and " bad" mobility at the same time, $\sigma_\epsilon^2 = 0$ and $\rho = 1$, leads to a net welfare gain of about 10 percent of lifetime consumption. The last result shows that the welfare formula (14) is highly non-linear and that the positive welfare effect of catching-up, $\rho < 1$, is closely linked to the presence or absence of persistent income shocks, ϵ. Calculations with other values of β yield similar results as indicated in Table 5.

In sum, the application of our general framework to Mexico provides striking results. The parameter that accounts for the largest part of measured mobility, σ_η, has (almost) no effect on welfare, and the two parameters that have large effects on welfare, σ_ϵ and ρ, have only a modest contribution to measured mobility, and least over small time durations. Clearly, our welfare results depend on the choice of preference parameters, namely the degree of risk aversion and the degree of impatience (discounting). However, by using a logarithmic utility function we have already chosen a relatively low degree of (relative) risk aversion, namely one, and any increase in the degree of risk aversion would only increase the welfare effects. Further, lowering the discount factor β will lower the welfare effects, but for a wide range of values of β the welfare effects remain substantial and the ranking of the different parameters remains the same (see Table 5). In short, our welfare results are valid for a wide range of preference parameters.

VII. Conclusions

This paper develops an analytically tractable framework linking individual income dynamics, social mobility and welfare. This analytical framework that we develop has the merit that the links between different determinants of income mobility and social welfare are drawn out in a simple and transparent manner − allowing for a clearer analytical and quantitative discussion of these interrelated concepts than has generally been possible in the past. In particular, we discuss in detail how different determinants of measured income mobility (shocks to income, and convergence forces, for instance) may have quite different implications for welfare. This implies that two societies with the same initial distribution of income and the same level of measured income mobility may be characterized by quite different levels of social welfare. Decomposing the determinants of mobility is thus shown to be crucial from the standpoint of welfare evaluation.

An important strength of the proposed framework is its empirical implementability. The quantitative evaluation of mobility and welfare in our context entails the estimation of income process parameters may be achieved using combined cross sectional and longitudinal data on individual incomes and relatively straightforward econometric techniques. The results from Mexico are striking. Most of measured mobility is estimated to be driven by transitory shocks to income and is therefore (almost) welfare neutral. Only a small part of mobility (i.e., mobility in permanent income) is driven by either social-welfare-reducing persistent income shocks or welfare-enhancing catching-up of low-income individuals with high-income individuals. Despite their small contributions to measured mobility, the implications for welfare are large. Decomposing mobility into its fundamental components is thus crucial from the standpoint of welfare evaluation.

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Table 1: Summary Statistics: 1987-2003

	Mean	Sd	Min	Max
Age	36.271	10.626	20	65
Schooling	10.624	5.460	0	22
Sex	0.737	0.440	0	1

Note: Based on the Mexican Monthly Urban Employment Survey, 1987-2003 using individuals between 20 and 65 years of age. Age and schooling in years.

Table 2: Mincer Regression

	Coef	Sd	t	p > |t|
Cons	3.699	0.009	422.450	0.000
Sex	0.310	0.002	191.140	0.000
Sch	0.077	0.001	143.160	0.000
Sch^2	-0.001	0.000	-45.380	0.000
Age				
21	0.044	0.005	8.730	0.000
22	0.088	0.005	17.540	0.000
23	0.127	0.005	25.740	0.000
24	0.173	0.005	34.570	0.000
25	0.208	0.005	41.530	0.000
26	0.242	0.005	47.780	0.000
27	0.268	0.005	52.450	0.000
28	0.288	0.005	56.510	0.000
29	0.309	0.005	60.240	0.000
30	0.328	0.005	64.350	0.000
31	0.348	0.005	66.740	0.000
32	0.360	0.005	68.540	0.000
33	0.370	0.005	71.270	0.000
34	0.382	0.005	71.890	0.000
35	0.389	0.005	73.360	0.000
36	0.391	0.005	73.160	0.000
37	0.407	0.005	75.150	0.000
38	0.422	0.005	77.940	0.000
39	0.421	0.005	76.910	0.000
40	0.426	0.006	77.270	0.000
41	0.442	0.006	76.630	0.000
42	0.451	0.006	77.750	0.000
43	0.448	0.006	76.700	0.000
44	0.459	0.006	74.430	0.000
45	0.455	0.006	74.150	0.000
46	0.450	0.006	70.690	0.000
47	0.452	0.007	66.900	0.000
48	0.441	0.007	64.660	0.000
49	0.430	0.007	61.210	0.000
50	0.434	0.007	60.680	0.000
51	0.431	0.008	56.920	0.000
52	0.430	0.008	54.200	0.000
53	0.423	0.008	52.360	0.000
54	0.420	0.009	48.510	0.000
55	0.398	0.009	44.750	0.000
56	0.400	0.009	42.730	0.000
57	0.393	0.010	39.600	0.000
58	0.367	0.011	34.870	0.000
59	0.356	0.011	32.000	0.000
60	0.322	0.011	28.640	0.000
61	0.307	0.012	24.860	0.000
62	0.302	0.014	22.000	0.000
63	0.286	0.015	19.640	0.000
64	0.309	0.016	19.460	0.000
65	0.247	0.016	15.360	0.000
Year and wave dummies		Yes		
N		782179		
R^2 Adj		0.595		

Note: Regression of log income on sex, age as a dummy variable, schooling, schooling square and a year time specific dummy and a dummy for whether the data correspond to the first period or the fifth. Data are pooled across all years. Based on the Mexican Monthly Urban Employment Survey, 1987-2003, using individuals between 20 and 65 years of age.

Table 3: Estimation of Mobility Parameters

	Full Sample	Restricted
ρ	0.977***	0.976***
	(0.0019)	(0.0037)
σ_ω^2	0.104***	0.104***
	(0.0038)	(0.0068)
σ_ϵ^2	0.015***	0.016***
	(0.0008)	(0.0016)
σ_η^2	0.203***	0.217***
	(0.0039)	(0.0073)
Time Dummies	Yes	Yes
N	387460	99570

Note: Estimation using Non-linear SUR estimation. Dependent variables: Eq 1 variance, Eq 2 covariance. Variance calculated as the square of the residual of the mincer regression. Covariance as the covariance of the residual in the first quarter observed with that of the fifth quarter. ρ represents the autoregressive coefficient or convergence parameter. σ_ω^2 represents the variance of the initial distribution of income. σ_ϵ^2 represents the variance of permanent shocks. σ_η^2 represents the variance of the transitory or measurement error component of income. A complete and separate set of time dummies is included in each equation. Estimates using the Mexican Monthly Urban Employment Survey, 1987-2003, using individuals between 20 and 65 years of age. Column 1 uses all observations. Column 2 just those beginning Q1 of each year. Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Mobility Analysis

	Span of measurement (t, in years)		
	1	10	25
Actual mobility	0.674	0.763	0.846
% Δ if:			
$\rho = 0$	-0.77	-5.2	-8.6
$\sigma_\epsilon^2 = 0$	-1.2	-6.6	-7.4
$\sigma_\eta^2 = 0$	-89.7	-45.7	-23.3

Note: Table shows the percentage decline in mobility as component parameters are individually set to zero relative to actual mobility calculated from equation (7) using parameters estimated in Table 3 based on the Mexican Monthly Urban Employment Survey, 1987-2003. ρ represents the autoregressive coefficient or convergence parameter. σ_ϵ^2 represents the variance of permanent shocks. σ_η^2 represents the variance of the transitory or measurement error component of income. Mobility is calculated across a span, t, of 1, 10 and 25 years.

Table 5: Welfare Analysis

	$\sigma_\epsilon^2 = 0$	$\rho = 1$	$\sigma_\epsilon^2 = 0$ and $\rho = 1$
% Δ if:			
$\beta = 0.96$	12.56	-8.04	10.5
$\beta = 0.95$	10.64	-5.82	8.91
$\beta = 0.94$	9.21	-4.45	7.72
$\beta = 0.90$	5.87	-2.05	4.93

Note: Table shows the percentage change in welfare calculated measured as a percent of lifetime consumption as σ_ϵ^2, the variance of permanent shocks, is set to 0 (no income risk) and ρ, the convergence parameter, is set to one (no convergence). β is the annual discount factor. Welfare is calculated using equations (11) and (14) and the estimated values in Table 3 using the Mexican Monthly Urban Employment Survey 1987-2003.

%