Family Transfers in Rural Mexico: An Application to Risk Sharing and Labor Supply Elasticity

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Abstract

This paper creates a model of labor supply and consumption when parents are supported by their adult children. The model yields three testable predictions: (1) children with positive wage shocks contribute more money to support their parents; (2) children with positive wage shocks work more hours than their siblings; (3) families with non-working parents have more income-pooling, and labor supply elasticity between siblings is larger. Even in households with complete income-pooling, the effect of wages on consumption is ambiguous, because leisure and consumption may be non-separable.

The model is tested using instrumental variables and data from the 1970 and 2000 Mexican Census. Empirical results demonstrate that children who received an exogenous wage shock send an average of 24%-29% of the extra earnings to the support of their parents. Furthermore, men who received an exogenous wage shock of 10% worked on average 4%-8% more throughout their lives. Among brothers living in their parents' household, the brother with wages 10% higher worked 3% more. Labor supply elasticity is higher in households with non-working fathers.

Introduction

People in the developing world face a great deal of short-term non-labor income variation. Crops can fail if the rains come too early or too late, or a farmer can become sick and unable to harvest crops in the field. There is a rich economics literature studying how villages create institutions that provide (or fail to provide) insurance against these shocks. However, people in the developing world are also exposed to long-term wage variation. Many adults are chronically ill, and unable to do strenuous physical labor. Children who drop out of school in response to temporary shocks earn lower wages for the rest of their lives. Long-term wage variation cannot be insured through the same institutions that provide short-term consumption smoothing. This paper will argue that the developing world has also created mechanisms for smoothing long-term wage differences.

This paper creates a model of labor supply and consumption when children's wages are random and retired parents are supported by their adult children. In this model, siblings pool their incomes when their parents need support, but otherwise they keep their incomes separate. Because the population is a mixture of families with non-working parents and parents who do work, we will observe partial income pooling among family members. The model yields three testable predictions: (1) children with positive wage shocks contribute more money to support their parents; (2) children with positive wage shocks work more hours than their siblings; (3) families with non-working parents have more income-pooling, and labor supply elasticity between siblings is larger

In this paper, I create two novel instruments to study within family effects of wage differences. Both of these instruments are uncorrelated with family background. Therefore, they correspond to a policy experiment that randomly raises one child's wages – but holds wages for the rest of the family fixed. How do I raise wages for one child? I increase their education, which in turn increases lifetime wages. As an additional check, I also use endogenous education differences between brothers to measure the effect of wage differences. Even after controlling for family fixed effects, men with more education earn more.

I am able to test all three predictions from my model using data from the 1970 and 2000 Mexican Census. Consistent with the prediction (1), I found that children who get an exogenous wage shock send 24%-29% of their extra earnings home to their parents. Consistent with the prediction (2), I found that men who get an exogenous wage shock of 10% work 4% harder than their siblings. Results were similar in the sample of brothers: a man who earns 10% more than his brother works 3%-4% harder. Consistent with prediction (3), within family labor supply elasticity is higher in households with a retired father. The labor supply results remain similar when I use retirement age to instrument for the parent's work status.

A final prediction of the income-pooling model concerns the effects of wage shocks on consumption. My model predicts that men with positive wage shocks consume more substitutes for leisure and less complements to leisure. For example, we might expect that men who work more hours will consume more coffee (substitute to sleep) and less alcohol (complement to partying). I find that an exogenous wage shock of 10% increases the probability that a man owns a computer in 2000 by 6%-8%, has no effect on food quality consumed in 1970, and decreases the likelihood he owns a TV in 2000 by

2%. This is consistent with the assumption that home computers are a complement to labor supply, that food quality is separable from leisure, and that TVs are a complement to leisure.

This paper will be divided into six parts: Part I reviews the literature on income pooling within families and villages. Part II creates a model of consumption and labor supply when income is pooled within a family and wages are random. Part III studies how to estimate within family effects. I solve for two different empirical strategies: instrumental variables and family estimates. I find that the two strategies sample different subgroups from a heterogeneous population. Part IV describes the datasets used and gives summary statistics. Part V describes the instruments used. Finally, part VI presents empirical results for transfers to parents, labor supply and consumption.

I. Previous Research on Income Pooling in Families and Communities

Most previous work on income pooling assumes that wages are fixed, and non-labor income is random. In that model, transfers exactly offset individual income shocks. Therefore, consumption by a given individual depends only on aggregate income for the group as a whole (Mace 1991). Because the model makes such specific predictions, it is very easy to test for complete income pooling.

In the developing world, economists observe significant income pooling. In India, food consumption mostly depends on total income for the village as a whole, and not on the individual family's income[1] (Townsend 1994). In Mexico, unexpected transfers from the government to the very poor are shared within a village as a whole (Angelucci and De Georgio 2006). However, the income pooling may not be complete. In Thailand, Townsend rejects full risk-sharing (Townsend 1995). Even within a household, individual consumption may depend one's own income, and not on the total family income (Duflo and Udry 2004). Regardless of whether families pool income completely, their actions suggest that they place great value on whatever income pooling exists. In India, parents intentionally marry their daughters into multiple villages, making the family less vulnerable to local shocks (Rosenzweig and Stark 1989). In Thailand, workers migrate to minimize aggregate family income risk, not their own income risk (Paulson 2000).

In contrast to the developing world, families in the United States do much less to reduce income inequality through income pooling. In the PSID, family transfers reduce income inequality within the family by only 4%-13% (Altonji, Hayashi and Kotlikoff 1997). If there were complete income pooling, then food consumption would depend only on average family income, not individual income. But in fact, Altonji, Hayashi and Kotlikoff (1992) find that children's income has a large effect on their own food consumption, but average family income has a small effect. Even bequests do little to reduce income-inequality within the family – most parents give equal amounts to each child, regardless of wages (Wilhelm 1996).

It is possible that different behavior observed is caused by factors outside the family. In a model with altruism, family members will give money when somebody is

[1] This is after controlling for family fixed effects, and studying how families smooth short-term risks.

desperately poor, but not simply to alleviate minor problems. In the developing world, credit markets are poorly developed. So, a single bad harvest can make a farmer poor enough to merit family help. In contrast, farmers in the developed world can use savings to smooth consumption, without resorting to family transfers. Similarly, governments in the developed world provide many more social insurance programs. Even people without savings are protected against abject poverty. In my model, I will focus on a family where adult children support their retired parents. I assume that parents cannot save for their own retirement, but are forced to rely on their children's help. This assumption is clearly not true in the United States, which has Social Security and corporate pensions.

There is some theoretical research studying income pooling when wages are variable. Cremer and Pestieau (1998) develop a model where parents cannot observe wages[2], but they can observe annual earnings. In that model, complete income pooling discourages children's labor supply. Altruistic parents will give some help to unlucky children, but not as much as the parents would give if they could observe wages directly. Becker and Tomes (1976) create a model of parental investment in children's schooling when ability is random. They show that expected income-pooling influences wage inequality. If the parents expect that children will pool income as adults, they will invest more in education for the smartest children. However, their model does not directly address labor supply for adult children. These theoretical studies not withstanding, I have not been able to find any empirical papers investigating the relationship between wages and labor supply in families with income pooling.

The problem of income pooling within a family maps closely to the problem of consumption-smoothing over a lifecycle. There is a rich literature studying consumption over the lifecycle. In a world with perfect credit markets, current consumption is predicted to depend only on life-time income and current leisure, not current income (Baxter and Jermann 1999). Tests of this hypothesis in the United States typically find mixed results. On the one hand, small changes in current income sometimes have larger than expected impacts on current consumption (Johnson, Parker and Soules 2004) and (Stephens 2003). On the other hand, people are better at smoothing relatively large income changes. For example, Aguiar and Hurst (2004) show that households are able to maintain their normal standard of living after retirement, even though they generally have much lower income.

The lifecycle model also differentiates between short-term and long-term labor supply elasticity. The short-term labor supply elasticity is known as the Frisch labor supply elasticity, and it measures how labor supply changes when wages rise, and marginal utility of consumption is held fixed. The long-term labor supply elasticity is known as the Marshallian labor supply elasticity, which measures how labor supply changes when wages rise, and non-labor income is held fixed. The empirical estimates for the two labor supply elasticities are very different. Oettinger (1999) and Fehr and Gotte (2002) used short-term wage variation caused by demand shocks[3] to get Frisch labor supply elasticity of .5-.65. Mulligan (1998) used long-term wage variation caused

[2] They use ability rather than wages and effort rather than hours worked, but the model is equivalent to model with labor supply and unobservable wages.

[3] Oettinger studied labor supply for baseball vendors, and used predicted attendance as a measure of wages. Fehr and Gotte created an artificial demand shock by paying some messengers more in the short term.

by the lifecycle to get a Frisch labor supply elasticity of .57[4]. Kimball and Shapiro (2003) survey the literature, and find that most estimates of Marshallian labor supply elasticity are close to 0. In a model of income-pooling within the family, individuals change labor supply when their own wages changes with the Frisch elasticity, and families change average labor supply when average wages change with the Marshallian elasticity. So, I predict that individuals will sharply increase their labor supply if they get a positive wage shock, but average family wages have little impact on labor supply.

II. A Model of Transfers Within Extended families

Researchers in Mexico have found two main mechanisms for sharing risk within a community: the cargo system and transfers within the family. In the cargo system, villagers volunteer to provide communal goods such as maintaining churches and wells or serving as mayor. Rich villagers are expected to host religious and social celebrations for the entire village. These events can be very expensive: Cancian (1965) finds that the most prestigious event in the village he studied cost enough to pay an unskilled laborer for 10 years. The cargo system is enforced by social norms: villagers gain prestige and power when they sponsor successful events and are shunned if they refuse to sponsor any events. The Mexican cargo system developed out of a unique blend of Aztec and Catholic cultures, but similar systems exist throughout the developing world (Schoeck 1966). For analytical simplicity, I will focus on cash transfers within the family. Results would be identical if I included the cargo system in the model as well[5].

In my model, a family consists of *n* adult children and one retired parent. The children may send money to support their parent in old age – or they may keep all of their earnings for themselves. Because Mexico is a developing country, it might seem that few people live long enough to worry about retirement. In fact, 77% of people born in 1935 survived to the legal retirement age of 65[6]. The Mexican Social Security System (IMSS) covers only the formal sector, so only 26% of men over 65 and 13% of women over 65 receive any payments at all. Therefore, many senior citizens rely of their adult children for support: 13% of men and 16% women received cash transfers from family in the last month.

Model

Suppose that there are *n* adult children in a family, and one retired parent. In rural Mexico, the typical family size was around 6-7 children[7] – but the model works for any family with at least two children. There are *m* normal consumption goods and one normal leisure good. This is a single period model, so there are no savings. Every child

[4] Taken from page 38 for prime-age men.
[5] This is true as long as men do not change their behavior to avoid participating in the cargo system. In fact, I found no evidence that men with positive wage shocks are more likely to leave their birth state, even though they moving would allow them to escape the cargo system.
[6] The percentage of parents who survived to 65 is even higher, because much of the mortality for this cohort occurred during childhood.
[7] This is estimated total fertility rate up to 1970. After 1970, fertility fell rapidly, and is now around 2 children per woman.

is altruistic towards the parent, so the parent's consumption is a public good for all children in the family. Every child in the family is ex ante identical, but at adulthood they each receive a random wage shock: $w_j = \overline{w} + w_j^{\varepsilon}$.

Child j has three decisions to make: a)How much money to send home to support his father, t_j; b) How much leisure, *L*. The cost of one unit of leisure is w_j, the amount of money the child could have earned from working. (For simplicity, I will assume that each person has 1 unit of time to divide between leisure and work); c)How much to buy of each consumption good, $c_j^1,...,c_j^m$.

There is already a rich literature studying public goods and free riders. In this paper, I will follow Warr (1983), and assume that the children interact in a simultaneous game: each child gives money to the parent without influencing how much their siblings give. In Appendix 3 and 4, I examine alternative methods to model the interaction, and show that results are qualitatively similar.

Because child j is altruistic towards his parent, his complete utility function is:

$$U_j = u(c_j^1,...,c_j^m, L_j) + \alpha U_p = u(c_j^1,...,c_j^m, L_j) + \alpha u(c_p^1,...,c_p^m, L_p)$$

We can write his maximization problem as:

$$\text{Max } U_j = u(c_j^1,...,c_j^m, L_j) + \alpha u(c_p^1,...,c_p^m, L_p), \text{ subject to:}$$

$$\text{Child j's budget constraint: } \sum_{i=1}^{m} c_j^i = w_j(1-L_j) - t_j$$

$$\text{Parent's budget constraint: } \sum_{i=1}^{m} c_p^i = t_j + \sum_{k\neq j}^{n} t_k + w_p(1-L_p)$$

We can then solve to get First Order Conditions:

$$(\partial u / \partial c_j^r) = (1/w_j)(\partial u / \partial L_j) = \lambda_j \text{ for any good r}$$

$$(\partial u / \partial c_p^s) = (1/w_p)(\partial u / \partial L_p) = \lambda_p \text{ for any good r}$$

$$\lambda_j \geq \alpha\lambda_p$$

There are two possible regions to the solution to the First Order Conditions[8]: a) $\lambda_j > \alpha\lambda_p$, b) $\lambda_j = \alpha\lambda_p$. In the first region, the family is at a corner solution. Child j would like to give a negative transfer to (take money from) the parent, but he cannot. Therefore, he picks a transfer of 0, the lowest allowed. In this scenario, there is no income pooling within the family. In second region, the family is at an interior solution. Child j is willing to give a positive transfer to his parent. In this scenario, the family pools income. I will show that these scenarios produce very different predictions for labor supply consumption and transfers sent.

[8] It is also possible that some children may be at a corner solution, and some children at an interior solution. Allowing that does not change results.

In Appendix 1, I solve for transfer, consumption and labor supply in the Corner Solution:

Lemma 1a: $\partial t_j / \partial w_k = 0$ & $\partial L_j / \partial w_k = 0$ & $\partial c_j^r / \partial w_k = 0$

In other words, brother j is completely unaffected by brother k's wages. Regardless of what brother k earns, brother j gives the same transfer (zero) to the parent. Therefore, brother j has the exact same non-labor income, and there is no reason for him to change is consumption or labor supply.

Lemma 1b: $(\partial L_k / \partial w_k) - (\partial L_j / \partial w_k)$ is ambiguous

In Lemma 1a, we showed that $\partial L_j / \partial w_k = 0$ always. So, Lemma 1b is equivalent to claiming that $(\partial L_k / \partial w_k)$ is ambiguous. The ambiguity occurs because two opposing forces operate: a) Raising brother k's wage increases his potential income, making him richer. All else equal, brother k will work less when he is richer (income effect); b) When brother k's wage is high, the foregone income from not working is larger. All else equal, brother k will work more when the cost of leisure is higher (substitution effect). The net impact of these forces is ambiguous. In practice, the two effects cancel out, so labor supply does not change significantly when wages rise (Kimball and Shapiro 2003).

Lemma 1c: $\sum_{r=1}^{m} (\partial c_k^r / \partial w_k) - \sum_{r=1}^{m} (\partial c_j^r / \partial w_k) > 0$

In Lemma 1a, we showed that $(\partial c_j^r / \partial w_k) = 0$ for any good r. So, Lemma 1c is equivalent to claiming that $\sum_{r=1}^{m} (\partial c_k^r / \partial w_k) > 0$. The proof is straightforward: By assumption, there are no savings and brother k gives no transfers to his parent. Therefore, he will spend all of his extra earnings on his own consumption and leisure. By assumption, consumption is normal, so he will always choose to consume more when his wages are high. In general, it is also true that $(\partial c_k^r / \partial w_k) > 0$ for any good r. However, that is not required by the model[9].

In Appendix 2, I solve for transfer, consumption and labor supply in the Interior Solution.

Lemma 2a: $(\partial t_j / \partial w_k) < 0$, $(\partial L_j / \partial w_k) > 0$ & $(\partial c_j^r / \partial w_k) > 0$ for any good r.

The first part of the lemma: $(\partial t_j / \partial w_k) < 0$ is the most difficult. This states brother j gives less money to the parent when brother k earns a high wage. This occurs because the parent's utility is concave. If child j gives the parent more money – then the parent's marginal utility of income falls. Therefore, child k is free to give less money.

[9] For example, brother k might work harder when his wages are high, and consume less alcohol.

The other parts: $(\partial L_j / \partial w_k) > 0$ & $(\partial c_j^r / \partial w_k) > 0$ for any good r are much more straightforward. By assumption, consumption goods and leisure are normal. Therefore brother k will use his extra income to work less, so $(\partial L_j / \partial w_k) > 0$, and buy more stuff, so $(\partial c_j^r / \partial w_k) > 0$

Lemma2b: $(\partial L_k / \partial w_k) - (\partial L_j / \partial w_k) < 0$

In other words, within-family labor supply elasticity is always positive. Because of income pooling within the family, both brother j and brother k are richer when brother k earns a high wage. Therefore, there is no income effect on relative labor supply $\left((\partial L_k / \partial w_k) - (\partial L_j / \partial w_k)\right)$. In contrast, the substitution effect occurs in full force. When brother k earns high wages, his opportunity cost for leisure is high. Therefore, he will work more. Because relative labor supply elasticity is determined **only** by the substitution effect, it is always positive. In general, we will also observe that $(\partial L_k / \partial w_k) < 0$, but the model only requires that $(\partial L_k / \partial w_k) - (\partial L_j / \partial w_k) < 0$[10].

Lemma2b: $(\partial c_k^r / \partial w_k) - (\partial c_j^r / \partial w_k)$ is ambiguous

Because income is completely pooled within the family, all brothers get the same marginal utility of consumption. However, labor supply varies within the family. Brothers with high wages work more. Therefore, consumption depends on cross-partials. If good r is a complement to leisure $(\partial u^2 / \partial c_k^r \partial L > 0)$, then $(\partial c_k^r / \partial w_k) - (\partial c_j^r / \partial w_k) < 0$. If good s is a substitution for leisure $(\partial u^2 / \partial c_k^s \partial L > 0)$, then $(\partial c_k^s / \partial w_k) - (\partial c_j^s / \partial w_k) > 0$.

My model also makes strong predictions about parents and children – not just pairs of siblings. In families that pool income, children are richer when their parents earn a high wage – and parents are richer when their children earn a high wage[11]. In families that do not pool income, children's wages have no effect on parents and parents' wage have no effect on children. However, I focus on sibling pair for two major reasons: 1)Sibling relationships are symmetrical, making them much easier to analyze theoretically; 2)Because parents pay for their children's education, parental earnings and wages have a direct effect on their children's schooling. Therefore, the empirical analysis is more complicated – especially when wages are measured with error.

In the population as a whole, some families are currently pooling income and other families keep income separate. Therefore, we will observe partial income pooling in the data. On average, brother k will consume more and work less when brother j gets a high wage – but not as much as he would under complete income pooling. On average, brother j will increase his labor supply when his wages rise – but not as much as he would under complete income pooling.

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[10] Even with income pooling, brother k still gets some income effect from his higher wages. Therefore, it is possible for the partial income effect to outweigh the substitution effect.

[11] Because average income is different for parents and children, I cannot make absolute statements about labor supply elasticity. However, it is likely that labor supply elasticity and consumption match the result for siblings.

III. Empirical Model

Suppose that there are n children in a family. The average wage for all children is $\overline{w}$, and each child receives a independent random wage shock w^{ε}. So, the wage for child j $w_j = \overline{w} + w_j^{\varepsilon}$. Suppose that economists are interested in a variable, *Y*, which is determined by the equation:

$$Y_j = \gamma_j \overline{w} + \beta_j w_j^{\varepsilon} + \varepsilon_j$$

Y is influenced by average family wages and individual wage shocks separately. For example, my model suggests that labor supply is not strongly affected by average family income, but increases significantly if one person earns higher wages than the rest of the family. Therefore, $\gamma_j \approx 0$ and $\beta_j >> 0$ if we are studying labor supply. Both γ_j and β_j are random individual-specific variables. For simplicity, I will also assume that γ_j and β_j are independent of $\overline{w}, w_j^{\varepsilon}$ and w_i^{ε}. We observe w_j and Y_j, but we cannot observe $\overline{w}$ and w_j^{ε} separately. Economists are interested in estimating the distribution of β.

The simplest method to estimate β uses an OLS regression of *Y* on *w*, without any controls. If the sample size is very large, our estimates will converge to the population analogues.

$$\widehat{\beta}_{OLS} = \mathrm{E}(w'Y)/\mathrm{E}(w'w) = \mathrm{Cov}(\gamma_j \overline{w} + \beta_j w_j^{\varepsilon} + \varepsilon_j, \overline{w} + w_j^{\varepsilon}) / \mathrm{Var}(\overline{w} + w_j^{\varepsilon})$$

By assumption, γ_j and β_j are independent of $\overline{\mathrm{w}}$ and $\mathrm{w}_\mathrm{j}^{\varepsilon}$, so we can take the means of the random coefficients and simplify the expression above to:

$$\widehat{\beta}_{\mathrm{OLS}} = \mathrm{Cov}(\gamma_j \overline{w} + \beta_j w_j^{\varepsilon} + \varepsilon_j, \overline{w} + w_j^{\varepsilon}) / \mathrm{Var}(\overline{w} + w_j^{\varepsilon}) =$$
$$\left(\mathrm{E}(\gamma_j)\mathrm{Var}(\overline{w}) + \mathrm{E}(\beta_j)\mathrm{Var}(w_j^{\varepsilon})\right) / \left(\mathrm{Var}(\overline{w}) + \mathrm{Var}(w_j^{\varepsilon})\right)$$

This OLS estimate is unsatisfactory for two reasons: a)It produces only a single number, not a complete distribution. This makes it impossible to study differences in individual responses. b)Even if we are only interested in the mean of β_j we cannot recover it from OLS. OLS estimates a weighted average of γ_j and β_j, with the weights determined by $\mathrm{Var}(\overline{w})$ and $\mathrm{Var}(w_j^{\varepsilon})$. If $\mathrm{Var}(\overline{w})$ is large, then $\widehat{\beta}_{\mathrm{OLS}}$ is close to $\mathrm{E}(\gamma_j)$, and if $\mathrm{Var}(w_j^{\varepsilon})$ is large, then $\widehat{\beta}_{\mathrm{OLS}}$ is close to $\mathrm{E}(\beta_\mathrm{j})$. Because there are two variables and only one equation, it is impossible to solve for both $\mathrm{E}(\gamma_j)$ and $\mathrm{E}(\beta_j)$.

I find that wages are highly correlated within a family. In a sample of brothers living at home, $\text{Corr}(w_i, w_j) = .62$[12].

$$\text{Corr}(w_i, w_j) = \text{Var}(\overline{w}) / \sqrt{\text{Var}(\overline{w} + w_i^{\varepsilon})\text{Var}(\overline{w} + w_j^{\varepsilon})} \approx$$
$$\text{Var}(\overline{w}) / \left(\text{Var}(\overline{w}) + \text{Var}(w_i^{\varepsilon}) + \text{Var}(w_j^{\varepsilon})\right)$$

Because brothers draw from the same distribution, $\text{Var}(w_i^{\varepsilon}) = \text{Var}(w_j^{\varepsilon}) \rightarrow$

$$\left(\text{Var}(\overline{w}) / \text{Var}(w^{\varepsilon})\right) = 3.26$$

So, $\text{Var}(\overline{\text{w}})$ is much larger than $\text{Var}(w^{\varepsilon})$ and $\widehat{\beta}_{\text{OLS}}$ is heavily biased towards $\text{E}(\gamma_j)$. In the remainder of the section, I will create and solve two separate methods for estimating β_{j} without bias. Because OLS is so heavily biased towards $\text{E}(\gamma_j)$, I will use it as a proxy for $\text{E}(\gamma_j)$ in the discussion. Results for $\text{E}(\gamma_j)$ were similar when I used state differences in average wages to estimate $\text{E}(\gamma_j)$.

Method 1: Instrumental Variables (IV)

Suppose we have an instrument Z, such that $\text{Cov}(Z_j, \overline{w}) = 0$ & $\text{Cov}(Z_j, w_j^{\varepsilon}) \neq 0$. Then *Z* is an instrument for w^{ε}, and we can use *Z* to recover β alone.

$$\widehat{\beta}_{IV} = \text{Cov}(\gamma_j \overline{w} + \beta_j w_j^{\varepsilon} + \varepsilon_j, Z_j) / \text{Cov}(\overline{w} + w_j^{\varepsilon}, Z_j)$$

By assumption, $\text{Cov}(Z_j, \overline{w}) = 0$, so we can simplify the equation to:

$$\widehat{\beta}_{IV} = \text{Cov}(\beta_j w_j^{\varepsilon}, Z_j) / \text{Cov}(w_j^{\varepsilon}, Z_j) = \left(\int_{-\infty}^{\infty} \beta_x P(\beta_j = \beta_x) \text{Cov}(w^{\varepsilon}, Z \mid \beta_j = \beta_x) \right) / \text{Cov}(w^{\varepsilon}, Z)$$

$\widehat{\beta}_{\text{IV}}$ is a weighted average of the various β_{j}'s, with the weights determined by how much Z affects w^{ε}. Unlike $\widehat{\beta}_{\text{OLS}}$, $\widehat{\beta}_{\text{IV}}$ estimates within-family effects alone[13]. However, like OLS, IV produces only a single number instead of the full distribution. In theory, we can use multiple instruments to recover multiple weighted local average treatment effects (LATE), and derive the complete distribution of β. In practice, it is

[12]The true correlation may be even higher. The Census only asks about wages earned in the last month, so short-term wage shocks or simple measurement error will bias the correlation between brothers' wages downward.

[13] This is assuming a very large family size. If the family is small, then there is some income effect from an exogenous wage shock for one member. The typical Mexican family has 6-7 children, so the income effects are small. Any remaining income effects will bias results towards the null.

difficult enough to find one or two valid instruments – and virtually impossible to find enough instruments to recover the complete distribution.

In this paper, I will use two instruments for schooling: weather ages 6-17 and school calendar ages 6-17. These instruments will be described in more detail later in the paper. Both instruments primarily affect children on the margin for dropping out of school before they are 17. Therefore, the instruments measure the effect of primary school and lower secondary school on behavior – but say nothing about the effect of college and graduate school. In addition, the children affected are not a random selection of the population – children in very poor rural areas never attended school, and children in rich urban areas were unlikely to drop out of school before graduation. Therefore, both instruments used in this paper have the largest impact on children from moderate income rural communities, and $\widehat{\beta}_{IV}$ will estimate the LATE for those communities.

Becker and Tomes (1976) predict that families that pool income have a more elastic demand for schooling. Parents in families without income pooling need to ensure that every child earns an adequate wage. So, they will allocate significant amounts of schooling to low ability children or children with high opportunity costs of schooling (Becker and Tomes 1976). In contrast, families that pool income view education for child j and child k as perfect substitutes. Only the total household earnings matter – not individual wages. Both of my instruments work by slightly changing the opportunity costs of schooling. Therefore, $\widehat{\beta}_{IV}$ overweights families with more income pooling. This will bias $\widehat{\beta}_{IV}$ towards finding a relatively large amount of income pooling.

Method 2: Family Estimates

Suppose that we observe two brothers in a household. Brother i has wages $w_i = \overline{w} + w_i^{\varepsilon}$, and brother j has wages $w_j = \overline{w} + w_j^{\varepsilon}$.

By assumption, the two brothers get the exact same $\overline{\mathrm{w}}$. So, we can difference their Y's to get the equation:

$$Y_i - Y_j = \gamma_i \overline{w} + \beta_i w_i^{\varepsilon} + \varepsilon_i - \gamma_j \overline{w} - \beta_j w_j^{\varepsilon} - \varepsilon_j = (\gamma_i - \gamma_j)\overline{w} + \beta_i w_i^{\varepsilon} - \beta_j w_j^{\varepsilon} + \varepsilon_i - \varepsilon_j$$

We can then regress $Y_i - Y_j$ on $w_i - w_j$ to estimate β.

$$\widehat{\beta}_F = \mathrm{Cov}(\alpha_i \overline{w} + \beta_i w_i^{\varepsilon} + \varepsilon_i - \alpha_j \overline{w} - \beta_j w_j^{\varepsilon} - \varepsilon_j, w_i^{\varepsilon} - w_j^{\varepsilon}) / \mathrm{Var}(w_i^{\varepsilon} - w_j^{\varepsilon})$$

By assumption, γ, β and $\overline{w}$ are uncorrelated with w_i^{ε} or w_j^{ε} So, we can simplify to:

$$\widehat{\beta}_F = \text{Cov}(\beta_i w_i^{\varepsilon} - \beta_j w_j^{\varepsilon}, w_i^{\varepsilon} - w_j^{\varepsilon}) / \text{Var}(w_i^{\varepsilon} - w_j^{\varepsilon}) =$$

$$\left(\int_{-\infty}^{\infty} \int_{-\infty}^{\infty} .5 * (\beta_x + \beta_y) * \text{P}(\beta_i = \beta_x \,\&\, \beta_j = \beta_y) * \text{P}(\text{Brothers observed} \mid \beta_i,\ \beta_j) \right) / \text{P}(\text{Brothers observed})$$

It is clear that the family estimate uses a non-random selection of the population: not all families have two sons. I will discuss this bias in more detail later in the paper. On the other hand, the family estimates allow us to estimate a distribution for β, not just a single point like the IV and OLS estimates. In particular, I will test whether income-pooling varies with the parent's financial needs. My model suggests that children support retired parents – but not working parents. Therefore, siblings with retired parents will pool income – leading to high labor supply elasticity. In contrast, siblings with working parents will not pool income – leading to low labor supply elasticity.

IV. Datasets Used

The main datasets used in this paper are taken from the 1970 and 2000 Mexican Census. In addition, I also used the 1960 and 1990 Census for background information. All of these Censuses are available for download at ipums.org. The 1980 Census was not publicly available, so I was unable to include it in my analysis. Summary statistics for the 1970 and 2000 Census are given in Tables 1 and 2.

In the instrumental variable sample, I will use all men 25-74 born outside of Mexico City. I restrict the sample to men to avoid questions of household production. In Becker's model of household specialization, men divide their time between market work and leisure, women divide their time between household production and leisure. The Mexican census asks about market work, but not household production, so women's work is excluded from my study. I also exclude men under 25, because they are still investing in their human capital, and exclude men over 74 to avoid selection caused by mortality. The final exclusion is men born in Mexico City. Mexico City is one of the largest urban areas in the world, so those men area not relevant to a model of rural families. Men born in rural areas who later move to the capital are assumed to retain their family obligations, and so remain in the study.

I will use the instrumental variables sample to test three hypothesizes: (1) Adult children with positive wage shocks contribute more money to support their parents; (2) Adult children with positive wage shocks work more hours than their siblings; (3)Adult children with positive wage shocks consume more substitutes for leisure, and less complements for leisure.

Even though the Mexican Census surveys all residents of Mexico, sample selection is still a serious problem. In 2000, approximately 10% of all adults born in Mexico currently live in the United States (Lacuesta 2004). These emigrants are lost to the sample[14]. In Appendix 5 I discuss the possible sign and direction of biases created by migration. However, sample selection is only a problem in 2000 – there was much less

[14] The United States Census asks country of birth, so I can identify Mexican born men. However, it does not ask state of birth for foreign born, so I cannot assign a schooling shock for men in the US census.

emigration in 1970[15]. In Tables 15 and 16, I find similar labor supply elasticities for the two censuses, suggesting the migration does not bias results. Emigration also cannot explain children sending home transfers in response to wage shocks. The majority of the transfers observed in Tables 11 and 12 are sent from children living in Mexico, not children living in the United States.

In the brothers sample, I restrict the sample to pairs of brothers living in their parents' house in the 2000 Census. I only include a pair of brothers if both men are aged 25-74 and report valid education. If there are more than two brothers in a household, I use the oldest two brothers. Because I am focusing on rural areas, I also exclude households where either brother was born in Mexico City. Despite all of these sample restrictions, I was able to find more than 28,000 pairs of brothers[16] out of approximately 2 million men total. Results were qualitatively similar if I used pairs of brothers where one brother is head of the household, but sample sizes were smaller.

Demographics for the sample of brothers living at home are given in Table 3. Comparing Table 3 with Table 1, we can see that men living in their parents' home are much younger and much less likely to be married than average. Men living at home are also more likely to be disabled, more likely to be in school and less likely to work. However, these differences have little net impact on labor supply elasticity. In Table 4, I regress wages and labor supply on education for the sample of brothers, and compare it to the same OLS regression for the complete sample. I find that labor supply elasticity is roughly similar for both groups[17]. Therefore, we can use a sample of brothers living at home to study labor supply elasticity in a broader sample.

The Mexican census does not ask about transfers within a household, so there is no way to determine how much each sibling contributes to household needs. Similarly, the only consumption data available is household based, so I cannot determine how much each brother is consuming individually[18]. However, the census does ask about labor supply for each individual. Thus, I can test whether within-family education differences create labor supply differences. I will focus on testing two hypothesizes: (1) children with positive wage shocks work more hours than their siblings; (2) families with non-working parents have more income-pooling, and labor supply elasticity between siblings is larger.

V. Wage Shocks Used

I limit my research to wage variation caused by education shocks. A child who drops out of school before learning to read are almost certain to earn far less than his brother who completes primary school. Therefore, education can be used as a proxy for

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[15] Mortality was much higher then, so that might create some sample selection. However, even in the developing world, mortality is relatively low after 5 (until old age). Therefore, education shocks ages 6-17 should not affect the composition of the sample for adult men.

[16] Most of these men are full brothers, but some may be half brothers or stepbrothers. These brothers do not share two common parents, so they are less likely to pool income.

[17] Results remain similar if I weight the complete sample to match the age and disability profile for the brothers.

[18] The 1960 and 1970 Census asks about shoe ownership, which might seem to be an individual good. However, the correlation between shoe ownership and education is completely explainable by climate and occupation.

wages. In addition, increasing education is also an important policy goal in its own right. In rural Mexico, schooling often viewed as a luxury, and children may drop out to help on the farm. The Mexican government has recently overhauled its welfare system to encourage rural children to stay in school longer[19]. My model suggests that this program will have enormous benefits to rural communities, but the parents will benefit at least as much as their children.

Using education shocks also avoids a number of difficult econometric problems. The Mexican Census asks about hours worked and monthly earnings, but not directly about wages. Economists can then calculate wages = (earnings/hours worked), but this calculation presents problems of its own. If hours are measured with error, then wages will also be measured with error. In addition, wages are not observable for men not working, because earnings and hours are 0. An econometrician studying labor supply must impute wages for these men, or drop them from the sample. In contrast, education is observed for all men in the sample, regardless of labor force participation. Even when education is measured with error, the measurement error is not correlated with reported hours or calculated wages.

It is important to note that my analysis does not require any assumptions about why schooling is associated with higher wages. OLS estimates of returns to schooling may be biased upwards, because schooling is positively correlated with innate ability, or biased downwards because of measurement error (Griliches 1977). Alternatively, education may have little effect on productivity, but used to signal ability to potential employers (Spence 1973). In my model, parents and children care only about wages, because wages are the 'price' of leisure. Behavior of families is the same regardless of why education is associated with higher wages. In fact, I find that IV estimates of the return to education are similar to OLS, suggesting OLS is not significantly biased[20].

I will use separate techniques to analyze wage shocks in the two datasets. For the general population, I create two new instruments for education: 1)School Calendar Ages 6-17; 2)Weather Ages 6-17. Because schooling determines wages, these instruments represent exogenous wage shocks to the group affected. Both of these instruments affect only the individual studied, and not his family[21]. Therefore, they are equivalent to a policy experiment that raises wages for one individual, but holds average family wages fixed. For the brothers sample, I use reported schooling to measure wages.

The first instrument for wages was created by changes in the school calendar during the 1960's. Originally, Mexico had two separate school calendars. The temperate states[22] followed calendar type "A", with a school year starting at the end of January and

[19] This program has been shown to have a large impact on education, so it might seem to be an ideal instrument for my research. Unfortunately, the program was only started in the 1990's, so the children affected are still in school at the 2000 Census.

[20] It is possible that IV estimates of the return to schooling are biased from selection into the labor market. I find that men who receive positive education shocks are much more likely to work. If men on the margin for dropping out of the labor force earn low wages, this selection will bias IV returns to education downwards. However, I find no evidence of selection affecting measured wages.

[21] Siblings close in age will be exposed to similar shocks. This biases results towards the null

[22] Chiapas, Distrito Federal (Mexico City), Guanajuato, Hidalgo, Mexico, Michoacan, Morelos, Oaxaca, Puebla, Queretaro, San Luis Potosi, Tabasco, Tlaxcala, Veracruz. These states are in the high altitude central region, so they are cooler. They are actually further south than many of the tropical states.

continuing until the end of November. The tropical[23] states followed calendar type "B", with a school year starting at the beginning of September and continuing until the end of June the next year. In 1965, the government decided to merge the two calendars by shortening the Type A school year by one month for the next 5 years. Therefore, type "A" states had school from late January to late October in 1966, late December to late September in 1967, late November to late August in 1968, late October to late July in 1969 and late September to late June in 1970. After 1970, all states started school in early September, and continued until the end of June.

Why did the school calendar change? According to the Education Bureau's reports, the main motive was to allow teachers and students to move across states with less disruption. In fact, I find no evidence that the overhaul had any positive effect on education for students who relocated. The null effect is not surprising – children in the developing world often attend school erratically. Therefore, schools are already set up to accommodate children on different schedules than the normal[24]. (Fischel 2003). However, the calendar change imposed huge costs on states that were forced to change their school year. Many children were not able to learn the same amount of material in 8 rather than 9 months: grade repetition in primary schools increased from 20% to 25% and rural drop-out rates increased from 20% to 25%[25].

The calendar change reduced wages for a very discrete group: men born between 1949 and 1964 in temperate states, who missed up to 5 months of school. Men born in tropical states suffered no interruption of schooling. In Figure 1, I compare the difference in average education and the difference in schooling provided. Eyeballing the data[26], we can see that men born in tropical states do better when they have more schooling. In Table 5, I find similar results with a regression. One month of missed school reduces completed education by .07 to .09 years. These estimates are consistent with the grade-repetition and drop-out rates cited above. In Table 6, I used the calendar change as an instrument to estimate returns to education. I find that one year of education increases wages by 8.5%-9.5%, which is similar to OLS results. So every month of school missed during childhood reduces adult wages by .7%-.8%[27]. For example, a man born in the temperate state of Hidalgo in 1955 will earn 4% less than his older brother born in 1945.

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[23] Aguascalientes, Baja California Norte, Baja California Sur, Campeche, Coahuila, Colima, Chihuahua, Durango, Guerrero, Jalisco, Nayarit, Nuevo Leon, Quintana Roo, Region Lagunera, Sinaloa, Sonora, Tamaulipas, Yucatan and Zacatecas

[24] He discusses schooling in the United States in the 1800's, but the issues are similar to the developing world now.

[25] This is for children in primary schools in temperate states not including Mexico City from 1965 to 1966. I was not able to obtain the same numbers for tropical states, but I have no reason to believe that they changed significantly from 1965 to 1966.

[26] The data also suggest that men born between 1940 and 1950 were also affected, even though they were too old to be in school between 1965 and 1970. This is likely caused by measurement error for age – some men who claim to be 60 are only 50.

[27] The results for Mexico are very different from Pischke (2003), who found that shorter school years had almost no effect in Germany. The most likely explanation for the difference is that only children on the margin for dropping out of school were affected by the calendar change. In Germany, very few children repeat primary grades and almost no children drop out of primary school. Therefore, a shorter school year has little long-term effect.

By contrast, the two brothers would earn the same if they had been born in the tropical state of Nuevo Leon.

The second instrument for wages is created by temperature variation within a year, changing the timing of demand for farm labor. In rural Mexico, schoolchildren value farm production above school attendance and will miss school if they are needed on the farm. Therefore, children will attend more school if peak farm labor demand happens to fall during the pre-scheduled vacation months, and less if peak farm labor demand coincides with the academic year. Even if a child does no farm labor themselves, they may still be indirectly affected by the agricultural calendar. For example, a young girl might miss school to watch her younger siblings at home so that her mother can help with the harvest. It might seem that communities could increase education by changing the school calendar to match agricultural needs. In fact, the Mexican school calendar is centrally planned, and cannot be adjusted to match local agricultural needs. Therefore, random variation in the timing of demand for farm labor will have a long-term impact on the amount of schooling completed.

How does temperature affect the demand for farm labor? In the short-term, warmer than average temperatures increase the demand for farm labor. Insects grow and multiply faster in warm temperatures (Trudgill, Honek, Li and Van Straalan 2005), so that children must spend more time ridding the farms of these pests. However, this short-term increase in demand for labor is reversed a few months later. Crops also grow faster in warmer temperatures (Pahlavanian and Silk 1988) (Pastenes and Horton 1996), leading to an earlier harvest. Figure 2 gives a graph of corn growth rates as a function of temperature. It shows that corn grows 3 times faster at 29°C (84°F) compared to16°C (60°F). Since traditional Mexican farmers plant only once a year, at the beginning of the rainy season, an earlier harvest does not increase total farm production, but rather creates a longer off-season. Thus, warmer temperatures shift the timing for farm labor demand, but have no effect on the total farm labor necessary.

It might seem that weather affects adults as well as children, so it cannot be used as an instrument for education. For example, warm weather might increase total farming profits (Lang 2001) or increase mortality (Ballester, Corella, Perez-Hoyos, Saez and Hervas 1997). In order to control for the effect of weather on adults, I will not use mean temperature as an instrument for education. Instead, I will use Delta Temp = Mean School Temp – Mean Vacation Temp as an instrument for education. Delta Temp is positive if a heat wave occurs during the academic year, and negative if a heat wave occurs during the school vacation. Because adults do not attend school, they have no reason to care about the exact timing of the heat wave. Therefore, Delta Temp is uncorrelated with farming profits or mortality. In contrast, Delta Temp is highly correlated with completed education: children get less schooling if a heat wave occurs during the academic year[28].

My analysis of the effects of weather on schooling is not unique in the economics literature. In India, Jacoby and Skoufias (1997) find that children are less likely to attend school when droughts reduce family income. In Cote d'Ivoire, Jensen (2000) finds that children are less likely to attend school if rainfall is too high or too low, and Duflo and Udry (2004) find that children are more likely to attend school when the yam crop

[28] In fact, heat waves during the school vacation increase schooling, because more farm labor is completed during the school vacation, leaving work to compete with schooling.

receives favorable rainfall. However, these papers differ from mine in two important respects. Firstly, they focus on the relationship between schooling and income, implicitly assuming that weather has no impact on the productivity of child labor. Secondly, they use school attendance as an end-point, with no empirical analysis of long-term effects on labor supply and consumption during adulthood.

In contrast, my study focuses on the long-term effects of monthly variation in temperature (and thus, farm labor demand). I used global warming research to construct my temperature dataset. The global warming research provides temperature histories for areas with well functioning weather stations. In order to construct a state-wide temperature dataset, I matched each point[29] in Mexico to the closest weather station, and averaged points across the state to get state-wide monthly temperatures. In all regressions, I control for the average monthly temperature, so Delta Temp is not affected by changes in the school calendar. I also control for year of birth, so my results are not affected by long-term weather changes.

I use the Mexican Census[30] to test for the impact of weather on school attendance. In Table 7, I find that boys are .7-1.3% less likely to be in school when mean temperature last month was 1° Celsius warmer. I can also observe long-term impacts of temperature on completed schooling. In Table 8, I find that men 25-74 in the 1970 Census have .4 less years of education when Delta Temp is 1° Celsius larger[31]. In Table 9, I find similar results for men in 2000. In Tables 10 and 11, I use temperature as an instrument to estimate the return to education. I find that one year of education increases wages by 10%-11% in 2000, and increases predicted monthly income[32] by 14%-19% in 1970. These results are consistent with returns to education estimated with OLS.

It is important to note that even though the first stage regressions for temperature shock and calendar shock are statistically significant, they are both fairly weak instruments. Staiger and Stock (1997) show that second stage estimates may be biased towards OLS estimates if the instrumental variable used is too weak. Based on their simulations, they suggest that economists avoid instruments with an F-statistic of less than 10. Depending on the specification, both wage shocks have instruments close to their threshold value of 10, so any bias that occurs is likely to be small. In any case, the bias is towards OLS, which makes it harder to reject the null of no income pooling within families.

In contrast to the instrumental variables sample, it is relatively simple to measure labor supply elasticity in the brothers sample. I simply regress ΔWages and ΔHours on ΔEducation. I can then calculate

$$\text{Labor Supply Elasticity} = \begin{pmatrix} (\Delta \text{ Wages/Mean Wages})/ \\ \Delta \text{ Education} \end{pmatrix} * \begin{pmatrix} (\Delta \text{ Hours/Mean Hours})/ \\ \Delta \text{ Education} \end{pmatrix}$$

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[29] To save computing time, I only matched points with integer latitude and longitude (confluence points) Mexico City and Tlaxacala are so small that they do not have any confluence points. I use the termperature in the surrounding states for those states.

[30] Table 3 uses the 1970, 1990 and 2000 Census. The 1960 Census did not give school attendance, and the 1980 Census was not available.

[31] Taken from column 1

[32] I use reported occupation to predict monthly income. I cannot use actual monthly income, because the 1970 Census asks about total income, which may include transfers. If cash transfers perfectly compensate for

Because education is measured with error, within-family estimates for the return to education are biased towards 0[33] (Griliches 1977). However, this bias is easy to correct. Within-family labor supply effects will also be biased towards 0 by the exact same ratio as within-family wage effects. The ratio of the two estimates is an unbiased estimate of labor supply elasticity.

VI. Empirical Results

1. Transfers Given to Parents.

We cannot use OLS to study the impact of adult children's wages on transfers given to parents. Most Mexican adults live apart from their parents, so it is impossible to link parents directly with their children. Therefore, we cannot observe children's wages, making it impossible to run and OLS regression of transfers received by parents on their children's wages. Even if we could observe children's wages, reverse causality makes an OLS regression misleading. On the one hand, high wage children are predicted to give more money to their parents, holding parental wealth fixed. On the other hand, rich parents are predicted to get less money from their children, holding children's wages fixed. In rural Mexico, children's education was viewed as a luxury – and therefore rich parents were much more likely to have high wage children. The net sign of the two effects is ambiguous.

However, we can use IV to observe a policy experiment that raises children's wages – but hold's parents' wages fixed. How do I observe such a policy experiment? My instruments for education exogenously vary wages for children, but do not affect parent's wages at all. Using IV also solves the problem of missing data on children's wages. The IV regression does not require that we observe child's actual wages, only their age and state of birth. That information is sufficient to calculate the child's exogenous wage shock, even without observed the child's actual wage. How do I calculated age and state of birth for each child in the family? The 2000 Census asks women how many children they have, and how old their youngest child is. I will assume that children are spaced an average of two years apart[34], and that children are always born in their mother's birth state. In my empirical regressions, I will focus on children who are predicted to be over 25 at the time of the 2000 census.

Results from an IV regression of transfers received on children's mean wages are given in Table 12 and Table 13. I find that increasing mean education for children by 1 year results in parents getting 225-275 more pesos a month. How large is 225-275 pesos a month? The average couple gets only 280 pesos a month in transfers, so 1 year of extra education doubles the transfers received. By comparison, a child living in the United States sends an average of about 270 pesos a month. Children's education also affects labor supply: fathers work 5-7 less hours a week when children get 1 more year of education. Results are given in Table 14.

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[33] OLS estimates are also biased downwards, but the effect is much smaller.

[34] This typically leads to the oldest children born after a woman is 16, except for very large families. There is no way to determine the gender of the children.

How much income-pooling does 225-275 pesos represent? On average, an adult in my sample earns 1900 pesos a month (900 for women and 2900 for men), and the typical parent has 5 children over 25. If I assume that one year of education increases wages by 10% - then an education shock of one year increases total earnings by 950 pesos a month (holding labor supply fixed). Therefore, parents get 24%-29% of their children's extra earnings.

2. Labor Supply Elasticity.

My model makes strong predictions about labor supply. If one man earns higher wages than the rest of his family, he will work much longer hours. We can use IV to observe a policy experiment that exogenously raises wages for one child – but holds wages for the rest of the family fixed. Results are given in Table 15 and 16. I find that one extra year of education increases labor supply for men in 2000 by 1.5 hours per week, and increases labor supply for men in 1970 by .6[35] months per year. These results are equivalent to a labor supply elasticity of .4 for both years[36]. The within family labor supply elasticity of .4 is much larger than the labor supply elasticity observed with OLS, which is less than .1.

Empirical results are similar when I use the sample of brothers. In Table 17, I study the effects of wage differences on labor supply in the complete sample of brothers. I find that a man with one extra year of education earns 4.4% more than his brother and works .6-.7 more hours each week. This is equivalent to a labor supply elasticity of .33-.4. Once again, I find that within-family elasticity in Table 17 is much larger than OLS elasticity in Table 4. The difference is strong evidence for income-pooling within a household.

How much does income pooling increase within family labor supply elasticity? Earlier in the paper, I showed that OLS labor supply elasticity is close to labor supply elasticity without income pooling, but slightly larger[37]. OLS estimates of labor supply elasticity are always less than .1. Therefore income pooling raises within family labor supply elasticity by at least .3.

The model created in this paper also suggests significant heterogeneity between families. Families with retired parents are more likely to pool income – so labor supply elasticity is higher in those families. I test this hypothesis in Tables 18 and 19. I find that labor supply elasticity is .25-.32 when the father is working – but .37-.46 when the father is retired. Results are even stronger if I use fathers' age to instrument for retirement. Labor supply elasticity is .16-.25 when the father is under 65, and .44-.50 when the father is over 65. These results match closely with the predictions in the model[38]. Therefore, family structure strongly influences labor supply elasticity. In Table 20, I also find that

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[35] Taken from column 1

[36] Assuming returns to education of 10% in 2000 and 15% in 1970, and average labor supply 40 hours a week in 2000 and 10 months a year in 1970.

[37] I showed that an OLS regression of outcomes on education primarily measure between-family effects of education. By assumption, there are no transfers outside of families. Therefore, between-family labor supply elasticity is always equal to labor supply elasticity without income pooling.

[38] Assuming credit markets are imperfect. If credit markets are perfect, children's labor supply will not change when their parents retire, because they saved for the expense ahead of time.

labor supply elasticity is higher in poorer states. This is consistent with the fact that men from richer states are more likely to receive pensions, and do not need to be supported by their families.

How does within family labor supply elasticity compare to within person labor supply elasticity? The model of income pooling within a family is extremely similar to a model of single individual smoothing consumption over time. A temporary wage increase in the lifecycle model, and individual wage increase in the family income pooling model only create a substitution effect, with no income effect. Therefore, within person labor supply elasticity is unambiguously positive, and should have a similar magnitude[39] to within family labor supply elasticity. Previous authors estimate a within person labor supply elasticity of .5-.65 (Oettinger 1999 Fehr and Goette 2004 and Mulligan 1996). These results match closely with within family labor supply elasticity estimated in Tables 15-20.

While these data might seem to support the hypothesis of nearly complete income pooling within a family, that conclusion requires an assumption of perfect credit markets. Even in the developed world, credit markets are imperfect, reducing short-term labor supply elasticity (Domeij and Floden 2006). In the developing world, credit markets are often very poorly functioning, making it harder for communities to respond to aggregate shocks (Jayachandran 2006). Therefore, we cannot assume that the similar point estimates imply perfect income pooling. An equally plausible alternative explanation is that 50% of household pool income in Mexico and 50% of US households use the credit market.

3. Consumption

The next set of empirical data will study the impact of wage shocks during childhood on consumption during adulthood. In my model, the effects of wage shocks on consumption depend on the cross-partials. If good x is a complement to leisure, then men with positive wage shocks consume less of good x. If good y is a substitute to leisure, then men with positive wage shocks consume more of good y. For the exact same population, I will show that wage shocks have varying effects on consumption of different goods. This is inconsistent with a model where consumption is determined by income alone, and suggests non-separability between consumption and leisure.

Many economists use food consumption to study income pooling within groups and over time. This measure is particularly important in the developing world, where undernutrition and malnutrition frequently cause disability and death. I will use data from the 1970 Mexican Census on food consumption to study how wage shocks affect the quality of adults' diet. Traditionally, Mexican peasants ate corn and beans almost exclusively, with occasional meat on holidays. Meat, milk, eggs and even wheat bread were special treats. Recent research by Hurst and Aguiar (2004) shows that quality of food consumed does not change with retirement. This suggests that utility from food quality and leisure are separable, and wage shocks will have no effect on food quality[40].

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[39] Assuming leisure is separable across time.

[40] Calories consumed are highly positively correlated with hours worked and effort expended (Foster and Rosenzweig 1994).

In Table 22, I use IV to study the impact of education on food quality. This corresponds to a policy experiment that raises wages for one child, but holds average family wages fixed. I find that point estimates are very close to 0, and I can never reject the null hypothesis that education has no effect on food quality. This is strong evidence for income pooling within the family. Of course, an alternative explanation for the observed results is that food quality is not a normal good. I test this explanation in Table 21 (OLS regression). When I do not control for average family wages, high wage men always consume more animal products. Point estimates are large and positive: one additional year of education increases consumption of meat, milk, wheat bread and eggs by approximately .3 meals per week. Results are similar if I regress food consumption on monthly income: richer households eat more animal products. For most animal products, I can reject the null hypothesis that point estimates are the same for OLS and IV.

Another measure of consumption available in the Mexican Census is electronics ownership in 2000. Because electronics are durable goods, they are difficult to adjust in the short-term. Therefore, they are not ideal for studying consumption smoothing in response to short-term shocks. However, education differences in childhood create long-term effects, so there is plenty of time to adjust durable goods ownership. I will focus on TV's and computers, because these are electronic goods with different relationships to leisure. TV's are a very time-intensive good, and are used exclusively for leisure[41]. Therefore, it is likely that TV's are a complement to leisure. In contrast, computers are used both for work and leisure. The sample excludes teenagers and college students, so relatively few people used their computers primarily for video games and Internet access. Therefore, it is likely that computers are a complement for labor supply.

The exact same education shocks have very different effects on TV ownership and computer ownership. In Table 23, I find that an education shock of 1 year reduces TV ownership by about 2%. This is a large effect – equivalent to a 14% increase in the population that does not own TV's (85% ownership rate). In contrast, an OLS regression finds that 1 year of education increases TV ownership by 2%, demonstrating that TV's are a normal. The results for computer ownership are very different. In Table 24, I find that an education shock of 1 year increases computer ownership by 5%-7%. This is a huge effect – equivalent to a 63%-85% increase in the population that owns computers (8% ownership). This is more than double the OLS coefficient.

The results in Table 23 are very strong evidence that consumption is non-separable from leisure. In a model with separable leisure, consumption depends only on net income. If a family shares risk 100% - then individual consumption is equal to average earnings. If a family shares 0% of risk, then individual consumption is equal to income is equal for all children in the family. In that model, we will never see high wage agents consuming less of a good than their low wage siblings. In fact, I observe that men with more education own fewer TV's – suggesting that TV's are a strong complement for leisure.

Conclusion

[41] At least for adult men. Women with young children often use TV's for childcare.

This paper created a model of labor supply and consumption when children's wages are random and non-working parents are supported by their adult children. In this model, siblings pool their incomes when their parents need support, but otherwise they keep their incomes separate. The model yields three testable predictions: (1) children with positive wage shocks contribute more money to support their parents; (2) children with positive wage shocks work more hours than their siblings; (3) families with non-working parents have more income-pooling, and labor supply elasticity between siblings is larger.

My empirical results strongly supported the theoretical predictions. Consistent with the prediction (1), I found that children who received an exogenous wage shock contribute an average of 24%-29% of the extra earnings to the support of their parents. Consistent with the prediction (2), I found that men who received an exogenous wage shock of 10% worked on average 4% more throughout their lives. As an additional check, I also studied the impact of endogenous wage differences between brothers living at home. I found that a man whose wage was 10% higher than that of his brother worked an average of 3%-4% more hours. Consistent with prediction (3), labor supply elasticity is higher in households with a non-working parent. The labor supply results remained similar when I use retirement age to instrument for the parent's work status. Although each individual result lends itself to many interpretations, the cumulative results provide strong evidence for income pooling within families.

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Table 1: Summary Statistics for the 2000 Mexican Census

	Young Adults 16-24	Adults 25-45	Adults 45-64	Adults 65+
Average Age	19.87	33.55	53.13	73.65
% Female	52.3%	52.7%	51.9%	53.4%
% In School	26.3%	3.3%	1.0%	0.5%
Mean Years Education	8.3884	8.00008	5.1652	3.0232
% Men Married	23.71%	80.17%	87.35%	73.63%
% Women Married	36.97%	77.34%	70.16%	38.76%
% Men Working	66.91%	90.59%	81.17%	42.30%
% Women Working	32.93%	39.25%	28.16%	10.18%
Men's Earnings Last Month	1,207.48 Ps.	3,075.00 Ps.	2,555.24 Ps	649.55 Ps
Men's Non-Labor Income Last Month	33.39 Ps.	43.92 Ps.	235.01 Ps	564.58 Ps
Men's Transfers from Family	12.89 Ps.	14.79 Ps.	54.54 Ps	118.33 Ps
Women's Earnings Last Month	525.42 Ps.	1,020.06 Ps.	610.94 Ps.	101.83 Ps.
Women's Non-Labor Income Last Month	52.18 Ps.	42.44 Ps.	158.18 Ps.	270.41 Ps.
Women's Transfers from Family	16.05 Ps.	63.24 Ps.	108.85 Ps.	154.53 Ps.
% Disabled	2.0%	2.2%	5.1%	18.3%
Number People	1,553,509	2,366,939	1,171,313	511,169

These statistics are for all adults in the Mexican Census not born in Mexico City. Observations are weighted by the sample weight given in the Census. Individual with invalid data for one question are removed for that summary statistic, but used for other observations. The official exchange rate in February 2000 was 9.4 Pesos to one American dollar.

Table 2: Summary Statistics for the 1970 Mexican Census

	Young Adults 16-24	Adults 25-45	Adults 45-64	Adults 65+
Average Age	19.72	33.30	52.83	72.24
% Female	48.9%	51.7%	50.9%	51.6%
% In School	14.4%	2.7%	1.2%	1.1%
Mean Years Education	3.25	2.32	1.79	1.24
% Men Married	23.0%	82.50%	87.89%	76.0%
% Women Married	43.7%	82.2%	71.06%	44.0%
% Men Working	68.3%	92.7%	91.1%	71.8%
% Women Working	22.0%	15.0%	14.9%	10.9%
Men's Income Last Month	417.76 Ps.	945.86 Ps.	1003.40 Ps.	540.87 Ps.
Women’s Income Last Month	150.97 Ps.	131.81 Ps.	126.72 Ps.	72.98 Ps.
Number People	70,925	94,716	44,987	16,794

These statistics are for all adults in the Mexican Census not born in Mexico City. Individual with invalid data for one question are removed for that summary statistic, but used for other observations. In 1970, the Mexican pesos was fixed at 12.5 pesos for 1 American dollar.

Table 3: Summary Statistics for the Brothers Sample

	Adults 25-45	Adults 45-64	Adults 65+
Average Age	30.55	50	67.06
% In School	5.3%	1.0%	2.3%
Mean Years Education	8.63	5.47	3.37
%Married	19.14%	13.61%	15.11%
%Working	81.47%	73.97%	49.68%
Earnings Last Month	1958 Ps.	1385 Ps.	256 Ps.
Non-Labor Income Last Month	13.71 Ps.	67.68 Ps.	108.87 Ps.
Transfers from Family	6.57 Ps.	11.83 Ps.	71.61 Ps.
% Disabled	5.0%	11.6%	12.9%
Number People	53,651	4,012	79

These statistics are for all pairs of brothers 25-74 who are currently living in their parents house. I exclude families where one either brother has invalid education or was born in Mexico City. Observations are weighted by the sample weight given in the Census. Individual with invalid data for one question are removed for that summary statistic, but used for other observations. The official exchange rate in February 2000 was 9.4 Pesos to one American dollar.

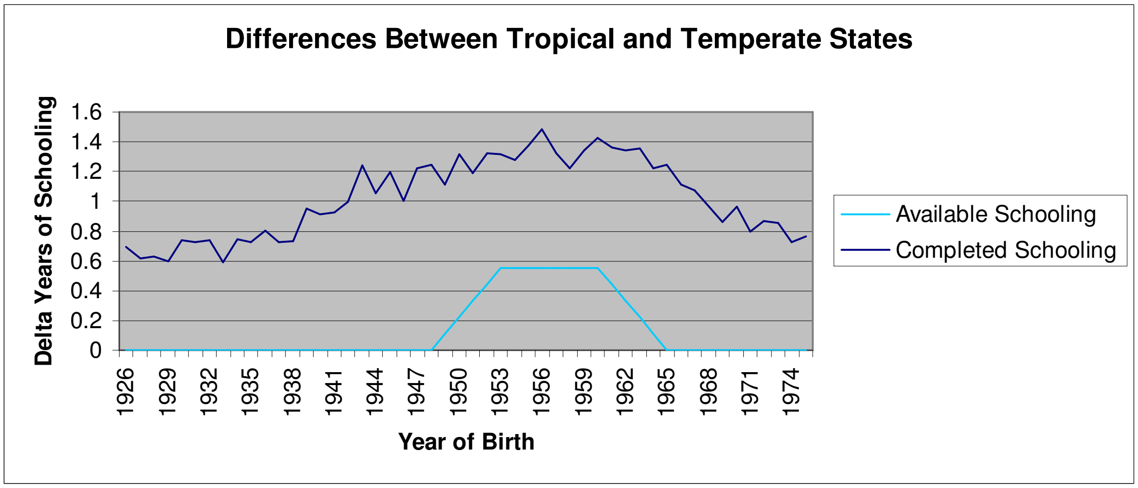
Table 4: OLS Regression of Labor Supply and Wages on Education

	Brothers Sample			Complete Population		
	Dependent Variable: Mean Hours Worked Last Week					
Years Education	.257	.217	.216	.510	.262	.287
	(.031)	(.031)	(.032)	(.011)	(.010)	(.011)
	Dependent Variable: ΔWages Earned					
	Brothers Sample			Complete Population		
Years Education	7.34%	7.42%	7.22%	9.29%	9.75%	9.32%
	(.12%)	(.12%)	(.12%)	(.03%)	(.03%)	(.02%)
Implied Labor Supply Elasticity	0.088	0.073	0.075	0.137	0.067	0.077
Control for Control for Ages?	N	Y	Y	N	Y	Y
Control for State of Birth?	N	N	Y	N	N	Y

In all regressions, I restrict the sample to men 25-74 who report valid data. Observations are weighted by the sample weights given. In the second column, I control for age by including a dummy for each year of age. In the third column, I control for state of birth by including a dummy for each state of birth.

This table compares OLS labor supply elasticity for brothers living at home with OLS labor supply elasticity for the general population. I find that the two are reasonably similar, suggesting that the highly selected sample of brothers living at home (and hence observable) can be used as a proxy for the complete sample of brothers (who are unobservable). In Mexico, returns to education increase with age – so the slightly lower returns to education for the brothers sample is unremarkable.

Figure 1



This figure demonstrates that the shorter school calendar significantly reduces completed educated in temperate states. The top line is:

Δ Education = (Mean Education Tropical States) – (Mean Education Temperate States)

The second line is:

Δ Years of School = (Years of School Tropical States) – (Years of School Temperate States)

Eyeballing the data, we can see that tropical states do (relatively) better for men born 1950 to 1966 – the same years that temperate states cut their calendar.

Table 5: First Stage Regression of Education on Months School Missed for Men 25-74 in 2000 Census

	Dependent variable: Years Education			
Months of School Missed	-0.092	-0.090	-0.085	-0.073
	(0.024)	(0.008)	(0.007)	(0.007)
Control for State Fixed Effects?	N	Y	Y	Y
Control for State Trends?	N	N	Y	Y
Restrict Sample to Men with Valid Wages	N	N	N	Y

In all specifications, I control for age by including a dummy for each year of age, and control for climate by including a dummy for temperate states. Observations are weighted by the sampling weight given in the census, and standard errors are clustered by cohort. Men with invalid data are excluded.

This table provides additional evidence the short school year hurt men in temperate states. Controlling for observables, one month less of school reduces completed education by .07 to .09 years.

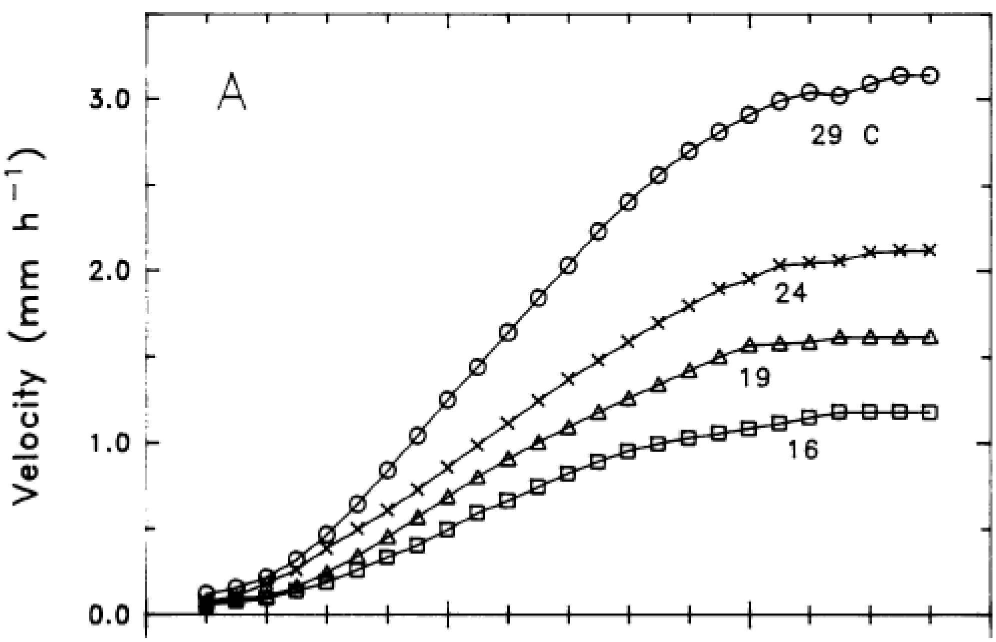
Table 6: IV Regression of Wages on Years Education for Men 25-74 in 2000 Census, Using Calendar as an Instrument

	Dependent Variable: Log Hourly Wages		
Years Education	8.7%	9.7%	9.5%
	(5.2%)	(1.0%)	(1.1%)
Control for State Fixed Effects?	N	Y	Y
Control for State Trends?	N	N	Y

Controls used are identical to Table 5. Men with invalid data are excluded from the sample.

This table is an IV regression of wages on education, using school calendar as an instrument for education. I find that one year of education increases wages by 9%-10%. This is consistent with other research in the returns to education literature.

Figure 2: Growth Rate for Corn As a Function of Temperature



This figure shows that corn grows substantially faster in warm temperature. The higher growth rate does not necessarily increase farm profits- water requirements are also increased, and pests grow faster.

Table 7: Regression of School Attendance on Temperature Last Month for Boys 6-17

	Dependent Variable: %In School Now	
Mean Temperature Last Month	-1.31%	-.74%
	(.49%)	(.39%)
Control for State Fixed Effects?	Y	Y
Control for State Trends?	N	Y

In all specifications, I control for age and year by including a dummy for each age-year cell. Observations are weighted by the sampling weight given in the census, and standard errors are clustered by state-year cell. Boys who do not report school attendance are dropped from the sample. Results are similar if I use state of birth instead of current state of residence.

The data for this table is taken from 3 Censuses, with one cell for each state. Therefore, I have only 96 observations total. Nevertheless, I am able to demonstrate that faster corn growth has large effect on school attendance. Holding all else equal, raising current temperature by only 1°C decreases school attendance by .7%-1.3%.

Table 8: First Stage Regression of Education on Temperature Ages 6-17 for Men 25-74 in 1970 Census

	Dependent variable: Years Education		
Delta Temp	-.471	-.096	-.194
	(.102)	(.104)	(.112)
Control for State Fixed Effects?	Y	Y	Y
Control for State Trends?	N	Y	Y
Restrict Sample to Men with Earnings	N	N	Y

In all specifications, I control for age by including a dummy for each year of age, and control for state of birth by including a dummy for each birth state. Observations are weighted by the sampling weight given in the census, and standard errors are clustered by cohort. Men who do not report years of education or state of birth are excluded.

Table 9: First Stage Regression of Education on Temperature Ages 6-17 for Men 25-74 in 2000 Census

	Dependent variable: Years Education		
Mean School Temp-Mean Vacation Temp	-.445	-.444	-.357
	(.065)	(.055)	(.058)
Control for State Fixed Effects?	Y	Y	Y
Control for State Trends?	N	Y	Y
Restrict Sample to Men with Valid Wages	N	N	Y

Controls identical to Table 8.

Tables 8 and 9 demonstrate that temperature during childhood has a long-term effect on completed education. I find that men receive less education if heat waves occur during the school year, and less education if heat waves occur during the school vacation.

Table 10: IV Regression of Predicted Monthly Income on Years Educations for Men 25-74 in 1970 Census, Using Temperature as an Instrument

	Dependent Variable: Log Mean Income by Occupation		
Years Education	13.66%	15.34%	19.20%
	(3.66%)	(3.26%)	(11.20%)
Control for Birth State Effects?	Y	Y	Y
Control for Current State of Residence?	N	Y	Y
Control for Birth State Trends?	N	N	Y

Controls used are identical to Table 8. The Census does not give earned income, but only total monthly income. If men include transfers given or received in their income, a regression of monthly income on education shocks will be biased downwards from risk-sharing within the family. I avoided that problem by using occupation to predict income.

Table 11: IV Regression of Wages on Years Educations for Men 25-74 in 2000 Census, Using School Temperature as an Instrument

	Dependent Variable: Log Hourly Wages		
Years Education	10.6%	10.3%	10.8%
	(1.77%)	(19.8%)	(1.99%)
Control for Birth State?	Y	Y	Y
Control for Birth State Trends?	N	Y	Y
Control for State of Residence?	N	N	Y

In all specifications, I control for age by including a dummy for each year of age. Observations are weighted by the sampling weight given in the census, and standard errors are clustered by cohort. Men who do not report years of education or state of birth are excluded.

In Tables 10 and 11, I use temperature as an instrument for education. I find returns to education of 10%-11% in 2000 and 14%-19% in 1970. It might seem that the returns to education for 1970 are too high – but they are similar to OLS estimates of the return.

Table 12: IV Regression of Transfers Received on Children's Average Education, Using School Calendar As An Instrument

	Dependent variable: Transfer Received by Mother From Family Abroad			
Children's Mean Education	26.81 Ps.	27.50 Ps.	26.21 Ps.	24.13 Ps.
	(14.55)	(13.83)	(14.10)	(13.99)
	Dependent variable: Transfer Received by Mother From Family in Mexico			
Children's Mean Education	90.06 Ps.	89.59 Ps.	112.93 Ps.	87.66 Ps.
	(18.08)	(18.03)	(117.57)	(18.05)
	Dependent variable: Transfer Received by Father from Family Abroad			
Children's Mean Education	45.45 Ps.	46.99 Ps.	45.71 Ps.	42.65 Ps.
	(19.86)	(20.02)	(19.69)	(19.88)
	Dependent variable: Transfer Received by Father from Family In Mexico			
Children's Mean Education	110.30 Ps.	110.11 Ps.	110.40 Ps.	109.44 Ps.
	(23.18)	(23.14)	(23.07)	(23.25)
Control for Birth State?	Y	Y	Y	Y
Control for State of Residence?	N	Y	N	N
Control for Mother's Age?	N	N	Y	N
Control for Mother's Education	N	N	N	Y

In all specifications, I control for the mean age of children over 25 with a dummy for each year of average age, control for the number of children over 25. I calculate average ages by assuming that children are spaced exactly two years apart. For example, if a woman has 10 children, and her youngest child is 16, then 5 children over 25, with an average age of 31. Couples who do not report valid data on transfers or family size, or who have more than 15 children are excluded. Observations are weighted by the sample weights given in the census, and clustered by state-age cells.

In Table 12, I use instrumental variables to create a policy experiment: wages for adult children increase, but parent's wages are held fixed. Using school calendar as an instrument, I find that parents get about 275 pesos a month if their children have 1 more year of education (average education, not total). This is about 29% of their children's extra earnings (holding labor supply fixed).

Table 13: IV Regression of Transfers Received on Children's Average Education, Using Temperature As An Instrument

	Dependent variable: Transfer Received by Mother From Family Abroad			
Children's Mean Education	24.65 Ps.	26.18 Ps.	26.21 Ps.	21.32 Ps.
	(19.18)	(19.12)	(19.14)	(19.16)
	Dependent variable: Transfer Received by Mother from Family In Mexico			
Children's Mean Education	52.34 Ps.	53.01 Ps.	49.21 Ps.	51.30 Ps.
	(18.67)	(18.58)	(18.67)	(18.50)
	Dependent variable: Transfer Received by Father from Family Abroad			
Children's Mean Education	47.43 Ps.	48.72 Ps.	46.84 Ps.	42.46 Ps.
	(25.21)	(25.39)	(25.18)	(25.36)
	Dependent variable: Transfer Received by Father from Family In Mexico			
Children's Mean Education	97.32 Ps.	98.25 Ps.	93.86 Ps.	98.92 Ps.
	(30.94)	(30.75)	(30.77)	(30.89)
Control for Birth State?	Y	Y	Y	Y
Control for State of Residence?	N	Y	N	N
Control for Mother's Age?	N	N	Y	N
Control for Mother's Education	N	N	N	Y

Controls are identical to Table 12.

In Table 13, I use instrumental variables to create a policy experiment: wages for adult children increase, but parent's wages are held fixed. Using temperature as an instrument, I find that parents get about 275 pesos a month if their children have 1 more year of education (average education, not total). This is about 24% of their children's extra earnings (holding labor supply fixed).

Table 14: IV Regression of Fathers's Labor Supply on Children's Education

Dependent Variable: Mean Hours Worked By Father				
	School Calendar Instrument			
Mean Education of Children	-4.78	-4.72	-4.77	-4.85
	(1.47)	(1.46)	(1.05)	(1.47)
	Weather Instrument			
Mean Education of Children	-6.30	-6.34	-4.32	-6.35
	(2.00)	(2.00)	(1.88)	(2.01)
Control for Birth State?	Y	Y	Y	Y
Control for State of Residence?	N	Y	N	N
Control for Age?	N	N	Y	N
Control for Education	N	N	N	Y

I restrict the sample to men 25-74. Parents who do not report valid labor supply are excluded. Controls are identical to Table 12.

In this Table, I demonstrate that leisure is a normal good. Men with high wage children are richer more transfers – and so they are able to retire earlier. In Tables 12 and 13, I showed that raising children's wages by 1 year increased total transfers by 225 to 275 pesos a month. Therefore, raising income by 100 pesos reduces labor supply by 2-3 hours a week.

It is important to note that the sample in Table 14 is mostly men in their 50's and 60's. The income elasticity for younger men may be significantly different.

Table 15: Regression of Labor Supply on Years Education in 2000

Dependent Variables: Hours Worked and Wages Earned			
		Weather IV	
Hours Worked	1.54	1.39	1.87
	(.58)	(.58)	(.48)
		Calendar IV	
Hours Worked	1.42	1.39	1.48
	(.30)	(.29)	(.28)
		OLS estimate	
Hours Worked	.27	.25	.25
	(.01)	(.01)	(.01)
Control for State of Birth?	Y	Y	Y
Control for Current State of Residence	N	Y	Y
Control for Birth State Trends?	N	N	Y

In all specifications, I control for age by including a dummy for each year of age, and control for state of birth by including a dummy for each state. Observations are weighted by the sampling weight given in the census, and standard errors are clustered by cohort. Men with invalid data are excluded.

Table 16: Regression of Labor Supply on Years Education in 1970

Dependent Variable: Mean Months Worked Last Year			
	IV Estimate, with Temperature as an Instrument		
Months Worked	.579	.544	-.962
	(.225)	(.201)	(1.277)
		OLS estimate	
Months Worked	.115	.107	.105
	(.005)	(.005)	(.005)
Control for State of Birth?	Y	Y	Y
Control for Current State of Residence	N	Y	Y
Control for Birth State Trends?	N	N	Y

Controls are identical to Table 15

In Tables 15 and 16, I use instrumental variables to create a policy experiment: wages for one child increase, but wages for the rest of the family are held fixed. In that policy experiment, I find that raising wages by 10% increases labor supply by 4%. In contrast, OLS measures the effect of raising children's wages, but not holding family wages fixed. Because wages for children and parents are highly correlated, OLS is closest to an experiment that raises wages for everybody in a family together. In that policy experiment, I find that raising wages by 10% increases labor supply by only 1%. The difference is caused by the income effect: men from families with high average wages are richer, and can afford to work less.

Table 17: Within-Family Regression of Labor Supply and Wages on Education

	Dependent Variable: ΔHours Worked Last Week		
ΔYears Education	.619	.590	.711
	(.043)	(.044)	(.048)
	Dependent Variable: ΔLog Wages Earned		
ΔYears Education	4.47%	4.47%	4.42%
	(.17%)	(.17%)	(.18%)
Implied Labor Supply Elasticity	0.346	0.330	0.402
Control for Control for Ages?	N	Y	Y
Control for Control for Average Education	N	N	Y

ΔEducation = Years Education Older Brother – Years Education Younger Brother
ΔHours = Hours Worked Older Brother – Hours Worked Younger Brother,
ΔWage = Log Hourly Wage Older Brother – Log Hourly Wage Younger Brother.
Families are only included in the labor supply regression of both brothers report valid hours, and only included in the wage regression if both brothers report valid wages.

I control for ages by including a dummy for each year of age for brother 1 and brother 2, and control for education by including a dummy for each year of brother 1's schooling, from 0 to 20. For simplicity, I compute labor supply elasticity using 40 hour week mean labor supply, rather than the actual mean which is slightly lower.

In this table, I compare labor supply and wages for brothers with different education. Comparing two brothers, I find that the brother with 1 more year of education earns 4.5% more, and works .6-.7 hours more per week. The low point estimates for return to education are caused by measurement error biasing results towards 0 (Griliches 1977). However, my estimates for labor supply elasticity are unbiased, because the two biases cancel out when I divide.

Table 18: Within-Family Labor Supply Elasticity, Split By Father's Work Status

	Dependent Variable: ΔHours Worked Last Week					
	Father Working			Father Retired		
ΔYears Education	.478	.467	.594	.729	.695	.861
	(.063)	(.064)	(.069)	(.087)	(.089)	(.098)
	Dependent Variable: ΔWages Earned					
	Father Working			Father Retired		
ΔYears Education	4.54%	4.48%	4.51%	4.83%	4.88%	4.71%
	(.26%)	(.26%)	(.28%)	(.34%)	(.35%)	(.38%)
Implied Labor Supply Elasticity	0.263	0.261	0.329	0.377	0.356	0.457
Control for Control for Ages?	N	Y	Y	N	Y	Y
Control for Control for Average Education	N	N	Y	N	N	Y

Controls and technique are identical to Table 17. Families without a father present are excluded.

In this table, I demonstrate that labor supply elasticity is higher when the father is retired. This is consistent with predictions of the model: income pooling only occurs when adult children support their parents.

Table 19: Within-Family Labor Supply Elasticity, Split By Father's Age

	Dependent Variable: ΔHours Worked Last Week					
	Father<65			Father 65+		
ΔYears Education	.308	.303	.481	.775	.753	.838
	(.071)	(.072)	(.078)	(.054)	(.055)	(.061)
	Dependent Variable: ΔWages Earned					
	Father <65			Father 65+		
ΔYears Education	4.89%	4.82%	4.86%	4.23%	4.28%	4.18%
	(.27%)	(.28%)	(.30%)	(.21%)	(.21%)	(.23%)
Implied Labor Supply Elasticity	0.157	0.157	0.247	0.458	0.440	0.501
Control for Control for Ages?	N	Y	Y	N	Y	Y
Control for Control for Average Education	N	N	Y	N	N	Y

Controls and technique are identical to Table 17. Families without a father present are excluded.

In this table, I use father's age to instrument for retirement status. I find that labor supply elasticity is much larger in families where the father is old enough to retire.

Table 20: Within-Family Labor Supply Elasticity, Split by Mean State Education

	Dependent Variable: ΔHours Worked Last Week					
	Low Education States			High Education States		
ΔYears Education	.671	.616	.711	.560	.542	.697
	(.057)	(.058)	(.063)	(.066)	(.066)	(.073)
	Dependent Variable: ΔWages Earned					
	Low Education States			High Education States		
ΔYears Education	3.67%	3.66%	3.66%	5.29%	5.32%	5.20%
	(.23%)	(.23%)	(.25%)	(.24%)	(.25%)	(.27%)
Implied Labor Supply Elasticity	0.457	0.421	0.486	0.265	0.255	0.335
Control for Control for Ages?	N	Y	Y	N	Y	Y
Control for Control for Average Education	N	N	Y	N	N	Y

Controls and technique are identical to Table 17.

In this table, I compare labor supply elasticity in high education states (mean more than 8.5 years of schooling), and low education states (mean less than 8.5 years). I find that labor supply elasticity is much larger in low education states. This is consistent with a higher rate of pension coverage in rich states – making it less necessary for children to support their parents. The larger returns to education in rich states are caused by non-linearities in the return to schooling: OLS finds a return to primary school of only 6% - but a 15% return to college.

Table 21: OLS Regression of Food Consumption on Years Education

	Dependent Variable: Days Ate Meat Last Week		
Years Education	.326	.296	.291
	(.003)	(.004)	(.003)
	Dependent Variable: Days Ate Fish Last Week		
Years Education	.042	.041	.041
	(.002)	(.002)	(.002)
	Dependent Variable: Days Ate Wheat Bread Last Week		
Years Education	.284	.238	.238
	(.004)	(.004)	(.004)
	Dependent Variable: Days Ate Eggs Last Week		
Years Education	.294	.264	.260
	(.004)	(.004)	(.004)
	Dependent Variable: Days Ate Dairy Last Week		
Years Education	.367	.321	.319
	(.005)	(.005)	*.005)
	Dependent Variable: Food Quality Index		
Years Education	.102	.090	.089
	(.001)	(.001)	(.001)
Controls for Birth State?	Y	Y	Y
Control for Current State of Residence	N	Y	Y
Controls for Household Composition	N	N	Y

In all specifications, I restrict the sample to men 25-74 with valid education and state of birth. I control for age by including a dummy for each year of age, and control for state of birth by including a dummy for each state. Observations are weighted by the sampling weight given in the census, and standard errors are clustered by cohort.

In the last row, I used the complete information on food consumption to create a food quality index. I created the index by regressing ln(monthly income) on 8 dummy variables for eating meat 0-7 days, 8 dummy variables for eating fish 0-7, etc. In other words, my food quality index is equivalent to monthly income predicted from food consumption.

OLS measures the effect of raising children's wages, but not holding family wages fixed. Because wages for children and parents are highly correlated, OLS is closest to an experiment that raises wages for everybody in a family together. In that policy experiment, I find that raising wages by 10% increases the quality of food consumption dramatically. This is consistent with common sense: poor people cannot afford to eat meat and eggs every day. Mexican peasants got the majority of their calories from corn and beans.

Table 22: IV Regression of Food Consumption on Education, Using Temperature as an Instrument

	Dependent Variable: Days Ate Meat Last Week		
Years Education	-.098	-.020	-.002
	(.153)	(.124)	(.122)
	Dependent Variable: Days Ate Fish Last Week		
Years Education	.029	.033	.037
	.070	.064	.064)
	Dependent Variable: Days Ate Bread Last Week		
Years Education	.024	.128	.168
	.181	.148	.146)
	Dependent Variable: Days Ate Eggs Last Week		
Years Education	-.075	.000	.013
	.165	.134	.132)
	Dependent Variable: Days Ate Dairy Last Week		
Years Education	-.051	.065	.079
	.206	.164	.163
	Dependent Variable: Food Quality Index		
Years Education	-.021	.007	.013
	.045	.034	.033
Controls for Birth State?	Y	Y	Y
Control for Current State of Residence?	N	Y	Y
Control for Household Composition?	N	N	Y

Controls used are identical to the in Table 21

In Tables 22, I use instrumental variables to create a policy experiment: wages for one child increase, but wages for the rest of the family are held fixed. I find that individual wages have almost no effect on quality of food consumed. This suggests that high wage men are sending their extra earnings to parents and siblings, and keeping very little for themselves.

Table 23: Regression of TV Ownership on Years Education

Dependent Variable: % Population that Lives in Household With A TV				
	IV Estimate, With Temperature As An Instrument			
Years Education	-2.1%	-1.7%	-2.65%	-2.7%
	(.8%)	(.8%)	(.9%)	(.9%)
	IV Estimate, With School Calendar As An Instrument			
Years Education	-1.9%	-1.5%	-2.4%	-2.0%
	(.6%)	(.5%)	(.6%)	(.6%)
	OLS Estimate			
Years Education	1.9%	1.8%	1.8%	1.9%
	(.0%)	(.0%)	(.0%)	(.0%)
Control for Current State of Residence	N	Y	N	N
Control for Household Composition	N	N	Y	N
Control for Birth State Trends?	N	N	N	Y

Controls are identical to Table 21. To save computing time on the OLS regressions, I use a 1% sample rather than the full 10%. Despite the smaller sample size, standard errors are still extremely low

In Tables 23, I use instrumental variables to create a policy experiment: wages for one child increase, but wages for the rest of the family are held fixed. I find that increasing wages by 10% decreases TV ownership by 2%. This is consistent with the increase in labor supply observed in Table 15 – men working long hours don't have time to watch TV. Therefore, they are less like to own TV's.

In contrast to the IV policy experiment, OLS measures the effect of raising children's wages, but not holding family wages fixed. Because wages for children and parents are highly correlated, OLS is closest to an experiment that raises wages for everybody in a family together. I find that increasing average family wages by 10% increases TV ownership by 2%. This is consistent with standard demand theory – TV's are a normal good. When labor supply is held constant (like we observe in Table 15), rich men are more likely to own TV's.

Table 24: Regression of Computer Ownership on Years Education

Dependent Variable: % Population that Lives in Household With A Computer				
	IV Estimate, With Temperature As An Instrument			
Years Education	5.6%	5.5%	5.8%	6.3%
	(.7%)	(.7%)	(.7%)	(.7%)
	IV Estimate, With School Calendar As An Instrument			
Years Education	7.3%	7.2%	7.7%	7.5%
	(.6%)	(.6%)	(.6%)	(.6%)
	OLS Estimate			
Years Education	2.4%	2.3%	2.3%	2.4%
	(.0%)	(.0%)	(.0%)	(.0%)
Control for Current State of Residence	N	Y	N	N
Control for Household Composition	N	N	Y	N
Control for Birth State Trends?	N	N	N	Y

Controls are identical to Table 21. To save computing time on the OLS regressions, I use a 1% sample rather than the full 10%. Despite the smaller sample size, standard errors are still extremely low

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In Tables 24, I use instrumental variables to create a policy experiment: wages for one child increase, but wages for the rest of the family are held fixed. I find that increasing wages by 10% increases computer ownership by 6%-8%. This is consistent with the increase in labor supply observed in Table 15 – computers are often used for work. at home. Therefore, men working long hours are more likely to own computers.

In contrast to the IV policy experiment, OLS measures the effect of raising children's wages, but not holding family wages fixed. Because wages for children and parents are highly correlated, OLS is closest to an experiment that raises wages for everybody in a family together. I find that increasing average family wages by 10% increases computer ownership by 2%. This is consistent with standard demand theory – computers are a normal good. When labor supply is held constant (like we observe in Table 15), rich men are more likely to own computers.

Appendix 1

Corner Solution For Transfers, Consumption and Labor Supply

Assume a general utility function with m consumption goods and one leisure good: $\text{u}(c_j^1,....c_j^m,L_j)$. The utility function is continuous, smooth and concave everywhere. For simplicity, I will assume that the price of the consumptions goods are all fixed at 1, and they are all normal and separable. However, I do not assume that consumption and leisure are separable. Some goods may be complements to leisure, and other goods may be substitutes.

Suppose that there are n children in a family. Child j receives a wage of w_j and 1 unit of time to allocate between consumption and leisure. After a child work, he gives a transfer $t_j(w_1...w_n)$ to his parent. Children are altruistic towards their parent, so that $\text{U}_\text{j}=\text{u}(c_j^1,....c_j^m, L_j)+\alpha\text{u}(c_p^1,...c_p^m, L_p)$. I will assume that the family is at a corner solution. Therefore, every child gives a transfer of 0 to his parent.

Lemma 1: $(\partial t_j/\partial w_k)=0,\ (\partial c_j^r/\partial w_k)=0,\ \&\ (\partial L_j/\partial w_k)=0$

Child j's problem can be written as:

$$\text{Max u}(c_j^1,...c_j^m, L_j)+\alpha(c_p^1,...c_p^m, L_p) \text{ subject to:}$$

$$\text{(1.1)}\qquad \text{Child j's budget constraint: } c_j^1+..+c_j^m = w_j(1-L_j)-t_j$$

$$\text{Parent's budget constraint: } c_p^1+..+c_p^m = w_p(1-L_p)+t_1+....+t_n$$

By assumption, $t_j=0$ no matter what value w_j or w_k has. Therefore, $(\partial t_j/\partial w_k)\text{=}0$.

Because transfers are always 0, we can simplify child j's problem to get:

$$\text{(1.2)}\qquad \begin{array}{l}\text{Max u}(c_j^1,...c_j^m, L_j)+\alpha(c_p^1,...c_p^m, L_p) \text{ subject to:}\\ \text{Child j's budget constraint: } c_j^1+..+c_j^m = w_j(1-L_j)\end{array}$$

Child j has a very straightforward utility function: he cares about his own leisure and consumption, and his parent's total utility. Therefore consumption and leisure for child j depend only on own wage, and transfer sent to the parent.

(1.3) $(\partial L_j/\partial w_k)\text{=}(\partial L_j/\partial t_j)\text{*}(\partial t_j/\partial w_k)\text{=}(\partial L_j/\partial t_j)\text{*}0\text{=}0$

(1.4) $(\partial c_j^r/\partial w_k)\text{=}(\partial c_j^r/\partial t_j)\text{*}(\partial t_j/\partial w_k)\text{=}(\partial c_j^r/\partial t_j)\text{*}0\text{=}0$

Lemma 2: $(\partial L_j / \partial w_j) - (\partial L_j / \partial w_k)$ is ambiguous

Child j's problem can be written as:

$$\begin{aligned} &\text{Max u}(c_j^1,...c_j^m, L_j) + \alpha(c_p^1,...c_p^m, L_p) \text{ subject to:} \\ (2.1)\quad &\text{Child j's budget constraint: } c_j^1 + .. + c_j^m = w_j(1-L_j) - t_j \\ &\text{Parent's budget constraint: } c_p^1 + .. + c_p^m = w_p(1-L_p) + t_1 + ... + t_n \end{aligned}$$

By assumption, $t_j = 0$. We can simplify child j's problem as:

$$(2.2)\quad \begin{aligned} &\text{Max u}(c_j^1,...c_j^m, L_j) + \alpha(c_p^1,...c_p^m, L_p) \text{ subject to:} \\ &\text{Child j's budget constraint: } c_j^1 + .. + c_j^m = w_j(1-L_j) \end{aligned}$$

This produces First Order Conditions:

$$(2.3)\quad (\partial \text{u}_j / \partial c_j^r) = (1/w_j)(\partial \text{u}_j / \partial L_j) = \lambda_j$$

We can then differentiate (2.3) with respect to w_j to get Second Order Conditions:

$$(2.4)\quad (\partial \text{u}_j^2 / \partial c_j^r \partial w_j) = (\partial \lambda_j / \partial w_j) \ \& \ (\partial \text{u}_j^2 / \partial L_j \partial w_j) = \lambda_j + w_j(\partial \lambda_j / \partial w_j)$$

For smooth functions, (∂f/∂x∂y) = (∂f/∂y∂x), so we can differentiate in reverse to get more information.

$$(2.5)\quad (\partial u_j / \partial w_j) = \sum_{r=1}^{m} (\partial \text{u}_j / \partial c_j^r)(\partial c_j^r / \partial w_j) + (\partial \text{u}_j / \partial L_j)(\partial L_j / \partial w_j)$$

$$(2.6)\quad (\partial u_j^2 / \partial w_j \partial L_j) = \sum_{r=1}^{m} (\partial \text{u}_j / \partial c_j^r \partial L_j)(\partial c_j^r / \partial w_j) + (\partial \text{u}_j^2 / \partial L_j^{\ 2})(\partial L_j / \partial w_j)$$

$$(2.7)\quad (\partial u_j^2 / \partial w_j \partial c_j^s) = \sum_{r=1}^{m} (\partial \text{u}_j / \partial c_j^r \partial c_j^s)(\partial c_j^r / \partial w_j) + (\partial \text{u}_j^2 / \partial L_j \partial c_j^s)(\partial L_j / \partial w_k) \ \forall \text{ good s}$$

By assumption, the utility from different consumption goods is separable. So, we can simplify (2.7) to get:

$$(2.8)\quad (\partial u_j^2 / \partial w_j \partial c_j^s) = (\partial \text{u}_j^2 / \partial^2 c_j^s)(\partial c_j^s / \partial w_j) + (\partial \text{u}_j^2 / \partial L_j \partial c_j^s)(\partial L_j / \partial w_j) \ \forall \text{ good s}$$

Combining (2.8) and (2.4), we get:

$$(2.9)\quad \begin{aligned}&(\partial\lambda_j/\partial w_j)=(\partial \mathrm{u}_\mathrm{j}^2/\partial^2 c_j^s)(\partial c_j^s/\partial w_j)+(\partial \mathrm{u}_\mathrm{j}^2/\partial L_j\partial c_j^s)(\partial L_j/\partial w_j)\rightarrow\\&(\partial c_j^s/\partial w_j)=\left((\partial\lambda_j/\partial w_j)-(\partial \mathrm{u}_\mathrm{j}^2/\partial L_j\partial c_j^s)(\partial L_j/\partial w_j)\right)/(\partial \mathrm{u}_\mathrm{j}^2/\partial^2 c_j^s)\end{aligned}$$

Similarly, we can combine (2.6) and (2.4) to get:

$$(2.10)\quad w_j(\partial\lambda_j/\partial w_j)+\lambda_j=\sum_{r=1}^{m}(\partial \mathrm{u}_\mathrm{j}/\partial c_j^r\partial L_j)(\partial c_j^r/\partial w_j)+(\partial \mathrm{u}_\mathrm{j}^2/\partial L_j^2)(\partial L_j/\partial w_j)$$

If we combine (2.10) and (2.9), we get:

$$(2.11)\quad \begin{aligned}&\sum_{r=1}^{m}\left((\partial \mathrm{u}_\mathrm{j}/\partial c_j^r\partial L_j)/(\partial \mathrm{u}_\mathrm{j}^2/\partial^2 c_j^r)\right)\left((\partial\lambda_j/\partial w_j)-(\partial \mathrm{u}_\mathrm{j}^2/\partial L_j\partial c_j^r)(\partial L_j/\partial w_j)\right)+\\&(\partial \mathrm{u}_\mathrm{j}^2/\partial L_j^2)(\partial L_j/\partial w_j)=w_j(\partial\lambda_j/\partial w_j)+\lambda_j\end{aligned}$$

$$(2.12)\quad \begin{aligned}&(\partial L_j/\partial w_j)=\left((\partial\lambda_j/\partial w_j)\left(w_j-\sum_{r=1}^{m}(\partial \mathrm{u}_\mathrm{j}/\partial c_j^r\partial L_j)/(\partial \mathrm{u}_\mathrm{j}^2/\partial^2 c_j^r)\right)+\lambda_j\right)/\\&\left((\partial \mathrm{u}_\mathrm{j}^2/\partial L_j^2)-\sum_{r=1}^{m}(\partial \mathrm{u}_\mathrm{j}/\partial c_j^r\partial L_j)^2/(\partial \mathrm{u}_\mathrm{j}^2/\partial^2 c_j^r)\right)\end{aligned}$$

Because utility is concave, $(\partial\lambda_j/\partial w_j)<0$, $\lambda_j>0$ & $\left(w_j-\sum_{r=1}^{m}(\partial \mathrm{u}_\mathrm{j}/\partial c_j^r\partial L_j)/(\partial \mathrm{u}_\mathrm{j}^2/\partial^2 c_j^r)\right)>0$. Because all consumption goods and leisure are normal, $\left((\partial \mathrm{u}_\mathrm{j}^2/\partial L_j^2)-\sum_{r=1}^{m}(\partial \mathrm{u}_\mathrm{j}/\partial c_j^r\partial L_j)^2/(\partial \mathrm{u}_\mathrm{j}^2/\partial^2 c_j^r)\right)<0$.

Therefore, $(\partial L_j/\partial w_j)=\left((-)(+)+(+)\right)/(-)=?$. So, we cannot tell whether high wages increase or decrease leisure. Both are possible for plausible utility functions.

Lemma 3: $\sum_{r=1}^{m}(\partial c_j^r/\partial w_j)>0$

According to (2.4) and (2.8) from Lemma 2,

$$(3.1)\quad (\partial \mathrm{u}_\mathrm{j}^2/\partial c_j^r\partial w_j)=(\partial\lambda_j/\partial w_j)\ \&\ (\partial \mathrm{u}_\mathrm{j}^2/\partial L_j\partial w_j)=\lambda_j+w_j(\partial\lambda_j/\partial w_j)$$

$$(3.2)\quad (\partial u_j^2/\partial w_j\partial c_j^s)=(\partial \mathrm{u}_\mathrm{j}^2/\partial^2 c_j^s)(\partial c_j^s/\partial w_j)+(\partial \mathrm{u}_\mathrm{j}^2/\partial L_j\partial c_j^s)(\partial L_j/\partial w_j)\ \forall \text{ good s}$$

We can them combine to get:

$$(3.3)\quad (\partial c_j^s/\partial w_j)=\left((\partial\lambda_j/\partial w_j)\text{-}(\partial \mathrm{u}_\mathrm{j}^2/\partial L_j\partial c_j^s)(\partial L_j/\partial w_j)\right)/(\partial \mathrm{u}_\mathrm{j}^2/\partial^2 c_j^s)$$

This is theoretically ambiguous: $(\partial\lambda_j / \partial w_j) < 0$, $(\partial \mathrm{u}_j^2 / \partial L_j \partial c_j^s) = ?$, $(\partial L_j / \partial w_j) = ?$ and $(\partial \mathrm{u}_j^2 / \partial^2 c_j^s) = ?$. Therefore, $(\partial c_j^s / \partial w_j) = \big((-)\text{-}(?)(?)\big)/(-) = ?$.

Of course, in practice it is extremely likely that $(\partial c_j^s / \partial w_j) > 0$, especially when $(\partial L_j / \partial w_j)$ is relatively small.

However, we can determine what happens to aggregate consumption. By assumption, there are no transfers, so the budget constraint is simply:

(3.4) $\sum_{r=1}^{m} c_j^r = w_j * (1 - L_j) \rightarrow \sum_{r=1}^{m} \partial c_j^r / \partial w_j = (1 - L_j) - w_j (\partial L_j / \partial w_j)$

Therefore, $\sum_{r=1}^{m} \partial c_j^r / \partial w_j < 0$ if and only if $(1 - L_j) / w_j < (\partial L_j / \partial w_j)$

However, that is impossible. By assumption, both consumption and leisure are normal goods. Therefore,

(3.5) $1 / w_j > (\partial L_j / \partial I_j) > 0$.

In other words, if give child j an extra dollar, he we spend some of his money on leisure and some of his money on consumption.

We can decompose labor supply elasticity into two parts.

(3.6) $(\partial L_j / \partial w_j) = (\partial L_j / \partial I_j) * (\partial I_j / \partial w_j) + (\partial L_j / \partial w_j)_H$

Combining (3.5) and (3.6), we get:

(3.7) $(\partial L_j / \partial w_j) < (1 / w_j) * (1 - L) + (\partial L_j / \partial w_j)_H$

$(\partial L_j / \partial w_j)_H$ is the pure substitution effect of changing wages. It is always negative, because higher wage raise the opportunity cost of leisure. We can simplify (3.7) to get:

(3.8) $(\partial L_j / \partial w_j) < (1 - L) / w_j \rightarrow \sum_{r=1}^{m} \partial c_j^r / \partial w_j > 0$

Appendix 2

Interior Solution For Transfers, Consumption and Labor Supply

Assume a general utility function with m consumption goods and one leisure good: $\mathrm{u}(c_j^1,....c_j^m,L_j)$. The utility function is continuous, smooth and concave everywhere. For simplicity, I will assume that the price of the consumptions goods are all fixed at 1, and they are all normal and separable. However, I do not assume that consumption and leisure are separable. Some goods may be complements to leisure, and other goods may be substitutes.

Suppose that there are n children in a family. Child j receives a wage of w_j and 1 unit of time to allocate between consumption and leisure. After a child work, he gives a transfer $t_j(w_1...w_n)$ to his parent. Children are altruistic towards their parent, so that $\mathrm{U}_j=\mathrm{u}(c_j^1,....c_j^m,L_j)+\alpha\mathrm{u}(c_p^1,...c_p^m,L_p)$. I will assume that the family is at an interior solution, so that every children gives a positive transfer to his or her parent. I will also assume that children move simultaneously – so that they cannot change their behavior in response to sibling's behavior.

Lemma 1: $\left((\partial L_j/\partial w_j)-(\partial L_j/\partial w_k)\right)<0$ & $\left((\partial c_j^r/\partial w_j)-(\partial c_j^r/\partial w_k)\right)$ is ambiguous

Child j's problem can be written as:

$$
\begin{aligned}
&\text{Max } \mathrm{u}(c_j^1,...c_j^m,L_j)+\alpha(c_p^1,...c_p^m,L_p) \text{ subject to:}\\
&\text{Child j's budget constraint: } c_j^1+..+c_j^m=w_j(1-L_j)-t_j\\
&\text{Parent's budget constraint: } c_p^1+..+c_p^m=w_p(1-L_p)+\sum_{k\neq j}^{n}t_k+t_j
\end{aligned}
\tag{1.1}
$$

Child j picks $(c_j^1,...c_j^m,L_j)$, $(c_p^1,...c_p^m,L_p)$ and t_j

However, transfers by the other children, $\sum_{k\neq j}^{n}t_k$ are a fixed constant

Because child j views the other child's transfers as fixed, this is equivalent to all children moving simultaneously. This version of the public good problem is often called the Cournot-Nash model. This solution was first introduced by Warr in 1983, but has been studied by many authors since.

We can solve child j's utility problem to get First Order Conditions

(1.2) $(\partial \mathrm{u}_{\mathrm{j}}/\partial c_j^r)=w_p(\partial \mathrm{u}_{\mathrm{p}}/\partial c_p^r)=\lambda_{\mathrm{p}}$ & $w_j(\partial \mathrm{u}_{\mathrm{j}}/\partial c_j^r)=(\partial \mathrm{u}_{\mathrm{j}}/\partial L_j)=\lambda_{\mathrm{j}}$ & $\lambda_j=\alpha\lambda_{\mathrm{p}}$.

Because all children in the family are at the interior solution, we can rewrite (1.2) as:

(1.3) $(\partial \mathrm{u}_{\mathrm{j}}/\partial c_j^r)=\lambda=(\partial \mathrm{u}_{\mathrm{k}}/\partial c_k^r)$ & $(\partial \mathrm{u}_{\mathrm{j}}/\partial L_j)=w_k\lambda=(\partial \mathrm{u}_{\mathrm{k}}/\partial L_k)$

We can then differentiate (1.3) with respect to w_j to get Second Order Conditions:

(1.4) $(\partial \mathrm{u}_{\mathrm{j}}^2/\partial c_j^r\partial w_j)=(\partial\lambda/\partial w_j)$ & $(\partial \mathrm{u}_{\mathrm{j}}^2/\partial L_j\partial w_j)=\lambda+w_j(\partial\lambda/\partial w_j)$

Similarly, we can differentiate (1.3) with respect to w_k to get Second Order Conditions:

(1.5) $(\partial \mathrm{u}_{\mathrm{j}}^2/\partial c_j^r\partial w_k)=(\partial\lambda/\partial w_k)$ & $(\partial \mathrm{u}_{\mathrm{j}}^2/\partial L_j\partial w_k)=w_j(\partial\lambda/\partial w_k)$

For smooth functions, (∂f/∂x∂y) = (∂f/∂y∂x), so we can differentiate in reverse to get more information.

(1.6) $(\partial u_j/\partial w_k)=\sum_{r=1}^{m}(\partial \mathrm{u}_{\mathrm{j}}/\partial c_j^r)(\partial c_j^r/\partial w_k)+(\partial \mathrm{u}_{\mathrm{j}}/\partial L_j)(\partial L_j/\partial w_k)$ ∀ siblings j & k

(1.7) $(\partial u_j^2/\partial w_k\partial L_j)=\sum_{r=1}^{m}(\partial \mathrm{u}_{\mathrm{j}}/\partial c_j^r\partial L_j)(\partial c_j^r/\partial w_k)+(\partial \mathrm{u}_{\mathrm{j}}^2/\partial L_j{}^2)(\partial L_j/\partial w_k)$ ∀ siblings j and k

(1.8) $(\partial u_j^2/\partial w_k\partial c_j^s)=\sum_{r=1}^{m}(\partial \mathrm{u}_{\mathrm{j}}/\partial c_j^r\partial c_j^s)(\partial c_j^r/\partial w_k)+(\partial \mathrm{u}_{\mathrm{j}}^2/\partial L_j\partial c_j^s)(\partial L_j/\partial w_k)$
∀ siblings j & k and good s

By assumption, the utility from different consumption goods is separable. So, we can simplify (1.8) to get:

(1.9) $(\partial u_j^2/\partial w_k\partial c_j^s)=(\partial \mathrm{u}_{\mathrm{j}}^2/\partial^2 c_j^s)(\partial c_j^s/\partial w_k)+(\partial \mathrm{u}_{\mathrm{j}}^2/\partial L_j\partial c_j^s)(\partial L_j/\partial w_k)$
∀ siblings j & k and good s

Combining (1.9) and (1.5), we get:

(1.10)
$$(\partial\lambda/\partial w_k)=(\partial \mathrm{u}_{\mathrm{j}}^2/\partial^2 c_j^s)(\partial c_j^s/\partial w_k)+(\partial \mathrm{u}_{\mathrm{j}}^2/\partial L_j\partial c_j^s)(\partial L_j/\partial w_k)\rightarrow$$
$$(\partial c_j^s/\partial w_k)=\left((\partial\lambda/\partial w_k)-(\partial \mathrm{u}_{\mathrm{j}}^2/\partial L_j\partial c_j^s)(\partial L_j/\partial w_k)\right)/(\partial \mathrm{u}_{\mathrm{j}}^2/\partial^2 c_j^s)$$

We can also rewrite (1.10) as:

(1.11) $(\partial c_j^s / \partial w_j) - (\partial c_j^s / \partial w_k) = -\left((\partial \mathrm{u}_\mathrm{j}^2 / \partial L_j \partial c_j^s) / (\partial \mathrm{u}_\mathrm{j}^2 / \partial^2 c_j^s)\right)\left((\partial L_j / \partial w_j) - (\partial L_j / \partial w_k)\right)$

Similarly, we can combine (1.7), (1.3) and (1.4) to get:

(1.12)
$$w_j(\partial \lambda / \partial w_k) = \sum_{r=1}^{m} (\partial \mathrm{u}_\mathrm{j} / \partial c_j^r \partial L_j)(\partial c_j^r / \partial w_k) + (\partial \mathrm{u}_\mathrm{j}^2 / \partial L_j^2)(\partial L_j / \partial w_k) \text{ for } \mathrm{j} \neq \mathrm{k}$$
$$w_j(\partial \lambda / \partial w_j) + \lambda = \sum_{r=1}^{m} (\partial \mathrm{u}_\mathrm{j} / \partial c_j^r \partial L_j)(\partial c_j^r / \partial w_j) + (\partial \mathrm{u}_\mathrm{j}^2 / \partial L_j^2)(\partial L_j / \partial w_j)$$

If we combine (1.10) and (1.12), we get:

(1.13)
$$\sum_{r=1}^{m}\left((\partial \lambda / \partial w_k)(\partial \mathrm{u}_\mathrm{j} / \partial c_j^r \partial L_j) - (\partial \mathrm{u}_\mathrm{j}^2 / \partial L_j \partial c_j^r)^2 (\partial L_j / \partial w_k)\right) / (\partial \mathrm{u}_\mathrm{j}^2 / \partial^2 c_j^s) + (\partial \mathrm{u}_\mathrm{j}^2 / \partial L_j^2)(\partial L_j / \partial w_k) =$$
$$w_j(\partial \lambda / \partial w_k) \text{ for } \mathrm{j} \neq \mathrm{k}$$

(1.14)
$$\sum_{r=1}^{m}\left((\partial \lambda / \partial w_j)(\partial \mathrm{u}_\mathrm{j} / \partial c_j^r \partial L_j) - (\partial \mathrm{u}_\mathrm{j}^2 / \partial L_j \partial c_j^r)^2 (\partial L_j / \partial w_j)\right) / (\partial \mathrm{u}_\mathrm{j}^2 / \partial^2 c_j^s) + (\partial \mathrm{u}_\mathrm{j}^2 / \partial L_j^2)(\partial L_j / \partial w_j) =$$
$$w_j(\partial \lambda / \partial w_j) + \lambda$$

By assumption, every child in the family has identical utility functions, and wage shocks are small. Therefore, the family is symmetrical and $(\partial \lambda / \partial w_k) = (\partial \lambda / \partial w_j)$. We can thereby combine (1.13) and (1.14) to get:

(1.15)
$$\sum_{r=1}^{m}\left((\partial \mathrm{u}_\mathrm{j}^2 / \partial L_j \partial c_j^r)^2 / (\partial \mathrm{u}_\mathrm{j}^2 / \partial^2 c_j^s)\right)\left((\partial L_j / \partial w_j) - (\partial L_j / \partial w_k)\right) + (\partial \mathrm{u}_\mathrm{j}^2 / \partial L_j^2)\left((\partial L_j / \partial w_j) - (\partial L_j / \partial w_k)\right) = \lambda \rightarrow$$
$$\left((\partial L_j / \partial w_j) - (\partial L_j / \partial w_k)\right) = \lambda / \left((\partial \mathrm{u}_\mathrm{j}^2 / \partial L_j^2) - \sum_{r=1}^{m}\left((\partial \mathrm{u}_\mathrm{j}^2 / \partial L_j \partial c_j^r)^2 / (\partial \mathrm{u}_\mathrm{j}^2 / \partial^2 c_j^s)\right)\right)$$

Because leisure is a normal good, $(\partial \mathrm{u}_\mathrm{j}^2 / \partial L_j^2) < \sum_{r=1}^{m}\left((\partial \mathrm{u}_\mathrm{j}^2 / \partial L_j \partial c_j^r)^2 / (\partial \mathrm{u}_\mathrm{j}^2 / \partial^2 c_j^s)\right)$. And the utility function is monotonically increasing, so $\lambda > 0$. Therefore,

(1.16) $(\partial L_j / \partial w_j) - (\partial L_j / \partial w_k) = (+)/(-) \rightarrow (\partial L_j / \partial w_j) < (\partial L_j / \partial w_k)$

If we then put the solution from (1.15) into (1.11), we get:

(1.17)

$$(\partial c_j^s/\partial w_j)-(\partial c_j^s/\partial w_k)=-\lambda\left((\partial \mathrm{u}_\mathrm{j}^2/\partial L_j\partial c_j^s)/(\partial \mathrm{u}_\mathrm{j}^2/\partial^2 c_j^s)\right)/\left((\partial \mathrm{u}_\mathrm{j}^2/\partial L_j^2)-\sum_{r=1}^{m}\left((\partial \mathrm{u}_\mathrm{j}^2/\partial L_j\partial c_j^r)^2/(\partial \mathrm{u}_\mathrm{j}^2/\partial^2 c_j^r)\right)\right)$$

This is ambiguous, because $(\partial \mathrm{u}_\mathrm{j}^2/\partial L_j\partial c_j^s)$ can be either positive or negative. If $(\partial \mathrm{u}_\mathrm{j}^2/\partial L_j\partial c_j^s)>0$, then good s is a complement to leisure. In that case, $(\partial c_j^s/\partial w_j)-(\partial c_j^s/\partial w_k)<0$. If $(\partial \mathrm{u}_\mathrm{j}^2/\partial L_j\partial c_j^s)<0$, then good s is a substitute for leisure. In that case, $(\partial c_j^s/\partial w_j)-(\partial c_j^s/\partial w_k)>0$

Lemma 2: $(\partial L_j/\partial w_k)>0$ & $(\partial c_j^r/\partial w_k)>0$ for any r & $(\partial t_j/\partial w_k)<0$ for $\mathrm{j}\neq\mathrm{k}$

In Lemma 1, I used Second Order conditions to get the equations:

(2.1) $(\partial c_j^s/\partial w_k)=\left((\partial\lambda/\partial w_k)-(\partial \mathrm{u}_\mathrm{j}^2/\partial L_j\partial c_j^s)(\partial L_j/\partial w_k)\right)/(\partial \mathrm{u}_\mathrm{j}^2/\partial^2 c_j^s)$

(2.2) $w_j(\partial\lambda/\partial w_k)=\sum_{r=1}^{m}(\partial \mathrm{u}_\mathrm{j}/\partial c_j^r\partial L_j)(\partial c_j^r/\partial w_k)+(\partial \mathrm{u}_\mathrm{j}^2/\partial L_j^2)(\partial L_j/\partial w_k)$ for $\mathrm{j}\neq\mathrm{k}$

(2.3) $\lambda+w_k(\partial\lambda/\partial w_k)=\sum_{r=1}^{m}(\partial \mathrm{u}_\mathrm{k}/\partial c_k^r\partial L_k)(\partial c_k^r/\partial w_k)+(\partial \mathrm{u}_\mathrm{k}^2/\partial L_k^2)(\partial L_k/\partial w_k)$

We can combine equations (2.1) and (2.2) to express $(\partial L_j/\partial w_k)$ in terms of $(\partial\lambda/\partial w_k)$:

(2.4)
$$w_j(\partial\lambda/\partial w_k)=(\partial \mathrm{u}_\mathrm{j}^2/\partial L_j^2)(\partial L_j/\partial w_k)+ \sum_{r=1}^{m}\left((\partial \mathrm{u}_\mathrm{j}/\partial c_j^r\partial L_j)(\partial\lambda/\partial w_k)-(\partial \mathrm{u}_\mathrm{j}^2/\partial L_j\partial c_j^r)^2(\partial L_j/\partial w_k)\right)/(\partial \mathrm{u}_\mathrm{j}^2/\partial^2 c_j^r)$$

We can rewrite that equation to get:

(2.5)
$$(\partial L_j/\partial w_k)=(\partial\lambda/\partial w_k)\left(w_j-\sum_{r=1}^{m}\left((\partial \mathrm{u}_\mathrm{j}/\partial c_j^r\partial L_j)/(\partial \mathrm{u}_\mathrm{j}^2/\partial^2 c_j^r)\right)\right)/ \left((\partial \mathrm{u}_\mathrm{j}^2/\partial L_j^2)-\sum_{r=1}^{m}(\partial \mathrm{u}_\mathrm{j}^2/\partial L_j\partial c_j^r)^2/(\partial \mathrm{u}_\mathrm{j}^2/\partial^2 c_j^r)\right)$$

Because concavity of the utility function, $(\partial\lambda/\partial w_k)<0$. Because all consumption goods are normal, $w_j>\sum_{r=1}^{m}\left((\partial \mathrm{u}_\mathrm{j}/\partial c_j^r\partial L_j)/(\partial \mathrm{u}_\mathrm{j}^2/\partial^2 c_j^r)\right)$. Finally, leisure is a normal goods - so $(\partial \mathrm{u}_\mathrm{j}^2/\partial L_j^2)<\sum_{r=1}^{m}\left((\partial \mathrm{u}_\mathrm{j}^2/\partial L_j\partial c_j^r)^2/(\partial \mathrm{u}_\mathrm{j}^2/\partial^2 c_j^r)\right)$. Therefore, we can solve for the sign.

(2.6) $(\partial L_j / \partial w_k) = (-)(+)/(-) > 0$

By assumption, leisure is a normal good and utility is completely separable across children in a family. Every penny given to the parents reduces income. Therefore, $(\partial L_j / \partial t_j) < 0$. So we can solve for the sign of $(\partial t_j / \partial w_k)$

(2.7) $(\partial t_j / \partial w_k) = (\partial L_j / \partial w_k)/(\partial L_j / \partial t_j) = (+)/(-) < 0$

By assumption, all consumption goods are normal. In other words, $(\partial c_j^r / \partial t_j)$<0. Therefore, we can solve for the sign of $(\partial c_j^r / \partial w_k)$.

(2.8) $(\partial c_j^r / \partial w_k) = (\partial c_j^r / \partial t_j) * (\partial t_j / \partial w_k) = (-)/(-) > 0$

Appendix 3

Children Can Give Control of Family to Altruistic Parent

Suppose that parents and children are mutually altruistic.
The utility function for a parent is:

$$\mathrm{U_p} = \mathrm{u}(c_p^1, \ldots c_p^m, L_p) + \sum_{j=1}^{n} \alpha \mathrm{U_j} = \mathrm{u}(c_p^1, \ldots c_p^m, L_p) + \sum_{j=1}^{n} \alpha \mathrm{u}(c_j^1, \ldots c_j^m, L_j)$$

The utility function for child j is:

$$\mathrm{U_j} = \mathrm{u}(c_j^1, \ldots c_j^m, L_j) + \alpha \mathrm{U_p} = \mathrm{u}(c_j^1, \ldots c_j^m, L_j) + \alpha (c_p^1, \ldots c_p^m, L_p)$$

The children have two choices: 1) They can allow the altruistic parent to completely control the family. In that case, the parent gets to pick consumption and labor supply for every child in the family. In this case, the family pools income completely. 2) Children can keep control of their own lives. In that case, there are no transfers between family members, and each child must balance their own budget constraint.

In the first period, children play a simple game that determines who controls the family. If every child gives control to the parent, then the parent controls the family. If even one child refuses to give control, then the parent does not control the family. The children take a simultaneous vote to decide who gets control[42]. Obviously, the parent strictly prefers to run the family themselves – but they are not given a vote. In the second period, consumption and labor supply is determined. We must solve separately for the two choices.

Suppose that the family is controlled by the altruistic parent. Because the parent has complete control, he can shift resources within the family at will. Then the parent's problem can be written as:

Max $\mathrm{u}(c_p^1, \ldots c_p^m, L_p) + \sum_{j=1}^{n} \alpha \mathrm{u}(c_j^1, \ldots c_j^m, L_j)$ subject to budget constraints:

$$\sum_{r=1}^{m} c_j^r = w_j (1 - L_j) - t_j; \;\; \sum_{r=1}^{m} c_p^r = w_p (1 - L_p) + \sum_{j=1}^{n} t_j$$

FOC: $(\partial \mathrm{u}/\partial c_j^r) = w_j (\partial \mathrm{u}/\partial L_j)$; $(\partial \mathrm{u}/\partial c_p^r) = w_p (\partial \mathrm{u}/\partial L_p)$; $\alpha (\partial \mathrm{u}/\partial c_j^r) = (\partial \mathrm{u}/\partial c_p^r)$

[42] Results are similar if the children use another decision mechanism, like majority voting. Results also remain similar if children vote sequentially.

The parent then solves his maximization problem, and gets an optimal consumption and labor supply vector:

$$(c_p^1, ...c_p^m, L_p) = (c_p^1*, ...c_p^m*, L_p*) \ \ \& \ (c_j^1, ...c_j^m, L_j) = (c_j^1*, ...c_j^m*, L_j*) \text{ for all j}$$

Without explicit functional form assumptions, we cannot solve for the exact outcomes. However, it is clear that income is pooled completely – the parent couldn't cares equally for all children, regardless of their wage. This outcome is exactly analogous to Becker's "Rotten Kid Theorem".

Suppose that the family is not controlled by the altruistic parent. In that case, every individual solves their own maximization problem.

The problem for the parent can be written as:

$$\text{Max u}(c_p^1, ...c_p^m, L_p) + \sum_{j=1}^{n} \alpha \text{u}(c_j^1, ...c_j^m, L_j) \text{ subject to: } \sum_{r=1}^{m} c_p^r = w_p(1 - L_p)$$

From the parent's perspect, $(c_j^1 ... c_j^m, L_j)$ are fixed constant for all j

FOC: $(\partial \text{u}/\partial c_p^r) = w_p(\partial \text{u}/\partial L_p)$

The parent then solves his maximization problem, and gets an optimal consumption and labor supply vector:

$$(c_p^1, ...c_p^m, L_p) = (c_p^{1\odot}, ...c_p^{m\odot}, L_p^{\odot})$$

Similarly, the problem for child j can be written as:

$$\text{Max u}(c_j^1, ...c_j^m, L_j) + \alpha \text{u}(c_p^1, ...c_p^m, L_p) \text{ subject to } \sum_{r=1}^{m} c_j^r = w_j(1 - L_j)$$

From the child's perspective, $(c_p^1, ...c_p^m, L_p)$ are fixed constants

FOC: $(\partial \text{u}/\partial c_j^r) = w_j(\partial \text{u}/\partial L_j)$

The child then solves his maximization problem, and gets optimal consumption and labor supply vector:

$$(c_j^1, ...c_j^m, L_j) = (c_j^{1\odot}, ...c_j^{m\odot}, L_j^{\odot})$$

In the first period, children decide whether to get control of their family to the parent. Children all know

$$(c_p^{1\odot}, ...c_p^{m\odot}, L_p^{\odot}),\ (c_p^1*, ...c_p^m*, L_p*),\ (c_j^1*, ...c_j^m*, L_j*) \ \& \ (c_j^{1\odot}, ...c_j^{m\odot}, L_j^{\odot}) \text{ for all j}$$

We can write the decision as a simultaneous game by child j and all other children.

	All other children give control to parent	At last one other child does not give control to parent
Child j gives control to parent	$\mathrm{u}(c_j^1*,...c_j^m*,L_j*)+$ $\alpha\mathrm{u}(c_p^1*,...c_p^m*,L_p*)$	$\mathrm{u}(c_j^{1\odot},...c_j^{m\odot},L_j^{\odot})+$ $\alpha(c_p^{1\odot},...c_p^{m\odot},L_p^{\odot})$
Child j does not give control	$\mathrm{u}(c_j^{1\odot},...c_j^{m\odot},L_j^{\odot})+$ $\alpha(c_p^{1\odot},...c_p^{m\odot},L_p^{\odot})$	$\mathrm{u}(c_j^{1\odot},...c_j^{m\odot},L_j^{\odot})+$ $\alpha(c_p^{1\odot},...c_p^{m\odot},L_p^{\odot})$

If we eliminate weakly dominated strategies, we get a very simple strategy for child j:

$\mathrm{u}(c_j^1*,...c_j^m*,L_j*)+\alpha\mathrm{u}(c_p^1*,...c_p^m*,L_p*)>\mathrm{u}(c_j^{1\odot},...c_j^{m\odot},L_j^{\odot})+\alpha(c_p^{1\odot},...c_p^{m\odot},L_p^{\odot})$	Gives up control
$\mathrm{u}(c_j^1*,...c_j^m*,L_j*)+\alpha\mathrm{u}(c_p^1*,...c_p^m*,L_p*)\leq\mathrm{u}(c_j^{1\odot},...c_j^{m\odot},L_j^{\odot})+\alpha(c_p^{1\odot},...c_p^{m\odot},L_p^{\odot})$	Keeps control

What benefits do children get from giving up control of the family? 1)Very poor children get large cash gifts from the parent. 2) Rich children who give up control are now able to give transfers to the parent. Therefore, the parent gets more consumption, making altruistic children better off. However, benefit 2) comes at a huge cost: the parent is now free to take as much as they like from the children. In many families, the children are mildly altruistic – and were willing to give something to the parent. But they are not willing to give as much as the parent likes. In this paper, I am focusing on adult children supporting their parent. Therefore, I will ignore scenario 1), where very poor children give up control to get money. Instead I will focus on scenario 2), where altruistic children give up control in order to be allowed to send money to the parent.

From the child's point of view, this model produces very different results from the Cournot-Nash model. In the Cournot-Nash model, the child's consumption and labor supply are continuous functions of wages for the every family member. In contrast, this model produces discontinuous results. If the parent is extremely poor, then the children hand over control of the family – and they are allocated low consumption and high labor supply. However, at a discrete point the children will no longer hand over control of the family. At that point, the children's consumption jumps and their labor supply drops.

However, from a risk-sharing perspective, this model produces similar results to the Cournot-Nash model. If the parent is very poor – then the children pool income. If the parent is richer, the children do not pool income.

Appendix 4

Income Pooling under a Stackelberg Equilibrium

In the Stackelberg method, people invest sequentially. Therefore, second movers can change their contribution in response to the first mover's choices – and the first mover incorporates the second mover's response to his own actions. Because the moves are sequential, the order in which the players move is critically important. Regardless of the order, people contribute less when they move sequentially compared to people moving simultaneously (Varian 1994).

Varian focuses on a sequential game with only two players and two stages. In my model, there are *n* children in the family, so there would be *n* stages if each child moved individually. This makes it much more complex to solve the model. In this section, I will simplify by assuming that there are only two stages. In the first stage, *n*-1 children move simultaneously. In the second stage, the last child moves individually.

Suppose that child *n* moves last. He knows that the other children have contributed a total of t_{-n}, and he must decide how much to give to the parent himself, t_n, how much leisure to take, *L*, and how much to consume. We can write his maximization problem as:

$$\text{Max } U_n = u(c_n^1, \ldots, c_n^m, L_j) + \alpha u(c_p^1, \ldots, c_p^m, L_p), \text{ subject to:}$$

$$\text{Child j's budget constraint: } \sum_{i=1}^{m} c_n^i = w_n(1 - L_n) - t_n$$

$$\text{Parent's budget constraint: } \sum_{i=1}^{m} c_p^i = t_n + t_{-n} + w_p(1 - L_p)$$

We can then solve to get first order conditions

$$(\partial u / \partial c_n^r) = w_n(\partial u / \partial L_n) = \lambda_n \text{ for any good r;}$$

$$(\partial u / \partial c_p^s) = w_p(\partial u / \partial L_p) = \lambda_p;\ \lambda_n \geq \alpha \lambda_p$$

Solving the first order conditions, we get a response function $t_n(t_{-n})$. Varian (1994) shows that $-1 \leq \partial t_n / \partial t_{-n} \leq 0$. In other words, child n will contribute less if the other kids give more, but he will not completely offset their transfers.

Suppose that child k moves in the first stage. He knows how much he expects children 1 to n-1 to give, and he knows the response function for child n. He must decide how much to give to the parent, t_k, how much leisure to take, *L*, and how much to consume. We can write his maximization problem as:

Max $U_k = u(c_k^1,...,c_k^m, L_k) + \alpha u(c_p^1,...,c_p^m, L_p)$, subject to:

Child j's budget constraint: $\sum_{i=1}^{m} c_k^i = w_k(1-L_k) - t_k$

Parent's budget constraint: $\sum_{i=1}^{m} c_p^i = \sum_{j \neq k}^{n-1} t_j + t_k + t_n(\sum_{j \neq k}^{n-1} t_j + t_k) + w_p(1-L_p)$

We can solve this problem to get first order conditions:

$$(\partial u / \partial c_k^r) = w_k(\partial u / \partial L_k) = \lambda_k \text{ for any good r;}$$
$$(\partial u / \partial c_p^s) = w_p(\partial u / \partial L_p) = \lambda_p;\ \lambda_k \geq \alpha(1 + \partial t_n / \partial t_{-n})\lambda_p$$

In this section, I will focus on the two most common solutions[43] to the First Order Conditions for children n and k: 1) $\lambda_k > \alpha(1 + \partial t_n / \partial t_{-n})\lambda_p$ & $\lambda_n > \alpha\lambda_p$. In this solution, neither child gives any transfer to parents. 2) $\lambda_k > \alpha(1 + \partial t_n / \partial t_{-n})\lambda_p$ & $\lambda_n = \alpha\lambda_p$. In this solution, child n is willing to give transfers to the parent – because he knows that every dollar he gives benefits the parent. However, all of the other children are not willing to give any transfers – because they know that only a fraction of their money benefits the beloved parent, and the rest goes to child n.

In scenario 1), no income-pooling occurs at all, regardless of the order the children move. Outcomes for the child are identical to the Nash Equilibrium without transfer that is examined in Appendix 1. In scenario 2), small amounts of income-pooling occur. Child n pools income completely with the parent, but children 1 to n-1 do not pool income at all.

However, even if very little income-pooling occurs in the Stackelberg solution, significant amounts of risk-sharing may still occur. Suppose that the parent gets to pick which child moves last. The parent is selfish, so they will pick the child who guarantees them the highest utility. By assumption, transfers given are a normal good. Therefore, the parent will always pick the richest kid to move last. This is an intuitive choice, the richest child has the most money to spare – so they will give the most money to the parent.

How does the parent's choice affect consumption and labor supply elasticity for the children? We can write child j's maximization problems as:

Max $U_j = u(c_j^1,...,c_j^m, L_j) + \alpha u(c_p^1,...,c_p^m, L_p)$, subject to:

Child j's budget constraint: $\sum_{i=1}^{m} c_j^i = w_j(1-L_j) - t_j$

t_j=0 if w_j<max(w_1,...w_n) & t_j=$t_j(w_j)$ if w_j=max(w_1,...w_n)

On average, the transfer given by child j is

[43] The other two solutions have child k giving, but not child n. However, that requires that child k is much richer than child n.

$$E(t_j)=t_j(w_j)*P(w_j=\max(w_1,...w_n))$$
$$\partial E(t_j)/\partial w_j=(\partial t_j/\partial w_j)*P(w_j=\max(w_1,...w_n))+t_j(w_j)*\partial P(w_j=\max(w_1,...w_n))/\partial w_j$$
$$\partial E(t_j)/\partial w_k=t_j(w_j)*\partial P(w_j=\max(w_1,...w_n))/\partial w_k$$

In other words, child j gives more money when his wages are high, and less money when his siblings earn high wages. Therefore, results for consumption and labor supply are similar to the Nash model.

Appendix 5

Effects of Sample Selection from Emigration to The United States

Lacuesta (2004) reports that approximately 10% of the population born in Mexico currently lives in the United States. The percentage is even higher for working aged men. So, the Mexican census is a selected sample of the total Mexican population, it excludes men who have chosen to leave. This selection could bias the measured effects of education shocks if educations shocks are associated with a higher or lower probability of migration. In fact, I find that men who receive negative education shocks from school calendar changes are less likely to disappear between the 1970 and 2000 Mexican Census, but education shocks from temperature have little impact on the likelihood of disappearance. The difference is likely caused by emigration, because results are similar when I focus on men under 65, who are unlikely to have experienced significant mortality[44].

It is not clear whether emigration increases or decreases average schooling in Mexico. Ibarran and Lubotsky (2005) find that recent migrants typically come from less educated families, but Chiquiar and Hanson (2002) suggest that migrants are more educated than the Mexican population. Regardless of the sign, the differences are relatively small. In the 2000 US Census, white men 20-74 born in Mexico[45] report an average of 8.6 years of education[46], and in the 2000 Mexican census, non-Indian men 20-74 report an average of 7.9 years of education. The true difference in education is probably even smaller: illegal immigrants are both poorly educated and disproportionately missed in the US Census. Because there is so little sample selection, emigration has little effect on average schooling in a cohort.

It is also possible that men who migrate to the United States may be unobservably different in other ways from the general population. For example, Lacuesta (2004) finds that Mexicans who temporarily migrated to the United States earn 10% more a month than otherwise identical men who never left. There may also be differences in labor supply. Comparing the 2000 US Census and the 2000 Mexican Census, I find Mexican-born men currently living in the United States work 8 hours less than Mexicans in Mexico. However, the two labor markets have different norms and the Census ask slightly different questions, so the differences do not necessarily indicate sample selection. A more reasonable explanation is simply that the normal work week is 5 days in the US and 6 days in Mexico.

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[44] It is also possible that the difference results from under-counting or improper weighting by the Mexican Census Bureau.

[45] This includes men who are imputed a Mexican birth.

[46] This is assuming that people have the midpoint for each education range and years of education are reported accurately. Ibarran and Lubotsky (2005) report that men in the US Census often appear to answer the questions inaccurately, biasing education upwards.