Parenting Style and Human Capital

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Abstract

Rules and boundaries regarding leisure activities are very common in households with teenagers. Data from the NLSY97 reveal that when questioned about who sets the limit on how late the respondent can stay out at night, about 67 per cent of the teenagers aged 12-13 in 1997 declare that parents do so, only 2 per cent say that the decision is taken jointly, and 30 per cent that they are allowed to decide. Indeed casual observation tells us that many parents believe that constraints and limits are an important factor for the well-being of their offspring. Other parents are prone to adopt a more self-regulatory parenting method. This observation along with the statistics obtained from the NLSY97 naturally raises the following questions:
i)to what extent can an attentive parenting style and strict discipline contribute to teenagers' skills formation/accumulation ? Or, conversely
ii)Are teenagers raised by permissive and liberal parents likely to be endowed at the beginning of their adulthood with low human capital?

The thought experiment underlying this questions is one in which a teenager is matched with parents with different preferences toward parenting and the results of this re-matches compared. Addressing this issue is complicated by the fact that parenting style and teenagers' behavior and its outcomes are jointly determined. Using data from the NLSY97 I develop and estimate two-period model of parents-teenager interaction with both moral hazard and adverse selection which allows me to perform the above experiment. Preliminary results show that the model is capable of reproducing the main patterns of the data.

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1 Introduction

Parenting a teenager is a challenging task. Many times, upon the observation of bad grades or dangerous behavior, parents wonder and debate if they should respond imposing more limits or giving more chances to their offspring to prove that those were idiosyncratic events. Based on the available information and on how much they dislike to enforce those limits, parents make daily decisions in an effort to increase their teenage son/daughter's chances of success. Indeed casual observation and annedotal evidence tell us that, everything else being the same, parents differ in their approach to parenting. Certain parents dislike setting limits, establish boundaries and eventually punish their teen if rules are broken. Others do not mind to consistently enforce a strict discipline. As a result, ceteris paribus, teenagers' behavior and their outcomes can be quite different.

Wether a self-regulatory and permissive parenting method delivers higher outcomes than a strict one is controversial [1]and the answer probably depends both qualitatively and quantitatively on the preferences and the skills of the teenager. The relationship between teenager's outcomes and parenting style has mostly been investigated by sociologists and experts of child development[2]while it has not been explored by economists. In these disciplines the typical exercise implemented is structured as follows. First, looking at parents' behavior, the researcher establishes the type of the parents using the framework developed by Baumrind (1968). Second, she would regress outcomes on the type of the parents. Such a procedure is unlikely to deliver consistent estimates of the effect of different parenting styles on the outcome of interest because it does not take into account that parent's choices are correlated with unobserved skills/preferences the teenager and parents are endowed with. The comparative static exercise that we would need to perform to achieve such a goal can be described as follows. Holding fixed the characteristics of the teenager let him/her interact with parents endowed with different preferences toward parenting methods than the one she/he had and establish how the outcome of interest would change. Repeating this hypothetical re-match, one could also establish which is the one type of parents that would yield the highest outcome for that specific type of teenager.

Focusing on cognitive skills as the outcome of interest, in this paper I develop and estimate a dynamic (two period) game theoretic model of parents-teenager interaction in which players'choices are jointly determined. Recovering players' preferences as well as the skills' production function parameters, allows me to perform the thought experiment I described.

The model incorporates characterizing aspects of the environment in which parents make decisions about which parenting style to adopt. In particular both players' face a dynamic problem because current skills affect future skills and preferences toward effort. Players' interact more than once and cannot commit to a certain course of actions. Further, although it induces more effort, parents dislike to restrict and regulate teenager's recreational activities. Finally teenagers' time dedicated to produce their own skills is imperfectly monitored by parents (moral hazard), who are uncertain about the motivation of the teenager (adverse selection). This asym-

[1]Although mainly discussing an issue of fairness an historical and famous example of this debate is in the parable of the Prodigal Son in Luke 15:11-32

[2]See the literature section for a summary of their findings

metry of information induces them to make decisions that are, sometimes, ex-post suboptimal[3]. In order to have a sense of the importance of having a dynamic model, it is useful to inspect table 7. The table contains answers from youths born in 1984 to questions regarding who sets limits on three issues: friends, the curfew and TV shows. Three alternative answers are available: 1) I (the youth) decide 2) My parents decide 3) We decide jointly. As we can see parents are less likely to decide when the teenager gets older. This behavior is consistent with the notion that skills are an asset that evolves dynamically: parents set limits at earlier ages because it contributes (indirectly) to the accumulation of human capital (investment-like decision). Moreover in a world in which teenager's effort is positively related to the amount of skills he/she is endowed with, setting limits at earlier ages implies good behavior and no need for a controlling parenting style tomorrow. Along the same lines it is interesting to see how, conditional on having chosen a particular alternative in survey year t , parents change their behavior in $t+1$. We see that, on top of reflecting the age effect we documented, it often happens that parents that in survey year t did not set limits or decided them jointly, find optimal in survey year $t+1$ decide the limits. Roughly speaking, the data reveal transitions from a lenient to a stricter parenting style.

On the one hand this patterns imply that the approach taken by sociologists, according to which parents base their choices only on their own preferences and on the age of the child, is not convincing if one wants to explain some important aspects of the data. On the other, they indicate the need of a model in which parents change their past behavior in both directions when new information becomes available.

Dynamics and asymmetric information are the characterizing aspects of my model. I chose to include those at the price imposed by tractability of abstracting from institutional aspects of the school environment, the decision of attending school and the inclusion of additional state variables. Although it implies certain limitations, I believe that this choice is consistent with the original goal of setting up a tractable model that captures the most salient features of issues parents face when dealing with a teenager. In fact, my model is not designed to quantify the importance of different factors that contribute to youths' educational choices [4]. Rather the model focuses on the interplay between teenagers' human capital accumulation and parental incentives to use non monetary tools.

This paper is organized as follows. Section 2 reviews related literature, section 3 and 4 describe the model and the data. Section 5 talks about estimation. Finally the appendix contains detail about the solution of the model and the parametric assumptions on the primitives.

2 Literature

The channel I focus on in this work is novel to the economic literature, both theoretical and empirical. Indeed in the last few decades the empirical literature mainly focused on the importance of parental resources as opposed to parental traits. There are three papers related to my

[3]This aspect is consistent with the idea that parents sometimes make "mistakes"

[4]One example of such a framework is represented by Eckstein and Wolpin (1999)

work: Weinberg (2001) and Akabayashi (1995) as well as Akabyashi (2006).
In the first paper the author seeks to provide a new mechanism that generates correlation of outcomes between parents and their offsprings. He employs a static (one period) principal agent model with an altruistic parent who promises monetary reward to her kid in case good outcomes are realized. Adding liquidity constraints the author generates intergenerational correlation of incomes. Also he shows that in his model parents with less resources are willing to substitute monetary rewards with physical punishment, which is consistent with what observed in the data. The approach I take departs from Weinberg (2001) in a few aspects. First, even though I only have a two period model, my model is dynamic. Second I do not assume that parents and their offspring can sign binding contracts, as he does[5]. This is particularly important in a dynamic setting in which the behavior of both actors can change substantially if both do not have the possibility of credibly commit to certain actions. My approach seems more closed to casual observation, as we don't often observe courts enforcing informal agreements regarding constraints on the kid's life and/or monetary transfers from parents to them conditional on certain behavior/aperformances being achieved by the kid. Indeed parents are allowed by law to implement any measure they believe is beneficial for the well-being of their offspring, except those that that undermine physical and mental health.
Finally the nature of the link between parents and kids in his model is different than mine. He employs a classic principal agent model in which the principal decides the level of a good/bad that the agent cares about, e.g consumption/corporal punishment. Conversely my model postulates the existence of a strategic complementarity thanks to which parents can affect the action changing their kids' preferences. Choosing no limit implies that the kid cares more about leisure with respect to when parents don't. This implies that even though they cannot commit to any action in the last period they can costly induce the kid to exert more effort. Finally when he includes in the analysis non monetary incentives he interprets those as corporal punishment while I have in mind more generally restrictions and boundaries that parents impose on the kid's daily activities.

In the second paper a theoretical model that explains child maltreatment is built. His dynamic model shows that child maltreatment can arise when parents ignore the kid's human capital. Parents with an initial high estimate of the human capital may tend to underestimate kid's effort, "which results in persistently punitive abusive interactions". There are several differences between my work and his one. First I want to give a quantitative assessment of the impacts of different parenting methods on cognitive skills, whereas Akabayashi only seeks to show that rational, altruistic and forward looking parents can engage into punitive behavior. Second, even though his model is dynamic from the point of view of the parents, it is not dynamic from the point of view of the child, as the latter doesn't take into account the future consequences of her current behavior, i.e. is myopic. In this sense even though, as of now, my model is only functioning with two periods, I go beyond Akabayashi in that I have two forward

[5]A somehow more realistic approach might be represented by allowing the players to employ the so called "relational contracts". However these agreements are based on the assumption that the two players interact forever. The lack of data implies that such an approach is not empirically feasible

looking players. Finally his model is better suited to explain parents-child interaction rather than parents-teenager interaction. In this sense similarly to Weinberg (2001), Akabayashi's parents can choose variables like time spent with the child, spanking, hugs and so forth. Those are conceptually different variables than the one I employ in my analysis.

In sum there are two main different between the existing literature and my work. First this is an empirical study, whereas the others are theoretical models. Second my (two-period) model studies the interaction of two forward looking players, i.e. it is fully dynamic.

Sociology. The greatest body of research on parenting practices has been produced by sociologists and researchers child development. In particular parenting style is a term created by Baumrind (1968). She divides parents into three categories: authoritarian, permissive and authoritative. Authoritative parenting broadly refers to the method used by those parent who enforce their rules, set clear standards, provide consistent discipline that is not overly punitive. Authoritative parenting is also associated to the concept of "flexibility". Parents are flexible when they alter their behavior when appropriate. In contrast authoritarian parenting style is sometimes referred to as the military parenting style. This type of parents puts an emphasis on obedience, and usually has very strict family rules. Authoritarian parenting stifles intellectual growth and creativity. It also encourages children to either rebel against their parents. Finally permissive parents give up most control to their children. Parents make few, if any, rules, and the rules that they make are usually not consistently enforced. They do not set clear boundaries or expectations for their children's behavior and tend to accept however the kid behaves.

Building on this framework sociologists typically implement the following exercise. From the observation of parental behavior, they establish to which category parents belong to. They then regress kids' outcomes on the type of parents. The general result is that authoritative parenting is more likely to deliver positive adolescent outcomes. Obviously this exercise is unlikely to produce consistent estimates about the impact of parenting methods on outcomes because it does not take into account that parents choices might be correlated with unmeasured and heterogenous preferences over parenting methods, with child's preferences/skills as perceived by parents as well as with past history.

The other basic fact documented by sociologists is that socio-economic status is correlated with parenting methods (see Bornstein (1991)). In particular middle-class parents are more likely to choose an authoritative parenting method while in low class households authoritarian parenting is the most common. With respect to my analysis I use parents characteristics as exogenous shifters of their preferences for different parenting method. Of course in the model parents also respond to their beliefs about their kid's preferences/skills.

In sum, with respect to the existing work in other disciplines, the goal of this paper is twofold. First I want to develop an empirically tractable, dynamic game-theoretic model which is able to give some economic content to the framework developed by sociologists taking into account the endogeneity problem described. The second and subsequent one is to use the model to perform the comparative static exercise outlined in the Introduction.

3 The model

The model describes the interaction between two players : the *kid*[6] and *the parents*. Parents are treated as a single decision maker. There are two periods. Periods are calendar years. The kid cares about *knowledge* (G_t) and leisure (l_t). Knowledge should be thought as the set of cognitive skills with which she is endowed . In order to achieve a certain level of knowledge she decides how much time, interpreted as effort, to dedicate to its production. The weight that the she puts on the final level of *knowledge* is private information. Knowledge evolves according to the law of motion $G_{t+1} = G(G_t, e_t, \epsilon_t)$, where $f(G_{t+1}|e_t, G_t)$ denotes the probability distribution of G_{t+1} given an effort level e_t and initial knowledge G_t.

Parents care about the final level of knowledge achieved by the kid at the end of the second period. They can influence the effort level selected by the kid by choosing one of two mutually exclusive alternatives: '*set limits*' or '*no limits*'. I denote by $R_t \in \{0, 1\}$ the choice set and whenever parents choose to set limits this will imply that $R_t = 1$. Parents pay a cost $c > 0$ of setting limits whereas 'no-limits' is a costless option. This is meant to capture that parents dislike exerting control, establishing rules and enforcing rules because such an activity entails a pyschic/monetary cost and/or because they are altruistic.

3.1 Preferences

Denoting by u_t and v_t the flow utility of, respectively, the kid and the parents and expressing the utility in terms of effort we have:

$$u_t = \begin{cases} u(e, R_t) - \Psi(G_t)c(e_t) \ , R_t \in \{0, 1\} & \text{if } t \leq T \\ \alpha_i G_2 \ , i \in \{1 \dots N\} & \text{if } t > T \end{cases}$$

$$v_t = \begin{cases} -I[R_t = 1]c \ c > 0 & \text{if } t \leq T \\ \beta G_2 & \text{if } t > T. \end{cases}$$

In the above specification the marginal utility of leisure is affected by the choice made by parents. I assume that

$$u'(e, R) < 0 \ \text{ and } \ u'(e, 1) < u'(e, 0) \ \ \forall e$$

The first inequality simply tells that utility is decreasing increasing in leisure. The second states that the marginal utility is leisure is lower when parents decide to set limits[7]. In this context *setting limits* incorporates all those restrictions, rules and monitoring practices that parents can impose on the leisure activities performed by the kid which happen to lower their value [8] Further I assume:

- A1) $u''(\cdot) < 0$, $u'''(\cdot) \leq 0$

[6] This term is used to denote a young man or woman aged 12-13 at the beginning of the first period.

[7] $I[\cdot]$ denotes the indicator function. See the appendix for the exact parametrization

[8] The model is therefore silent about the sources of the mechanism that links the parents and the kid, i.e. the fact that setting limits implies that the marginal utility of leisure is lowered.

- A2) $u'(1) = -\infty$ (*Inada* condition)
- A3) $\Psi(G) \geq 0,\ \forall G \in [0, \infty)$
- A4) $\Psi'(\cdot) < 0,\ lim_{G \to \infty} \Psi(G) = 0$
- A5) $c(0) = 0,\ c'(0) = 0,\ c'(\cdot) > 0,\ c''(\cdot) \geq 0,\ c'''(\cdot) \geq 0$

Therefore the kid will condition her optimal effort on current knowledge because the psychic cost of producing it is lowered when current knowledge is higher.

3.2 Technology and MLRP

I assume that the knowledge production function is given by:

$$G_{t+1} = \mathbb{G}(e_t, G_t)\epsilon_t = (\eta_0 + \eta_1 e_t + \eta_2 G_t)\epsilon_t$$

Where I assume that:

- $\eta_0 > 0,\ \eta_1 > 0,\ \eta_2 > 0$
- $\epsilon_t \sim exp(\lambda), \epsilon_t$ i.i.d

Therefore both higher effort and current knowledge (stochastically) increase future knowledge. The idiosyncratic shock ϵ_t represents any i.i.d. factor that affects production. [9] Given the assumption made on the parametric form of the production function, on the sign of the parameters as well as the density of ϵ_t we have that the *monotone likelihood ratio property* holds:

$$\frac{\partial}{\partial G_{t+1}} \left(\frac{f_e(G_{t+1}|e, G_t)}{f(G_{t+1}|e, G_t)} \right) > 0 \quad (MLRP)$$

In words the MLRP property implies that, whenever effort level increases, it is more likely that high levels of knowledge realize. Also note that because $\epsilon_t \in [0, \infty)$ and it is multiplicative, it follows that $prob(G_{t+1} = G^*|e_t, G_t) > 0,\ \forall\ G^* \in [0, \infty), \forall G_t \in [0, \infty), \forall e_t \in [0, 1]$. This fact will imply that Bayes'rule, together with the equilibrium play, is always used by parent update their beliefs

3.3 Information structure, timing

Parents don't know the type α of the kid (*adverse selection*). Moreover they don't observe the effort level exerted by the kid (*moral hazard*) and the realization of the idiosyncratic shock ϵ_t. However the realization of the knowledge G_t is public and it is everything they observe. The stage game is sequential and the order of moves is as follows:

- parents choose R_t
- the kid chooses the effort level

[9] The specification adopted is not the most flexible that one could choose. Even preserving linearity, the results that will be exposed do not necessarily go through if an interaction term eG is included. Thus the restrictions imposed serve for the purpose of making the theoretical analysis tractable

- a shock ϵ is drawn
- knowledge realization becomes public
- parents update their beliefs using Bayes rule

The stage game is played twice. I denote by G_0 the initial level of knowledge at the beginning of period 1 and p_0 the vector with N elements containing the prior over the N types α_i. Analogously p_{t-1} is the vector containing the beliefs over the types at the beginning of period t. I also denote by $\mathcal{H}_t$ the public history at time t so that $\mathcal{H}_0 = G_0$, $\mathcal{H}_1 = \mathcal{H}_0 \times \{R_1, G_1\}$ and so on.

3.4 Strategies and Equilibrium

The game we described falls under the umbrella of finite horizon dynamic stochastic games with incomplete information and imperfect monitoring. A parents' strategy at time t (R_t) is a map from the public history $\mathcal{H}_t$ into an action in their choice set: $R_t : \mathcal{H}_t \rightarrow \{0, 1\}$. A strategy profile for the T-period game $\mathbf{R}^T$ is given by a collection of such a strategy for every period t: $\mathbf{R}^T = \{R_1, R_2, \ldots, R_T\}$. Analogously a time-$t$ strategy for the kid is a map $e_t : \mathcal{H}_t \rightarrow [0, 1]$ and a strategy profile $\mathbf{e}^T = \{e_1, e_2, \ldots, e_T\}$. We can now state the following

Lemma 3.1. *In the last period the only payoff-relevant state variables are G_{T-1} and R_T for the kid and p_{T-1} and G_{T-1} for the parents.*

Proof. The first statement follows immediately from the fact that the G_{T-1} and R_T are the only state variables entering into the last period kid's problem (see below the kid's problem). This is the case because R_T enters into her current utility while G_{T-1} affects future utility. All the other element of $\mathcal{H}_T$ are not relevant to decide the optimal level of effort. Analogously, past actions that parents took only matter in the last period through beliefs. Also past realization of G_t only matters through beliefs if $t < T - 1$. □

Lemma 3.2. *In any period $t \leq T - 1$ the kid conditions the optimal level of effort only on the vector of state variables $S_t = \big(R_t, p_{t-1}, G_{t-1}\big)$. Parents condition R_t only on $S_t^p = \big(p_{t-1}, G_{t-1}\big)$*

Proof. The claim can be proven proceeding backwards. Starting from period $T-1$, after parents have selected R_{T-1}, the kid knows that the only elements that will affect the action taken in T by parents are contained in the vector S_T^p, whose elements depends on S_{T-1}^p and e_{T-1} through Bayes's rule and the production function. On the other hand as in period T, choices parents made prior to $T - 2$ and realization of G different than G_{T-2} enter into her current and future pay-off only through beliefs. Parents anticipate that the kid will only condition e_{T-1} on S_{T-1}^p and for the same reason of the kid they will choose R_{T-1} only conditioning on S_{T-1}^p.
Applying this argument for period $T - 3,\ T - 4, \ldots, 1$ we have the desired claim. □

The lemmas therefore tell us that in general, and in particular for my case of $T = 2$, we can restrict our attention to equilibria in which parents' strategy in the second period is of the form $R_2 : \{G_1, p_1\} \rightarrow \{0, 1\}$ while the kid $e_2 : \{G_1, R_2\} \rightarrow [0, 1]$

3.5 Equilibrium and estimation

The solution concept I adopt is the standard Perfect Bayesian Equilibrium. It is well known that games of incomplete information usually display multiple equilibria. It is also well known that the estimation of models with multiple equilibria is problematic. The approach I take in this work is to i) restrict my attention to a special class of equilibria ii) find sufficient conditions on the primitives such that a particular equilibrium belonging to that class arises. Event though this approach rules out other equilibria, the gain in terms of feasibility of the estimation procedure is substantial. In fact, I know that whenever those sufficient conditions hold, the map from the parameters to the likelihood of the observed events is unique. The cost is that the optimization of the likelihood will be performed on a subset of the parameters' space.

With respect to i) I look at the equilibrium which display two main features

- The kid plays a type monotonic strategy. Type monotonicity (TM henceforth) in this context implies that in both periods, kids that care more about G_2 (higher α) exert more effort
- Parents play a cut-off strategy, i.e. there exists a critical value of G_1 that determines the optimal action to be taken in $t = 2$. In particular parents choose to set limits ($R_2 = 1$) if G_1 is below an endogenously determined cut-off, and select ($R_2 = 0$) otherwise.

Such an equilibrium is therefore such that whenever the kid doesn't perform well she gets punished. At the same time MLRP and TM will imply that whenever parents observe good realization of G_1 beliefs shift up toward better types. [10]

Lemma 3.3. *Whenever the inequalities 1)-3) and assumptions A1)-A5) hold, there exists a unique equilibrium in which parents play a cut-off strategy and the kid adopts a type-monotonic effort strategy. The cut-off strategy is of the form:*

$$R_1^{eq} = \begin{cases} 1 & \textit{if } G_1 < \underline{G} \\ 0 & \textit{otherwise} \end{cases}$$

with $\underline{G} \in [0, \infty)$

In the next few sections I show that the conditions mentioned in the lemma are such that this unique equilibrium arises. The proof is organized as follows. In subsections 3.6 and 3.7 proceeding backwards I show that in both periods, holding fixed the cut-off strategy R_1^{eq} in lemma 3.3, the kid plays a type monotonic strategy. In subsection I show that R_1^{eq} is indeed a best response when TM is adopted by the kid and that the cut-off $\underline{G} \in [0, \infty)$ is uniquely determined.

[10] A more general principal-agent model in which equilibria of this kind are analyzed in described in Banks and Sundaram (1998). In their model the agent is retained when her performance exceeds a critical value, otherwise he is dismissed

3.6 Kid'a problem in period T

We can now write the problem of the kid of type α_i in the last period for a given strategy adopted by parents, after the realization of G_1:

$$max_{e\in(0,1)} u(e,R) - \Psi(G)c(e) + \delta\alpha_i \int_0^\infty \mathbb{G}(e,\epsilon)f(\epsilon)$$

The problem is concave in e. The objective function is differentiable in e therefore we can use the $K-T$ conditions to characterize the optimal solution. Omitting time-index we get:

$$T(G,e,R) = u'(e,R) - \Psi(G)c'(e) + \delta\alpha_i \int_0^\infty \mathbb{G}'(e,\epsilon)f(\epsilon) = 0$$

For future purposes we can now see that in order to rule out a corner solution at 0 we need to make sure that $T(G,0,R) > 0$ for all G,R,α_i. Under our parametric assumptions on $u(\cdot,\cdot)$ and $c(\cdot)$, this is the case if:

$$\delta\alpha_i\eta_1\mathbb{E}[\epsilon] > R \Leftrightarrow \lambda R < \delta\eta_1\alpha_i$$

In order for the above to hold for all G,R,α_i we need:

$$\lambda\overline{R} < \delta\eta_1\alpha_1 \tag{1}$$

Characterization of the optimal effort

We can now use the implicit function theorem to characterize the optimal solution. In particular we can see that:

$$\frac{\partial e}{\partial G} = -\frac{\frac{\partial T}{\partial G}}{\frac{\partial T}{\partial e}} = \frac{\psi'(\cdot)c'(\cdot)}{u''(e,R) - \psi(G)c''(\cdot) + \delta\alpha_i \int_0^\infty \mathbb{G}''(e,\epsilon)f(\epsilon)} > 0$$

$$lim_{G\to\infty} \frac{\partial e(G,R)}{\partial G} = 0$$

$$\frac{\partial e}{\partial \alpha_i} = -\frac{\frac{\partial T}{\alpha_i}}{\frac{\partial T}{\partial e}} = -\frac{\delta \int_0^\infty \mathbb{G}'(e,\epsilon)\epsilon f(\epsilon)}{u''(e,R) - \psi(G)c''(\cdot) + \delta\alpha_i \int_0^\infty \mathbb{G}''(e,\epsilon)f(\epsilon)} > 0$$

3.7 Kid's problem in period $T-1$

We now proceed to characterize the optimal effort level when parents play a cut-off strategy with cut-off $\underline{G} \in (0,\infty)$. The other two cases in which parents choose as optimal cut-off 0 or ∞ are special cases in which the kid knows that no matter what the realization of knowledge after the first period is parents do not set limits and do set limits, respectively. In the case in which the cut-off is finite we can back out from the production function the critical value of the shock ϵ_{T-1} which given an effort level e and the current state G, allows the kid to fall above $\underline{G}$. I denote such a critical value by $\underline{\epsilon}(e,G)$. For ease of notation I denote by G' the realization of knowledge at the end of period $T-1$ and I omit all the time indexes. We can now write down the problem of the kid in $T-1$:

$$V(G,R) = max_{e\in(0,1)} u(e,R) - \psi(G)c(e) + \delta \int_0^{\underline{\epsilon}(e,G)} V(G',1)f(\epsilon) + \delta \int_{\underline{\epsilon}(e,G)}^\infty V(G',0)f(\epsilon)$$

The objective function of the kid in $T-1$ is differentiable in e. This is a consequence of the differentiability of $V(G', R)$ and $\underline{\epsilon}(e, G)$. Notice that e_{T-1} also enters in $\underline{\epsilon}(e, G)$ therefore we can use the Leibneiz' rule to differentiate the objective function with respect to e.Also because the shock is multiplicative and belongs to $[0, \infty)$ it is always the case that there is a positive probability, for any possible $e \in [0, 1]$, to fall below or above any given cut-off $\underline{G} \in (0, \infty)$. Therefore the objective function is continuous in e. The Kuhn-Tucker conditions for the problem are given by:

$$T(e, G, R) = u'(e, R) - \psi(G)c'(e) + \delta[\int_0^{\underline{\epsilon}(e,G)} \frac{\partial V(G', 1)}{\partial G'} \frac{\partial G'}{\partial e} f(\epsilon) + \int_{\underline{\epsilon}(e,G)}^{\infty} \frac{\partial V(G', 0)}{\partial G'} \frac{\partial G'}{\partial e} f(\epsilon)] + \delta \frac{\partial \underline{\epsilon}(e, G)}{\partial e} f(\underline{\epsilon}(e, G))[lim_{G' \to \underline{G}^-} V(G', 1) - V(\underline{G}, 0)]$$

Given the parametrization adopted for the knowledge production function we have that:

$$\underline{\epsilon}(e, G) = \frac{\underline{G}}{\mathbb{G}(e, G)}$$

Because our assumptions on $\mathbb{G}$ we can rewrite the above expression as follows:

$$T(e, G, R) = u'(e, R) - \psi(G)c'(e) + \delta[\int_0^{\underline{\epsilon}(e,G)} \frac{\partial V(G', 1)}{\partial G'} \eta_1 \epsilon f(\epsilon) + \int_{\underline{\epsilon}(e,G)}^{\infty} \frac{\partial V(G', 0)}{\partial G'} \eta_1 \epsilon f(\epsilon)] - -\delta \frac{\underline{G}\eta_1}{(\mathbb{G}(e, G))^2} f(\underline{\epsilon}(e, G))[lim_{G' \to \underline{G}^-} V(G', 1) - V(\underline{G}, 0)]$$

The above is a non linear equation in e_{T-1} which can be solved using standard methods.

Lemma 3.4. *Whenever the following inequality holds the objective function of the kid in $T-1$ is concave in e:*

$$2[\mathbb{G}(0, 0)]^2 = 2\eta_0^2 > \lambda G^* \tag{2}$$

Where $G^\star$ denotes the highest possible (finite) cut-off the parents may choose[11]

Proof. The second derivative of the objective function of the kid is given by:

$$\frac{\partial T}{\partial e} = u''(e, R) - \psi(G)c''(e) + \delta^2[\int_0^{\underline{\epsilon}(e,G)} \frac{\partial V(G', 1)}{\partial G'} \mathbb{G}''(\cdot)\epsilon f(\epsilon) + \int_{\underline{\epsilon}(e,G)}^{\infty} \frac{\partial V(G', 0)}{\partial G'} \mathbb{G}''(\cdot)\epsilon f(\epsilon)] + \delta[\int_0^{\underline{\epsilon}(e,G)} \frac{\partial V(G', 1)}{\partial G' \partial G'} (\eta_1 \epsilon)^2 f(\epsilon) + \int_{\underline{\epsilon}(e,G)}^{\infty} \frac{\partial V(G', 0)}{\partial G' \partial G'} (\eta_1 \epsilon)^2 f(\epsilon)]$$
$$\delta[\underbrace{\frac{\partial \underline{\epsilon}(e, G)}{\partial e^2}}_{>0} f(\underline{\epsilon}(e, G)) + \underbrace{\frac{\partial \underline{\epsilon}(e, G)^2}{\partial e}}_{>0} \underbrace{f'(\underline{\epsilon}(e, G))}_{<0})] \underbrace{[lim_{G' \to \underline{G}^-} V(G', 1) - V(\underline{G}, 0)]}_{<0} + \delta \underbrace{\frac{\partial \underline{\epsilon}(e, G)}{\partial e}}_{<0} f(\underline{\epsilon}(e, G))\underline{\epsilon}(e, G) \underbrace{[lim_{G' \to \underline{G}_-} \frac{\partial V(G', 1)}{\partial G'} - \frac{\partial V(\underline{G}, 0)}{\partial G'}]}_{>0} < 0$$

Because the value function is concave in G we can see that whenever the following inequality holds the claim is true:

$$\underbrace{\frac{\partial \underline{\epsilon}(e, G)}{\partial e^2}}_{>0} f(\underline{\epsilon}(e, G)) + \underbrace{\frac{\partial \underline{\epsilon}(e, G)^2}{\partial e}}_{>0} \underbrace{f'(\underline{\epsilon}(e, G))}_{<0} > 0$$

[11] This value can be computed solving the problem of the kid of type N, and constructing the gain from setting limits in the last period

where:

$$\frac{\partial \underline{\epsilon}}{\partial e} = \frac{-\underline{G}\eta_1}{(\mathbb{G}(e,G))^2}$$
$$\frac{\partial \underline{\epsilon}}{\partial \epsilon^2} = \frac{\underline{G}2\eta_1^2}{(\mathbb{G}(e,G))^3}$$

Given our assumption on the density of the shock we get that a sufficient condition for the global concavity of the problem is given by:

$$\frac{\partial \underline{\epsilon}}{\partial \epsilon^2} = \underline{G}\frac{2\eta_1^2}{\mathbb{G}(e,G)^2} > \lambda \underline{G}^2 \frac{\eta_1^2}{\mathbb{G}(e,G)^3} \Leftrightarrow 2[\mathbb{G}(e,G)] > \lambda \underline{G}$$

Taking the minimum of the LHS with respect to e and G and the maximum of the RHS with respect to $\underline{G}$ we get the inequality in the lemma. □

We now need to show that: $\frac{\partial e_{T-1}}{\partial \alpha_i} > 0$. This can be done using the implicit function theorem. We only need to calculate

$$\frac{\partial T(\cdot)}{\partial \alpha_i} = \delta[\int_0^{\underline{\epsilon}(e,G)} \frac{\partial V(G',1)}{\partial G' \partial \alpha_i}\eta_1 \epsilon f(\epsilon) + \int_{\underline{\epsilon}(e,G)}^{\infty} \frac{\partial V(G',0)}{\partial G' \partial \alpha_i}\eta_1 \epsilon f(\epsilon)] +$$
$$\delta \underbrace{\frac{\partial \underline{\epsilon}(e,G)}{\partial e}}_{<0} f(\underline{\epsilon}(e,G))[lim_{G' \to \underline{G}^-} \frac{\partial V(G',1)}{\partial \alpha_i} - \frac{\partial V(\underline{G},0)}{\partial \alpha_i}]$$

Now:

$$\frac{\partial V(G',1)}{\partial \alpha_i} - \frac{\partial V(\underline{G},0)}{\partial \alpha_i} = \delta \int_0^{\infty} [\mathbb{G}(e(G,1),G) - \mathbb{G}(e(G,0),G)]\epsilon f(\epsilon) > 0$$

and:

$$\frac{\partial V(G',R)}{\partial G' \partial \alpha_i} = \delta \eta_2$$

We can write the above expression as follows:

$$\frac{\partial T(\cdot)}{\partial \alpha_i} = \delta^2 \eta_2 \int_0^{\infty} \mathbb{G}'(e,\epsilon)\epsilon f(\epsilon) + \delta^2 \frac{\partial \underline{\epsilon}(e,G)}{\partial e} f(\underline{\epsilon}(e,G)) \int_0^{\infty} [\mathbb{G}(e(\underline{G},1),G) - \mathbb{G}(e(\underline{G},0),G)]\epsilon f(\epsilon)$$

Lemma 3.5. *Whenever the following inequality holds type monotonicity holds:*

$$\eta_2 > \eta_1 exp(-\frac{1}{\lambda})\frac{1}{\lambda^3} \tag{3}$$

Proof. In order to have that $\frac{\partial e}{\partial \alpha_i} > 0$ it suffices to show that $\frac{\partial T}{\partial \alpha_i} > 0$ given that $\frac{\partial T}{\partial e} < 0$ Given that we assumed $\mathbb{G}''(\cdot) = 0$ we have that :

$$\frac{\partial T}{\partial \alpha_i} > 0 \Leftrightarrow \eta_2 \eta_1 \mathbb{E}[\epsilon] > \frac{\eta_1 \underline{G}}{(\mathbb{G}(e,G)^2} f(\frac{\underline{G}}{\mathbb{G}(e,G)}) \int_0^{\infty} [\mathbb{G}(e(\underline{G},1),\epsilon) - \mathbb{G}(e(\underline{G},0),\epsilon)] f(\epsilon) \Leftrightarrow$$
$$\eta_2 \eta_1 \mathbb{E}[\epsilon] > \frac{\eta_1 \underline{G}}{(\mathbb{G}(e,G)^2} f(\frac{\underline{G}}{\mathbb{G}(e,G)}) \eta_1 \mathbb{E}[\epsilon] \Leftrightarrow \eta_2 > \frac{\eta_1 \underline{G}}{(\mathbb{G}(e,G)^2} f(\frac{\underline{G}}{\mathbb{G}(e,G)})$$

where the second inequality comes from the fact that we set $e(\underline{G},1) = 1$ and $e(\underline{G},0) = 0$. The RHS of the inequality is function of endogenous variables. Let's call $x = \underline{G}$ and $y = \mathbb{G}(e) + g(G))$ and let's interpret the RHS as a function g of x and y. We can therefore maximize the function $g(x,y)$ with respect to its arguments (it is easy to check that g is concave in x and y). Given that $f(\cdot)$ is an exponential with parameter λ it is easy to check that g is maximized when $x = 1/\lambda$ and $y = \lambda$. Plugging this values into the last inequality we get the bound in the lemma □

3.8 Parents's best response

Given the above strategies we want to check that the best response adopted by the parents in the last period takes indeed the form of a cut-off one. Let G_{T-1} be the state variable at the beginning of the last. After having selected a certain R_{T-1} in the previous period, in the last period parents will solve the following problem:

$$max_{R_2 \in \{1,0\}} \{\mathbb{E}[W(G_T|1] - c, \mathbb{E}[W(G_T|0]\}$$

we omitt the time index and the dependence of the kids' strategies and of and parents' payoff and beliefs on G_{T-1}. We can now rewrite the problem parents face as choosing:

$$max\{\Pi_T(G_{T-1}), c\}$$

Let $p^i_{T-1}(G_{T-1})$ denote the posterior probability of the kid being type i at the beginning of period T after the generic action R_{T-1} was selected in the previous period. We denote by $\Pi_T(G_{T-1})$ the following function:

$$\Pi_T(G_{T-1}) = \sum_i p^i_{T-1}(G_{T-1}) \underbrace{[\mathbb{E}[W(G_T|1;\alpha_i)] - \mathbb{E}[W(G_T|0;\alpha_i)]]}_{\Gamma(G_{T-1}|\alpha_i)}$$

Therefore $\Pi_T(G_{T-1})$ is a weighted average of the gain from setting limits conditional on being type α_i ($\Gamma(G_{T-1}|\alpha_i)$) with weights given by the beliefs on the kid being of type α_i. We can now state the following lemma:

Lemma 3.6. *Under our parametric assumptions* $\Gamma(G_{T-1}|\alpha_i)$ *is strictly decreasing in* $G_{T-1}, \forall i$

Proof. We have that

$$\Gamma'(G_{T-1}) \propto \int_0^\infty \mathbb{G}'(e(G,1),\epsilon) f(\epsilon) e'(G,1) - \int_0^\infty \mathbb{G}'(e(G,0),\epsilon) f(\epsilon) e'(G,0) \propto e'(G,1) - e'(G,0)$$

Having in mind that $\mathbb{G}''(\cdot) = 0$ we can now check that $e'(G,1) < e'(G,0)$:

$$e'(G,1) < e'(G,0) \Leftrightarrow \frac{\Psi'(\cdot)c'(e(0)}{u''(e(0),0) - \psi(G)c''(e(0))} > \frac{\Psi'(\cdot)c'(e(1)}{u''(e(1),1) - \psi(G)c''(e(1))]}$$
$$\Leftrightarrow \Psi'(\cdot)c'(e(0)[u''(e(1),1) - \psi(G)c''(e(1))] > \Psi'(\cdot)c'(e(1)[u''(e(0),0) - \psi(G)c''(e(0))]$$

The above inequality can be reverted because $\Psi'(\cdot) < 0$. We can now check that:

$$c'(e(0) \overbrace{[u''(e(1),1) - \psi(G)c''(e(1))]}^{A} < c'(e(R)1 \underbrace{[u''(e(0),0) - \psi(G)c''(e(0))]}_{B}$$

From our assumptions we have that $c'(e(0) > c'(e(0)$ because $c''(\cdot) > 0$. We can now see that under our assumptions $A < B < 0$ so that the inequality holds:

$$u'''(\cdot) < 0 \Rightarrow u''(e(1),1) < u''(e(0),0) < 0$$
$$c'''(\cdot) \geq 0 \Rightarrow -\psi(G)c''(e(1)) \leq -\psi(G)c''(e(0)) < 0$$

Therefore under our assumptions the gain of setting limits is strictly decreasing in the state variable G_{T-1}

□

Corollary 3.7. *As $G_{T-1} \to \infty$ the gain of setting limits becomes flat, i.e* $lim_{G_{T-1}\to\infty}\Gamma(G_{T-1}|\alpha_i) = \underline{\Gamma}^i$

Proof. This is a result of the fact that we assumed that $lim_{G\to\infty}\Psi(G) = 0$ which implies that:

$$lim_{G\to\infty}\frac{\partial e(G,R)}{\partial G} = 0$$

□

Lemma 3.8. *Under our assumptions the gain of setting limits, is decreasing in the type α_i*

Proof. We now want to show that $\Gamma(G_{T-1}|\alpha_i) < \Gamma(G_{T-1}|\alpha_j)$, $\forall \alpha_j < \alpha_i$, $\forall$ G_{T-1}. In order to do so it suffices to show that

$$\frac{\partial\Gamma(G_{T-1}|\alpha_i)}{\partial\alpha_i} < 0 \Leftrightarrow \int_0^{\infty}\mathbb{G}'(e(1,\alpha_i)),\epsilon)\frac{\partial e(1,\alpha_i)}{\partial\alpha_i}f(\epsilon) - \int_0^{\infty}\mathbb{G}'(e(0,\alpha_i),\epsilon)\frac{\partial e(0,\alpha_i)}{\partial\alpha_i}f(\epsilon) \propto \frac{\partial e(1,\alpha_i)}{\partial\alpha_i} - \frac{\partial e(0,\alpha_i)}{\partial\alpha_i} < 0$$

We can see that:

$$\frac{\partial e(1,\alpha_i)}{\partial\alpha_i} < \frac{\partial e(0,\alpha_i)}{\partial\alpha_i} \Leftrightarrow -\frac{\int\mathbb{G}'(e(0))\epsilon f(\epsilon)}{u''(e(0),0)-\psi(G)c''(e(0))} > -\frac{\int\mathbb{G}'(e(1)\epsilon f(\epsilon)}{u''(e(1),1)-\psi(G)c''(e(1))} \Leftrightarrow \underbrace{u''(e(0),0)-\psi(G)c''(e(0))}_{B} > \underbrace{u''(e(1),1)-\psi(G)c''(e(1))}_{A}$$

As in the previous lemma the above inequality holds under our parametric assumptions.

□

We can now characterize the optimal strategy of the parents after any history G_{T-1} and associated beliefs $p(G_{T-1})$.

Corollary 3.9. *After any given action chosen in the last but one period, the gain of setting limits in the last period is strictly decreasing in G_{T-1}*

Proof. Analogously to Banks and Sundaram (1998) for any $G_{T-1} > \overline{G}_{T-1}$ let $p(i)$ and $p(\bar{i})$ the beliefs placed on the kid being of type i after witnessing G_{T-1} and $\overline{G}_{T-1}$, respectively. Then it follows that p stochastically dominates $\overline{p}$, in the sense that for any $l \in \{1,\dots N\}$ it is the case that:

$$\sum_{k=l}^{N}p(\overline{k}) > \sum_{k=l}^{N}p(k) \quad (\star)$$

This means that when higher level of knowledge are realized, beliefs shift toward higher types. To see why this result holds we need to show that, for any given l:

$$\frac{\sum_{j=l}^{N}\pi_j\varphi(G|e_j)}{\sum_{i=1}^{N}\pi_i\varphi(G|e_i)} \geq \frac{\sum_{j=l}^{N}\pi_j\varphi(\overline{G}|e_j)}{\sum_{i=1}^{N}\pi_i\varphi(\overline{G}|e_i)}$$

where π_i, $\forall i = 1,\dots,N$ denotes the prior on the kid being of type i and $\varphi(G|e_i)$ denotes the probability of observing G conditional on the the effort level chosen by type i. We can now rewrite the following expression as follows:

$$\sum_{j=l}^{N}\pi_j\varphi(G|e_j)[\sum_{i=1}^{l-1}\pi_i\varphi(\overline{G}|e_i)+\sum_{i=l-1}^{N}\pi_i\varphi(\overline{G}|e_i)]\geq\sum_{j=l}^{N}\pi_j\varphi(\overline{G}|e_j)[\sum_{i=1}^{l-1}\pi_i\varphi(G|e_i)+\sum_{i=l-1}^{N}\pi_i\varphi(G|e_i)]\Leftrightarrow$$

$$\sum_{i=1}^{l-1}\sum_{j=l}^{N}\pi_i\pi_j\varphi(G|e_j)\varphi(\overline{G}|e_i)+\sum_{i=l}^{N}\sum_{j=l}^{N}\pi_i\pi_j\varphi(\overline{G}|e_i)\varphi(G|e_j)\geq$$

$$\sum_{i=1}^{l-1}\sum_{j=l}^{N}\pi_i\pi_j\varphi(\overline{G}|e_j)\varphi(G|e_i)+\sum_{i=l}^{N}\sum_{j=l}^{N}\pi_i\pi_j\varphi(G|e_i)\varphi(\overline{G}|e_j)$$

Canceling common terms the inequality becomes:

$$\sum_{i=1}^{l-1}\sum_{j=l}^{N}\pi_i\pi_j\varphi(G|e_j)\varphi(\overline{G}|e_i)\geq\sum_{i=1}^{l-1}\sum_{j=l}^{N}\pi_i\pi_j\varphi(\overline{G}|e_j)\varphi(G|e_i)$$

We can now know that:
i) because of type-monotonicity $e_j \geq e_i, \forall j > i$
ii) because of the monotone likelihood ratio property $\varphi(\overline{G}|e_j)\varphi(G|e_i) \geq \varphi(\overline{G}|e_i)\varphi(G|e_j)$

It follows that ($\star$) holds.

It is now easy to see that $\Pi_T(G_{T-1})$ is decreasing in G_{T-1} because of i) and ii). Consider the two-types case. We need to show that:

$$\frac{\partial\Pi_T(G_{T-1}}{\partial G_{T-1}}=\frac{\partial}{\partial G_{T-1}}[1-p_{T-1}(G_{T-1})\Gamma_1(G_{T-1})+p_{T-1}(G_{T-1})\Gamma_2(G_{T-1}]<0$$

We can easily see that:

$$\frac{\partial\Pi_T(G_{T-1}}{\partial G_{T-1}}=\underbrace{p'_{T-1}(G_{T-1})}_{X}\underbrace{[\Gamma_2(G_{T-1})-\Gamma_1(G_{T-1})]}_{Y}+(1-p_{T-1}(G_{T-1}))\Gamma'_1(G_{T-1})+p_{T-1}(G_{T-1})\Gamma'_2(G_{T-1})<0$$

Now because of corollary 2.6 $X > 0$. Moreover because of lemma 2.5 $Y < 0$. Finally because of lemma 2.4 $\Gamma_2(G_{T-1})$ and $\Gamma_1(G_{T-1})$ are negative.
The argument is intuitive when we refer to its geometrical interpretation. Essentially given any $G_1 < G_2$, consider the convex combination in the set $[\Gamma_2(G_1), \Gamma_1(G_1)]$ using weight $p(G_1)$. It has to be the case that its value is greater with respect to the convex combination in the set $[\Gamma_2(G_2), \Gamma_1(G_2)]$ because i) both the lower bound and the upper bound are decreasing ii) we put more weight on the lower bound.
The same argument can be drawn for the N-types case. Consider again the average of the points $\Lambda(G_1) \equiv \{\Gamma_N(G_1), \Gamma_{N-1}(G_1), \ldots, \Gamma_1(G_1)\}$ with weights $\Sigma(G_1) \equiv \{p_N(G_1), p_{N-1}(G_1), \ldots, p_1(G_1)\}$. Then obviously its value will be greater then the average of the points $\Lambda(G_1) \equiv \{\Gamma_N(G_2), \Gamma_{N-1}(G_2), \ldots, \Gamma_1(G_2)\}$ using $\Sigma(G_1)$ because $\Gamma_i(G_1) > \Gamma_i(G_2), \quad \forall i$. This fact is even more true when we apply the corresponding weights because type monotonicity implies $\Sigma(G_2)$ stochastically dominates $\Sigma(G_1)$.

□

Lemma 3.10. *After any action taken in the first period, in the last (decision) period parents adopt the following cut-off strategy:*

$$R_T = \begin{cases} 1 & \text{if } G_{T-1} \leq \underline{G} \\ 0 & \text{if } G_{T-1} > \underline{G} \end{cases}$$

Proof. The claim follows immediately from the previous corollary and corollary 2.4. We know that when $G_{T-1} = 0$ parents will average the set of points $\Lambda(0)$ using the beliefs $\Sigma(0)$. Defining $\Gamma^{\star}(G, R)$ the gain from setting limits after G realized and R was chosen in the first period we can distinguish 3 cases:

1. $c > \Gamma^{*}(0, R) \Rightarrow \underline{G} = 0$
2. $c < lim_{G\to\infty}\Gamma^{*}(G, R) \Rightarrow \underline{G} = \infty$
3. $\Gamma^{*}(0, R) < c < lim_{G\to\infty}\Gamma^{*}(G, R) \Rightarrow \underline{G} \in (0, \infty)$

The first two cases express the case in which parents have a dominant strategy in the second period. In the first independently on the realization of G_{T-1} it is never optimal to set limits. In the second case it is always optimal to set limits. Finally in the third case the equilibrium cut-off is such that, given the current G and any effort level, falling above it is a non measure zero event. □

4 Data, Descriptive Statistics and Patterns

The National Longitudinal Studies of Youth 1997 is the most recent of the National Longitudinal Surveys (NLS) programs. The survey provides information about youth living in the Unites States born during the years 1984 through 1980. The original sample contains 8,984 individuals living in 6,819 households. In particular 1,862 households originated more than one respondent and the most common relationship between multiple respondent was that of siblings. The interviews were conducted annually and as of now there are 9 waves available, ranging from 1997 to 2005. The initial sample is over represented by Blacks and Hispanics, and consists of roughly 50 percent of boys.

In each survey round, the *Youth Questionnaire* is administered to every respondent. The topics covered range from youth's schooling to employment activities. Many other information about the respondent's family background are also available. In the first round the *Parent questionnaire* collected information from one of the youth's biological parent.[12] For my purposes I retain in my sample only youths born in 1984 independently of ethnicity and sex. Such a sample is populated by 1711 individuals who were attending grades 6 to 9 a the time of the first interview (see table 2 for the exact distribution as well as the one referred to the born in 1983). The reason of such a restriction is that the variables in the *Autonomy/Parental control* section (described below) are available only for those born in 1983 and 1984. Moreover I do not consider the 1983 cohorts so that average age of the sample is more homogenous. This is important because the model postulates that parents have the same prior in period 1. Obviously adding kids that are older would most likely violate this assumption. I abstract from the

[12] For detailed information about the topics covered in the *Parent's questionnaire* and the *Youth Questionnaire* see the NLSY97 guide

grade attended also because grade progression at this stage is nearly universal (see table 1 to see which of the variables needed are available for each cohort).
The nature of the endogenous variables of the model described in the previous section is intrinsically latent. By this we mean that only noisy measures of them are available or, in other words, that we need to use proxies. In particular we have three endogenous variables:

- *limits-no limits*
- *knowledge*
- *effort*

As described in the model parents can change the effort level of the kid ”setting limits”. This term is borrowed from the label of some of the variables contained in the *Autonomy/Parental control* section of the NLSY97. In each round respondents born in 1983 and 1984 are asked about the person or people who make decisions concerning three of their activities: i) how late they may stay out at night ii) the kind of TV shows or movies they may watch, and iii) who they are allowed to “hang out” with. Three alternative responses for each questions are available:

1. PARENT OR PARENTS SET LIMITS
2. PARENTS LET ME DECIDE
3. MY PARENTS AND I DECIDE JOINTLY

For each of this limit it is reported if the decision is made only by the respondent, by the the respondent jointly with his/her parents or only by the parents. [13]

A follow up question asks about the number of times the respondent broke the rules in the last month, as well what kind of consequence (if any) there would be if they had found out that the respondent had violated the rules and which person would implement the (eventual) punishment . Importantly in the *Parent questionnaire* responding parents of youths born in 1983 and 1984 are asked the same set of questions in order to have a sense of how much these responses were reflecting an objective situation. From now on I will refer to period 1 as the first survey round (1997), to period 2 as the second survey round and so forth.
Given that in the first round we have data for both we can compare how much the responses of the youth differ from those of the responding paren. As for the curfew limit, as we can see from table 3, in roughly 66 per cent of cases (sum of numbers on the diagonal) the parent and the youth agree on the person(s) who does so. A big part of the disagreement (25 per cent) on the answer is given by the fact that the parent declares that he sets the limits whereas the youth declares he/she does. Inspecting tables 4 and 5 for the TV and friends limits, we see that answers do not match in 43.52 and 41.32 per cent of the cases (sum of elements off the diagonal). The bulk of the mismatch comes from the youth (parent) declaring the the limit is decided jointly while the parent(kid) declares that he/she decides him/herself. Therefore given that overall the mismatch between categories that conceptually differ more (one actor declaring

[13] From now on I will refer to those variables as the “limits variables” and to the limits of type i) as the curfew-limit, of type ii) as the TV limits and to limits in iii) as to the friends limits

that he/she sets the limits or that the other does, while the other reporting the opposite[14]), having to use solely the responses of the youth doesn't seem to be an undermining limitation for the analysis.

It also useful to check to what extent parents enforce those limits and make sure that rules are not systematically violated. As we can see from table 6 the majority of youths do not violate the curfew in the first round survey (when the cohort of the born in 1984 is 13 years old), but the propensity to do so increases with age. Moreover youths are more likely to break friends and TV limits. However it is the case that the majority of them violates those limits only once in the month prior to the interview date. What this statistics tell us is that most of the time parents make sure that agreed or imposed rules are respected.[15] Having said that in using them I have well in mind that they only are indicative of how much control parents are exerting and that taking them literally is not a sensitive choice [16] .

Table 8 documents a substantial difference, conditional on race [17], in parents' propensity to set curfew/friends limits. In particular when the youth is black there is a 75 per cent probability that parents set limits versus 67/65 for Hispanic and white youths[18]. This pattern persists for the friends limits while is not there for the TV limits. As it is well known that Blacks have an higher probability of living in dangerous neighborhoods and achieve lower education this correlation is consistent with the well-known positive association between low socio-economic status and stricter parenting methods. As we can see from the table the difference in behavior conditional on race is mitigated as the youth gets older.

Further there is no substantial difference in parents behavior conditional on the sex of the youth, as Table 9 documents. This indicates that outcomes that are gender specific, e.g. unwanted pregnancies, are not of first order in shaping parents' choices about limits and boundaries. Perhaps surprisingly, the data do not reveal much correlation between parenting choices and parents education. More striking is the correlation with parents' gross income, self reported in the *Parents Questionnaire*. As we can see from table 10 the average yearly gross income of parents that decide on the curfew and on the TV shows together with the youth ($37859 and $37664) is higher than those who let the kid decide ($25900 and $30175) or decide themselves on this issues ($31139 and $33942). This is not true for the friends limits in which the highest average income is earned by parents that let the kid decide($40330 versus $31509 for parents who decide and $24544 for parents that decide jointly). Again this correlation seems to point out that in richer households youths have an higher degree of autonomy and parents are more

[14]this happens in 16, 13 and 2 per cent of the cases for the curfew, TV and friends limits respectively

[15]Another set of variables I could have used come from the reported punishment the kid would have to suffer in case he/she was caught violating the limits. However, even though they exhibit enough variation across households I chose not to include those to proxy for parenting style because they are not correlated with the probability of breaking the limits.

[16]In reality parents set limits on a much higher number of activities, e.g. the use of drugs/alchol, car, telephone and so on. Even if all of them were available a model in which parents choose all of them would be most likely unfeasible. At the same time each of the available variables tell us something about how much the life of the youth is regulated by parents restrictions

[17]Most likely parents are of the same race of the respondent. Difference in race in the NLSY97 is limited to roughly 4 per cent of the cases

[18]I define white whoever does not belong to Black or Hispanic ethnicity

prone to adopt an non-authoritarian parenting style. For the purpose of our analysis these facts imply that relating parent's cost of setting limits to some of their observable characteristics is consistent with the data.

With respect to parents' behavior the heart of this analysis lies in their **dynamic behavior**. Few interesting facts can be outlined. First as can be seen from table 7, for the 1984 cohort, there is variation across households in the responses for all the type of limits. The magnitude of this variation however differs depending on the type of limit we consider. For example, if we pick the TV limits in period 1, we can see the same proportion of parents chooses each of the three options. Moreover, at every age of the youth, the type of limits parents are more likely to set are those on how late he/she can stay out at night, followed by the TV limits and friends limits. The biggest difference in period 1 (age 12-13) occurs between the proportion of parents setting the curfew vs the proportion of parents choosing the friends: 67.89 versus 23.89. This presumably indicates that parents feel that setting an upper bound on the amount of leisure is more important than avoiding the interaction with unwanted peers and/or that setting the first type of limit entails a lower cost.
Second, there is an age effect, i.e. for each of the three activities the kid is more likely to decide as he/she gets older. Interestingly though, this is not true for the friends limits in period 4-5. As table 7 reveal, more parents are setting limits in period 5 than period 4. Our the model has built in two mechanisms that are consistent with the existence of the age effect we observe in the data. First, abstracting from the asymmetric information environment we described, because of the finite horizon parents have incentive to 'invest' in limits earlier because this will increase on average the amount ok skills the kid is endowed with in the second period. Second, as we showed, in the second period effort is increasing. Therefore, everything else being the same, parents will be less likely to find optimal to set limits in the second period, i.e. they may be willing to trade limits today with no limits tomorrow. This behavior can be thought as "dynamic production function": parents will induce the kid to 'behave' well when he/she is younger as they know that, if endowed with enough human capital, he/she will "behave well" when older without need of any restriction and limit.
Along these lines it is important to learn to what extent parents switch from one option to the others, for all the three type of limits. We can than look at the **transitions** through time of the limits-variables If we inspect table 11 as we mentioned we see that parents have lower probability of deciding limits in period 2 of the model. However relatively often it also happens that parents that were not setting limits or deciding them jointly with the youth in period 1 find optimal to set limits in period 2 . For example with respect to the curfew limits almost 35 (41) per cent of the parents who were letting the kid decide (jointly decide) on this issue in the first round, find optimal to decide the limits in the following one. Therefore if we are willing to order our responses to capture the latent variable 'parental control' as follows : *kid-jointly-parents*, we conclude that parents often switch from a '*lenient*' to a '*tougher*' parenting method. This regularity is common to the friends limits and of the TV limits. In both cases roughly 25 percent of the kid who were deciding on it in 1997 declare in 1998 they are no longer doing so. Analogously of those who were deciding together with parents, 41 per cent declare

that parents are deciding in 1998 on the curfew, 12 and 15 on the friends on the TV shows they can see, respectively. Transitions in periods 2-3 for all of the kind of limits also display these kind of switches. If we link these facts to our analysis, we seek to explain those transitions positing a positive relationship between the probability that parents engage in less controlling parenting style with improvements in the human capital the kid achieves in the second period. Conversely setbacks are (eventually) punished setting limits. In fact transitions of the type *no limits-(jointly) limits* can be generated by the model both by the fact that parents only receive utility from knowledge in the terminal period and by the shift of beliefs toward worse types following "unsatisfactory" realization of G_1.

Turning to **knowledge**, recall that in the context of the model it was meant the capture the cognitive skills that the youth is endowed with. I do not consider non cognitive skills both for tractability purposes[19] and for the lack of appropriate data. [20]As often done I use test scores to measure cognitive skills (see also Todd and Wolpin (2005)) and the Peabody Individual Achievement Test (PIAT) which measures academic achievement of children ages five and over. The PIAT is among the most widely used brief assessments of academic achievement. One of the PIAT subtests, the Mathematics Assessment, was given to round 1 respondents not yet enrolled in the 10th grade (as those in my samples). In rounds 2 through 6, this test was given to respondents who were age 12 as of December 31, 1996, and who were in the 9th grade or lower in round 1. Consistently with well known facts regarding racial/ethnic test score gaps (see Todd and Wolpin 2006) table 12 documents this gap across races/ethnic groups also for the NLSY97 respondents born in 1984. In particular for youths aged 12-13 there is a difference of roughly 13 points in the PIAT math scores between white youths and Hispanic/Blacks. In the model parents take initial knowledge (G_0) as given and condition their behavior on it. Looking at table 13 we can see that youths whose parents set limits with have the highest level of skills at the beginning and the end of period 1 (PIAT M in 1997) [21]

Finally in order to proxy for *effort*(e) I will use responses to the question which asks (only) in the first round in the *Youth questionnaire* how much time in a typical week the youth devotes to do homeworks. In the model *effort* is conceptualized as time spent producing knowledge. [22] It is interesting to see from table 14 that the average time spent doing homeworks in the

[19]Although parents may care about both characterizing the equilibrium in the stochastic game described when more than skill-type realizes is well beyond the scope of the paper

[20]The type of tests typically used to proxy for the non cognitive skills, such as the ones used in Cunha and Heckman (2006) are not available in the NLSY97

[21]Another possible measure of knowledge might be given by school GPA which is available starting from 9^{th} grade on as well as self reported grades achieved in 8^{th} grade. However as can be seen from table 1 this information are not available in 97-99 for those born in 1984 independently on grade attended in 1997. Moreover using standardized test scores is a better alternative with to respect to using measures of academic performances which might not be directly comparable. For instance consider school A and B. If the average ability of the students attending school A is higher than those of school B, it may be the case that getting good grades is harder. In this case lower grades achieved by student attending school A not necessarily reflect lower knowledge with respect to a student attending B who has a better academic record

[22]This variables among the ones available seem the most appropriate. Obviously if schools differ systematically in the amount of home-works assigned the first variable would not reflect the actual time invested in the

typical week differs among racial/ethnic groups. In particular, in the 1984 cohort, Hispanic and White youths aged 12-13 study an average of 5.7 and 5.3 hours per week. Blacks 4.6 hours per week. As we said not only time devoted to study appears to be the most natural input but also it is the case that, as we can see from table 15 it is strongly positively correlated with future educational attainment. It is also interesting to look at the correlation between time spent doing homework and the limits variables. Starting from the curfew limits from table 17 we see that the correlation is not so strong although whenever parents set the limits the youth spends about 20 minutes more per week than kids whose parents allow to decide. The magnitude of the correlation is similar for the friends limits and stronger for the TV limits. In this last case whenever the parents or the kid decides jointly with them the average time is higher of about half an hour per week. Obviously because we don't observe the (heterogenous) preferences of the youth without performing a counterfactual experiment in which parents have different preferences/skills that induce them to behave differently, we don't know how kids would change their time allocation. [23] Finally table 18 documents how time spent doing homework in period 1 is positively correlated with the PIAT M in 1998 (period 2) controlling for other covariates. [24]

5 Estimation

I estimate the model using maximum likelihood. In order to account for that fact that parents choice are latent I assume that the choice "limits-no limits" are correlated to the observed limits variable through a *measurement equation.* In particular denoting by $\{Y_t^c, Y_t^f, Y_t^{TV}\}$ the limits variable observed at time t we can order each of the limits-responses as follows:

1. Parents decide
2. Parents and I decide jointly
3. I decide

Let X_t^l and X_t^{nl} be the (latent) choice of setting limits/no limits at time t and $Y_t^{j,i}$, $j \in \{c, f, TV\},\ i \in \{1, 2, 3\}$, denote the (ordered) responses to the limits questions. We can now introduce three measurement equations which link the Y's to parents' choice X. I assume that the probability of observing $Y_t^{j,i}$ evolves according to an ordered probit. Denoting by ν^j the serially uncorrelated noise term and letting $\underline{\nu} = (\nu^c, \nu^f, \nu^{TV})$ denote the noise term in each

production of skills. It is worth mentioning that no information regarding other activities clearly beneficial to the production of skills is available. For instance the respondents also provide information about time spent reading for pleasure and . However given that nothing is known about the content of such reading I don't feel it would it would be a sensitive choice to use this variable

[23] Another rather strong correlation intercurs between the TV limts and the average time spent watching TV per week. In our sample, e.g. kids aged 12-13, the average time per day is roughly 3 hours for kids the are allowed what TV shows to watch, 2 hours an half for kids that decide jointly with their parents and only about 2 hours for those whose parents set the limits. Although time watching TV is not used in the analysis this correlation indicates that in fact setting limits reduces the propensity to engage in recreational activities

[24] The specification is of the added value type. Measures of home and school inputs are not available in the NLSY97. This might explain the low R^2

of the measurement equations I assume that $\underline{\nu} \sim N(0, \Omega)$. Ω is non diagonal. We have that the probability of observing each response to the question regarding limit j is given by:

$$\pi_1^j = pr(Y^j = 1|X) = \Phi\Big(\frac{\kappa_1^j - \beta^j I[X = 0]}{\sigma^j}\Big)$$
$$\pi_2^j = pr(Y^j = 2|X) = \Phi\Big(\frac{\kappa_2^j - \beta^j I[X = 0]}{\sigma^j}\Big) - \pi_1^j$$
$$\pi_3^j = 1 - \pi_1^j + \pi_2^j$$

where $I[\cdot]$ denotes the indicator function and σ^j the standard deviation of the noise ν^j. Therefore on top of the parameters in Ω the measurement equations include the vector $\underline{\beta} = (\beta^c, \beta^f, \beta^{TV})$ and the matrix $\underline{\xi}$ containing the κ's parameter (cut-offs is the ordered probit)

As mentioned in the data section, we use time devoted to study to measure effort. It is reasonable to assume that such a variable is measured with error and convenient to assume that the measurement error is multiplicative. Denoting by s_t^o the effort observed at time t and by s_t the true effort level exerted at time t we have that $s_t^o = s_t exp(\epsilon_t^s)$, where I assume that $\epsilon_t^s \sim N(0, \sigma^s)$.
Letting $\Sigma = \{\omega, \underline{\beta}, \underline{\xi}, \sigma^s\}$ denote the set of parameters coming from the measurement equations we have that 13 elements are in it.

5.1 Heterogeneity

Given that there is only one cross section in which both the input and the output of the knowledge production function are observed I assume that all the initial heterogeneity in skills in captured by the PIAT M test scores. With respect to parents I assume that they differ with respect to the cost c of setting limits. In particular I assume that there are two types of parents, i.e. $c \in \{c_L, c_H\}$. The identification of the c's should come from the restriction that parents that have a kid with similar permanent observed characteristics (race) and initial observed skills (G_0) will behave differently only if they are of a different type. It is clear that such an argument would be questionable if we assumed that youths are heterogenous in unobserved skills or that parents have different prior on the type of kid. I denote by Λ, we have that:

$$\Lambda = \{c, \overline{R}, \underline{\alpha}, \underline{p}_0, \underline{\eta}, \lambda, \phi, \chi, \gamma\}$$

where $\underline{p}_0$ is the vector which contains the prior on $\underline{\alpha}$.

5.2 Likelihood

I denote the parameter space by $\Theta = \Lambda \cup \Sigma$ .We can then write the vector containing the observed variables in period 1 for individual i:

$$O_1 = \{s_1^o, Y_1^c, Y_1^f, Y_1^{TV}, G_1\}$$

The contribution to the likelihood of such an individual $P(O_1)$ is given by the joint probability of observing each of the outcomes in O_1 where we use the (unique) equilibrium of the game to compute such probabilities, for any given set of parameters $\theta \in \overline{\Theta}$. By $\overline{\Theta}$ I denote the part of the parameter space in which the restriction (3) and assumptions $A1 - A5$ hold. We can now write down the contribution for an individual in the sample for the first period by computing $P(O_1)$. Once the model is solved, conditional on G_0 and Z, we know the optimal X selected by each type of parent. We then have all the information we need to compute, through the measurement equations, the probability of observing each element of Y_1. Similarly, the solution of the model implies that, given the type of kid, G_0 and X_1, s_1 is uniquely determined. This implies that we can use the measurement equation and the production function to compute $p(s_1^o)$ and $p(G_1)$. $P(O_1|c_j, \alpha_i, G_0)$ is then given by the product of these probability. The conditional probability $P(O_1|G_0, Z)$ is finally computed integrating out the probability of the kid being of type α_i and the parent being of type c_j. The probability of observing O_2 is compute similarly with the difference that it doesn't contain s_2^o. The likelihood contribution of an individual is given by $L^i = P(O_1^i)P(O_2^i)$. Including the parameters coming from the unobserved heterogeneity structure on c we have a total of 30 parameters.

6 Appendix

6.1 Parameterizations and sufficient conditions

Preferences

$$u(e) = (1-e)\Big(I[R_t = 1] + I[R_t = 0]\overline{R}\Big) + \chi\frac{e^{\phi}}{e-1} - \omega exp(-G_t)e^{\gamma}, \text{ with } \overline{R} > 1$$

where $\phi > 3$ and $\gamma > 2$ imply that $(A1)$ holds

6.2 Solution

In order to solve the model we use the content of lemma 2.7. In particular we perform the following steps

1. Given a kid with initial knowledge G_0 fix an action R in the first period
2. Find the corresponding equilibrium cut-off $\underline{G}(R)$ and compute the value of the strategy $\Sigma(R) = \{R, \underline{G}(R)\}$
3. pick the equilibrium strategy which is $argmax\{\Sigma(\underline{R}), \Sigma(\overline{R})\}$

The crucial part of this algorithm is step 2). Let's define the following equilibrium equation:

$$\Pi_T(\underline{G}) - c = 0$$

In words this says that, given an action R and initial knowledge G_0 the equilibrium cut-off is such that the gain of setting limits evaluated at $\underline{G}$ equals the cost. In particular in order to compute $\Pi_T(\underline{G}^i)$ (the gain from setting limits for a candidate equilibrium cut-off $\underline{G}^i$), we need to perform the following steps

i) solve the problem of the kid in the last period for every type and compute $\Gamma_i(G_1), G_1 \in (0, \infty), \forall i$

ii) solve the problem of the kid in the first period for every type and compute the beliefs $p_1^i(G_1), \forall i, \forall G_1 \in (0, \infty)$ using Bayes rule and the strategy $\Sigma(R^i) = \{R, \underline{G}^i\}$

iii) compute $\Pi_T(\underline{G}^i) - c$

As usual the equilibrium cut-off $\underline{G}$ is the fixed point of this procedure in the sense that whenever we conjecture $\underline{G}$ as the equilibrium cut-off we in fact get that the equilibrium equation holds. In practice I interpret $\Pi_T(G)$ as a non linear equation whose value can be computed performing steps **i)-iii)**. Lemma 2.7 ensures that the numerical procedure picks the unique cut-off of equilibrium. The only problem is given by the fact that $\underline{G}$ might be ∞. With respect to this whenever I don't find the equilibrium cut-off in $[0, G_{max}]$, G_{max} being a large positive number, I conclude that parents always set limits in the last period.

7 Tables

Table 1: Available data for high school graduates born in 83 or 84 with normal grade progression

attending 6^{th} grade in in ac year 96/97

	6^{th}	7^{th}	8^{th}	9^{th}	10^{th}	11^{th}	12^{th}
TV Limits	YES	YES	YES	NO	NO	NO	NO
Curfew limits	YES	YES	YES	NO	NO	NO	NO
Friends limits	YES	YES	YES	NO	YES	NO	NO
Study time	YES	NO	NO	NO	NO	NO	NO
Self Decl. Grades	NO	NO	YES	NO	NO	NO	NO
Transcript GPA	NO	NO	NO	YES	YES	YES	YES
PIAT MATH	YES	YES	YES	YES	YES	YES	YES
CAT-ASVAB	YES	NO	NO	NO	NO	NO	NO

attending 7^{th} grade in in ac year 96/97

	6^{th}	7^{th}	8^{th}	9^{th}	10^{th}	11^{th}	12^{th}
TV Limits	NO	YES	YES	YES	NO	NO	NO
Curfew limits	NO	YES	YES	YES	NO	NO	NO
Friends limits	NO	YES	YES	YES	NO	YES	NO
Study time	NO	YES	NO	NO	NO	NO	NO
Self Decl. Grades	NO	NO	YES	NO	NO	NO	NO
Transcript GPA	NO	NO	NO	YES	YES	YES	YES
PIAT MATH	NO	YES	YES	YES	YES	YES	YES
CAT-ASVAB	NO	YES	NO	NO	NO	NO	NO

attending 8^{th} grade in in ac year 96/97

	6^{th}	7^{th}	8^{th}	9^{th}	10^{th}	11^{th}	12^{th}
TV Limits	NO	NO	YES	YES	YES	NO	NO
Curfew limits	NO	NO	YES	YES	YES	NO	NO
Friends limits	NO	NO	YES	YES	YES	NO	YES
Study time	NO	NO	YES	NO	NO	NO	NO
Self Decl. Grades	NO	NO	YES	NO	NO	NO	NO
Transcript GPA	NO	NO	NO	YES	YES	YES	YES
PIAT MATH	NO	NO	YES	YES	YES	YES	YES
CAT-ASVAB	NO	NO	YES	NO	NO	NO	NO

Table 2: Distribution of Grade Attended in ac. Year 96/97

grade attended	born in 84	born in 83
4	0.06	0
5	0.35	0.06
6	5.85	0.9
7	36.44	5.88
8	56.26	39.54
9	0.87	52.6
10	0.12	0.85
11	0.06	0.11
12	0	0.06
	N=1726	N=1768

Table 3: Agreement in Response: Curfew Limits

N=1532	Parents' Responses		
	Who sets the curfew?		
	Parents	Kid	Joint
Parents	61.88	0.39	5.35
Kid	2.15	0.07	0.52
Joint	25.33	0.2	4.11

Table 4: Agreement in Response: Friends Limits

N=1532	Parents' Responses		
	Who sets the curfew?		
	Parents	Kid	Joint
Parents	15.27	2.15	6.46
Kid	14.23	12.99	19.58
Joint	12.01	4.24	13.05

Table 5: Agreement in Response: TV Limits

N=1532	Parents' Responses		
	Who sets the curfew?		
	Parents	Kid	Joint
Parents	20.65	2.87	13.39
Kid	11.47	6.78	12.38
Joint	13.29	3.19	16.09

Table 6: Breaking Limits in the Last Month

	Survey year: 1997		
N=1771	Curfew Limits	Friends Limits	TV Limits
Never	66.46	42.63	48.95
Once	8.2	3.11	5.87
More than once	25.24	54.26	46.08
	Survey year: 1998		
N=1771	Curfew Limits	Friends Limits	TV Limits
Never	58.84	28.4	32.69
Once	8.13	2.6	2.99
More than once	33.03	69	64.31
	Survey year: 1999		
N=1771	Curfew Limits	Friends Limits	TV Limits
Never	50.14	8.58	41.28
Once	28.83	1.98	74.2
More than once	25.07	2.94	71.99

Table 7: Limits by Period

	Survey year: 1997		
	Curfew Limits	Friends Limits	TV Limits
Parents	67.89	23.89	36.63
Kid	2.88	46	31.34
Jointly	39.23	30.11	32.03
N	1738	1737	1739
	Survey year: 1998		
	Curfew Limits	Friends Limits	TV Limits
Parents	56.24	12.49	20.11
Kid	5.4	58.79	50.47
Jointly	38.36	38.71	29.42
N	1611	1609	1611
	Survey year: 1999		
	Curfew Limits	Friends Limits	TV Limits
Parents	46.3	9.8	14.38
Kid	7.65	64.5	59.92
Jointly	46.05	25.7	25.7
N	1568	1572	1572
	Survey year: 2001		
	Curfew Limits	Friends Limits	TV Limits
Parents	-	13.81	-
Kid	-	51.59	-
Jointly	-	34.6	-
N	-	1477	-

Table 8: Limits and Race

	Survey Year: 1997				Survey Year: 1998				Survey Year: 1999			
	Curfew Limits											
	Parents	Kid	Jointly	N	Parents	Kid	Jointly	N	Parents	Kid	Jointly	N
Hispanic	67.45	3.94	28.61	381	60.06	5.38	34.56	353	52.19	5.83	41.98	343
Black	75.52	3	21.48	433	63.06	7.65	29.29	379	56.87	5.49	37.64	364
White	64.55	2.37	33.08	928	51.76	4.42	43.38	883	39.51	9.5	50.98	863
	Friends' Limits											
Hispanic	28.16	43.36	28.16	380	13.31	55.81	30.88	353	10.17	62.5	27.33	344
Black	34.87	36.49	28.64	433	17.32	52.23	30.45	381	14.25	56.99	28.77	365
White	17.35	51.08	31.57	928	10.24	62.8	26.96	879	7.86	68.21	23.93	865
	TV Limits											
Hispanic	35.96	35.17	28.87	381	18.64	48.59	32.77	354	14.53	55.81	29.65	344
Black	35.33	35.33	29.33	433	20.63	52.65	26.72	378	10.68	62.74	26.58	365
White	37.5	27.8	34.7	928	20.39	50.4	29.22	883	15.95	60.12	23.93	865

Table 9: Limits and Gender

	Survey Year: 1997				Survey Year: 1998				Survey Year: 1999			
	Curfew Limits											
	Parents	Kid	Jointly	N	Parents	Kid	Jointly	N	Parents	Kid	Jointly	N
Boys	67.15	3.82	29.02	889	54.32	7.43	38.25	834	44.84	10.2	44.96	814
Girls	68.67	1.88	29.45	849	58.3	3.22	38.48	777	47.88	4.91	47.21	754
	Friends' Limits											
Boys	27.3	43.03	29.66	890	12.76	60.05	27.2	831	10.43	65.4	24.17	815
Girls	20.31	49.11	30.58	847	12.21	57.46	30.33	778	9.11	63.54	27.34	757
	TV Limits											
Boys	38.58	30.71	30.71	889	22.38	49.7	29.72	831	15.95	57.91	26.13	815
Girls	34.59	32.00	33.41	850	17.69	51.28	31.03	780	12.68	62.09	25.23	757

Table 10: Limits and Family income

Survey Year: 1997			Survey Year: 1998			Survey Year: 1999		
Curfew Limits								
Parents	Kid	Jointly	Parents	Kid	Jointly	Parents	Kid	Jointly
32139	25900	37859	31993	30348	40681	33919	30574	38406
Friends' Limits								
24544	40330	31509	25308	38248	31338	26500	37964	33830
TV Limits								
33942	30175	37664	33136	35604	34162	32282	35767	34010

Table 11: Transitions

Transitions of the Curfew Limits

	Period 2					Period 3					Period 3			
Period 1	Parents	Kid	Jointly	N	Period 2	Parents	Kid	Jointly	N	Period 1	Parents	Kid	Jointly	N
Parents	63.48	4.55	31.97	344	Parents	60.61	5.42	33.96	848	Parents	52.35	6.81	40.84	1043
Kid	**34.78**	23.91	**41.3**	46	Kid	**35**	22.5	**42.5**	80	Kid	**41.6**	18.6	**39.53**	43
Jointly	**41.36**	5.54	53.09	469	Jointly	**27.09**	8.66	64.05	587	Jointly	**33.4**	8.3	58.3	458

Transitions of the Friends Limits

	Period 2					Period 3					Period 5			
Period 1	Parents	Kid	Jointly	N	Period 2	Parents	Kid	Jointly	N	Period 3	Parents	Kid	Jointly	N
Parents	26.7	42.33	31.06	367	Parents	30.65	38.71	30.65	186	Parents	28.11	27.35	44.44	234
Kid	**5.56**	74.12	**20.33**	738	Kid	**4.5**	78.04	**17.45**	888	Kid	**7.46**	67.51	**25.03**	1730
Jointly	**11.98**	48.55	39.46	484	Jointly	**10.38**	49.44	40.18	433	Jointly	**15.46**	41.48	43.06	634

Transitions of the TV Limits

	Period 2					Period 3					Period 3			
Period 1	Parents	Kid	Jointly	N	Period 2	Parents	Kid	Jointly	N	Period 1	Parents	Kid	Jointly	N
Parents	35.22	30.39	33.85	582	Parents	41.12	28.29	30.59	304	Parents	25.17	41.78	33.04	572
Kid	**7.62**	73.52	**18.64**	499	Kid	**4.86**	80.03	**15.11**	761	Kid	**4.81**	81.17	**14.02**	478
Jointly	**14.9**	50	35.1	510	Jointly	**12.78**	45.81	41.41	454	Jointly	**11.02**	60.52	28.46	499

Table 12: PIAT MATH Raw Average Score By Race/Ethnic Group

	Hispanic	Black	White
1997	60.5	61.2	72.9
1998	68.1	63.2	78.1
1999	70.6	67.6	80.7
2000	73.5	69.4	83.7
2001	74.9	70.9	86.1

Table 13: PIAT M Raw Average Score and 1997 Limits

1997	AV.PIAT M 1997			AV. PIAT M 1998		
	Kid	Parents	Jointly	Kid	Parents	Jointly
curfew limit	67.2	60.8	68.9	71.8	67.1	74.6
friends limit	62.7	69.2	68.7	66.6	74.4	74
TV limit	66.4	66.6	69.6	71.6	70.7	75.1
1998				Kid	Parents	Jointly
curfew limit				71.5	68.2	75.5
friends limit				64.9	74.4	73
TV limit				70.5	73.5	73.4

Table 14: Time Study By Race/Ethnic Group

Hispanic	Black	White
5.78	4.66	5.34
375	439	921

Table 15: Average Hours per Week Devoted to Study at 12-13 by Educational Attainment

Dropout	High School Graduate	Enrolled in Some College
4.51	5.42	5.99

1984 cohort

Table 16: Average Hours per Week Watching TV at 12-13 by Educational Attainment

Dropout	High School Graduate	Enrolled in Some College
21.11	19.94	16.6

1984 cohort

Table 17: Limits and Study

	curfew limits	friends limits	TV limits
parents	5.33	5.13	5.41
kid	5.01	5.42	4.89
joint	5.17	5.19	5.48

Table 18: Average Weekly Time Study at age of 12-13 and PIAT MATH at 13-14

	(1)	(2)	(3)
	piat_m_raw_98	piat_m_raw_98	piat_m_raw_98
piat_m_raw_97	0.647***	0.652***	0.702***
	(0.0199)	(0.0197)	(0.0190)
time_study	0.118	0.122	0.150*
	(0.0644)	(0.0644)	(0.0657)
black	-6.468***	-6.647***	
	(0.776)	(0.769)	
Hispanic	-1.900*	-2.205**	
	(0.808)	(0.786)	
fath_edu_1	1.058		
	(0.663)		
_cons	29.70***	29.92***	24.28***
	(1.526)	(1.520)	(1.357)
N	1482	1482	1482
F	305.3	380.6	689.9

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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