



EUROPEAN UNIVERSITY INSTITUTE
Department of Economics

Essays on Human Capital Accumulation and Inequality

Claudia Trentini

*Thesis submitted for assessment with a view to obtaining the degree of
Doctor of Economics of the European University Institute*

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Part I

Introduction

This thesis is composed by four independent chapters. Their common denominator is the process of human capital accumulation analyzed under different perspectives and using different techniques. In the following I will shortly describe each chapter in more detail.

Chapter 1 addresses an important aspect of the effects of trade liberalization that has gained much attention in recent years: raising skill premia. It is motivated by recent evidence showing that trade liberalization in developing countries is often associated with a large increase in wage inequality. I investigate the mechanism through which a trade related increase in the demand for skilled labor affects human capital investment and the wealth distribution of a developing country economy.

In particular I focus on a scenario where the liberalizing economy is in a poverty trap. This is because developing economies are often plagued by credit market imperfections. Imperfect financial markets raise the probability that individuals are constrained in their human capital investment decisions and that the economy is an poverty trap. I use a standard overlapping generation model to show how a trade related increase in the demand for skilled labor can release a developing country from a poverty trap, leading to increased human capital accumulation and technology progress. The skill biased technological shock benefits the whole economy and "trickles down" - through the interest rate - to unskilled workers a la Aghion & Bolton (1997).

Chapter 2, which is joint work with Lidia Farre, analyzes the educational choices of Argentinean teenagers during different phases of the economic cycle. We use data for Argentinean households over the period 1995-2002 to examine households' response to negative idiosyncratic income shocks in different macroeconomic scenarios.

We study how teenagers' school progress responds to household head unemployment during periods of high economic growth and compare it to the response during recession years, when families are more likely to be financially constrained. After accounting for the potential endogeneity of household head unemployment we find that school failure in response to unemployment shocks increases during periods of economic instability. Further we find that for first born boys this results from a greater involvement in labor market activities. Our results add to the existing literature on the long term cost of macroeconomic crises.

In Chapter 3 I analyze a different aspect of the Argentinean macroeconomic crisis and the related social costs. Argentina experienced an important increase of informal employment and wage dispersion in the last 20 years.

This chapter extend a search model with exogenous human capital accumulation to include an informal sector. The model is parametrized such to fit Argentinean data in order to investigate the effect of employment protection measures on informality, employment and wage dispersion under two different macroeconomic conditions. I find that for low educated workers both severance pay and minimum wages increase informality. In the presence of

a wage floor severance payments do not affect employment but only shift marginal workers from the covered sector to the unregulated one. I find that a decrease in the return to human capital skills increases the incentives to seek informal employment. Labor market protection measures and declining human capital return are able to explain most of the increase in informality and much of the increase in wage dispersion.

Last chapter is coauthored with Christian Dustmann and focuses on the very early phases of human capital investment: pre school years. In this chapter we investigate test score gaps and their evolution for white and ethnic minority children aged 3 and 5 in the UK. We also analyse the effect of early school exposure on test score gaps, and differences in the effect of entry age on early school performance. Ethnic test score gaps at age 3 - when most children are not enrolled in Kindergarten yet - are large. Background characteristics (in particular exposure to the English language) explain part, but not all of this differential. Between the age of 3 and 5, the ethnic test score gap narrows. Exposure to preschool measured at age 5 - even if limited to only a few months - has a larger positive effects on test scores for those minority groups who started from a more disadvantaged position. Further, keeping exposure to pre-school constant, ethnic minority children loose less from entering pre-school at a younger age than majority individuals; for some groups, there is an overall gain from entering school early. Our findings point at a reduction in achievement gaps between minority and majority children in the UK between age 3 and age 5, which is partly due to a larger positive effect of pre-school on achievements of minorities.

Part II

Chapters

Chapter 1

International technology spillovers, poverty traps and development

ABSTRACT

Credit market imperfections raise the probability that individuals are constrained in their investment decisions and that the economy is an poverty trap. An overlapping generation model where agents choose whether to become educated when young is presented. Education is expensive and needs to be financed by borrowing. Interest rate is derived endogenously. Trade liberalization provides an exogenous increase in skilled workers productivity under the form of a technology spillover. It is shown that a skill biased technology shock, while increasing income inequality can trickle down to unskilled workers and spur an increase in human capital investment and growth. The new equilibrium is characterized by a higher human capital, higher growth rate and possible specialization in the high technology sector.

1.1 Introduction

Recent evidence shows that trade liberalization in developing countries is often associated with a large increase in wage inequality (Goldberg and Pavcnik (2007)). It has been argued that trade increases technology transfers from industrial to developing countries and that the transfer technology is biased in favor of skilled labor.¹ Purpose of this paper is to analyze how such a technological transfer affects human capital investment and the wealth distribution of a developing country economy characterized by credit constraints.

In the presence of borrowing constraints the distribution of income and wealth becomes an important determinant of investments in human capital. Moreover, in credit constrained economies an increase in the skill premia might exacerbate the economy's divide between those who can invest in education and those who cannot, without increasing human capital accumulation. A growing literature shows that if credit markets are not perfect and the acquisition of education is costly, poverty traps can arise.²

This paper shows how a trade related increase in the demand for skilled labor can release a developing country from a poverty trap, leading to increased human capital accumulation, technology progress, and wealth equality in the long run. The basic intuition is that an increase in labor productivity experienced only by the skilled workers can benefit the whole economy and "trickle down" - through the interest rate - to unskilled workers a la Aghion and Bolton (1997).

The idea of trade related technology spillovers or transfers goes back to the work of Grossman and Helpman (1991) and found some convincing supporting evidence in the empirical work of Robbins (1995), Robbins (1996), or Wood (1997) especially for Latin American countries. Wood (1997) eloquently summarizes the empirical findings on trade liberalizations and criticizes the conventional wisdom associated with Stolper- Samuelson result, which predicts gradual eradication of wage disparity in the South.³

¹Bayoumi, Coe and Helpman (1999), Coe, Helpman and Hoffmaister (1997), Coe and Helpman (1995) find that the research and development (R&D) spillovers from the industrial countries to the developing countries are substantial. Total factor productivity in developing countries was positively associated with R&D expenditure abroad. More important here, however, the spillovers were linked to trade flows between the industrial and developing countries. The spillover from an industrial country to a developing country was proportional to the share of the industrial country's imports in the developing country's gross domestic product. Robbins (1995), Robbins (1996), Wood (1997) or Hanson and Harrison (1999) identify technology transfers as the most likely reason for the increase in wage inequality.

²The literature on educational choice and endogenous credit constraints builds on the pioneering work by Zeira (1991), Tsiddon (1992) and Galor and Zeira (1993).

³According to standard Heckscher - Ohlin theories North-South trade should be characterized by a clear trade pattern: the industrial "North" exports high-quality goods to the developing "South" which exports primary goods or lower-technology goods to the North. In this context trade liberalization in a developing country should be associated with an increase in the relative demand for unskilled labor and a narrowing of

The increase in skilled labor productivity is due to technology spillovers as already hypothesized by Grossman and Helpman (1991).⁴

While in the existing literature on human capital accumulation, interest rate is usually taken as given, this paper assumes both an endogenous real interest rate and agents who are heterogeneous both *ex ante* and *ex post*.⁵ In particular considering credit constraints few have considered the interactions between physical and human capital investments. In deciding whether to become educated or not when young, agents are also deciding whether to become borrower or lenders. Thus not only is the educational choice determined in equilibrium, but the division of the population into borrowers and lenders is endogenous. I will then describe the evolution of the economy following the trade "shock" to a new unconstrained equilibrium.

The economy is characterized by credit constraints that undermine investment in human capital. Credit market imperfections are pervasive in the case of education loans due, in part, to the fact that as human capital does not act as collateral for loans, there is a moral hazard problem in lending to finance education. Evidence that credit constraints affect human capital accumulation in developing countries abounds. For example Jacoby and Skoufias (1997) or Jacoby (1994) find strong links between financial market imperfections and human capital accumulation in India and Peru respectively.⁶

The model features two period lived agents who value both consumption and bequest to their children. Individuals differ both in ability (or cost to learn) and inherited wealth. To invest in education individuals use their inherited wealth as collateral in return for a loan to pay for the initial cost to learn and a human capital investment. Potential moral hazard in debt repayment limits borrowing.

Initially few agents are efficient enough to invest in human capital and those who do, invest little. With few skilled workers, technology is stagnating, the demand for capital is low and thus the interest rate is low. An exogenous productivity shock increases human capital investment of the skilled workers on the extensive margin allowing for an increase in the interest rate benefitting the unskilled/lenders. Wealth grows permitting an increase in the share of skilled workers. However, an increase in skilled human capital generates higher technology progress and thus a higher wage inequality. In the new steady state agents will not be limited by their wealth in the investment into human capital but only by ability.

wage differentials.

⁴This channel offers a very flexible way to model skill premia increases and it can be reconciled with recent theories analyzing issues of fragmentation (Feenstra and Hanson (1995) or technological catch-up in the South as in Trefler and Zhu (2005).)

⁵Notable exceptions considering endogenous interest rates are Fender and Wang (2003) and Galor and Moav (2004).

⁶For a cross-country evidence see e.g. Checchi (2001) and Flug, Spilimbergo and Wachtenheim (1998).

This paper contributes not only to the study of trade and inequality but also to the existing literature on trade and human capital accumulation.

Departing from a standard two by two Heckscher - Ohlin prediction past literature on trade and human capital accumulation has reached different conclusions on the effects of trade on human capital accumulation. Findlay and Kierzkowski (1983) find that the accumulation of human capital in capital skill-scarce countries falls when the rewards to education are reduced by the availability of cheaper skill-intensive import goods. In contrast Eicher (1999) present a model where trade in goods alone is sufficient to reduce differences in rates of growth, technological change and factor endowment between leader and laggard economies. In his model both the human capital and technological change are endogenous and their respective costs of accumulation interact. Stokey (1996) presents a dynamic model of growth where free trade has almost no impact on human capital accumulation even if full integration does have a substantial impact on skill premia. Cartiglia (1997) shows that trade leads to a convergence across countries in human capital endowments in a model where the credit market is missing and the investment in education is determined by the wage of skilled workers.

The mainstream of the literature on trade and income distribution has focused on the way trade and technology determine factor prices and then the distribution of income.⁷

This literature relays on trade induced technical change to explain wage inequality considering intermediate inputs trade and the hypothesis of production fragmentation between North and South (Feenstra and Hanson (1995), Trefler and Zhu (2005), Jones (2000)).⁸

This model differs from this literature in that it considers the human capital accumulation process and possible imperfections in the credit market. The interest is thus in the dynamic process of development set in motion by the trade shock. The model also analyzes the consequences of credit market imperfections and high wealth inequality on trade pattern.

Ranjan (2001) and Wynne (2005) also show that the distribution of income can have dynamic effects on trade. Credit market imperfections make wealth distributions endogenous, affecting the accumulation of human capital in the first case, the production in the labor intensive sector in the second case.

This paper differs from Ranjan (2001) in that it endogenizes the interest rate and the resulting division of the population into borrowers and lenders is endogenous.⁹

⁷see Goldberg and Pavcnik (2007) for a survey of this literature and related evidence.

⁸ Shifting production of middle skill intensive goods from the North to the South raises the skill intensity of employment everywhere.

⁹Aghion and Bolton (1997) have endogenous choice between becoming a borrower or lender in a model where agents differ in initial wealth and physical investment loans are subject to credit constraints. They consider primarily the trickle-down effect of physical capital accumulation when credit constraints underpin persistent income inequalities.

In this spirit the paper very closely relates to the literature focusing on the income distribution dynamics along stages of economic development in closed economies with imperfect credit markets.¹⁰ In particular among this group of papers the dynamic analysis relates to Lloyd-Ellis and Bernhardt (2000) and Galor and Moav (2004). These papers focus on a different issue however: the relation between inequality and growth.

The plan of the paper is as follow. Next section introduces the model. Section 1.3 analyzes the model in a stationary environment. Section 1.4 considers trade liberalization and the transition to a new equilibrium. A numerical example is presented. Section 1.5 concludes.

1.2 The model

1.2.1 Production structure

The economy produces a single non-tradable final good, denoted by Y , and two tradable intermediate goods one high tech and one low tech, denoted by X^s and X^u . The final good is used for consumption as well as an input into education. It is also chosen as the numeraire. The production function for the final good is as follows:

$$Y = (X^s)^\alpha (X^u)^{(1-\alpha)} \quad (1)$$

The intermediate good's , X^s , production is a function of skilled human capital H and a set of capital goods $z(j)$ indexed by the variable j . To avoid complications arising from integer constraints, the index j is modelled as a continuous variable. Technological progress is represented by the invention of new types of capital goods (Romer (1990)). Capital varieties are differentiated but not necessarily superior to one another. More capital varieties lead to more total factor productivity because each variety has diminishing returns to scale.

$$X^s = \left(\int_0^b z(j)^{1-\eta} dj \right) (H^P)^\eta \quad (2)$$

where $z(j)$ represents the input of capital good j used in the high skill good, b is the number of capital goods employed, and H^P is skilled human capital used in production. Given the number of capital goods used, the technology represented in (2) exhibits constant return to scale. All the manufacturers rent capital goods, $z(j)$ from the patent holder and hire skilled labor H^P to produce manufactured goods. All manufacturers are price takers and earn zero profits. Supposing that every capital good is used in equal quantity z , as will be

¹⁰See e.g. Banerjee and Newman (1993), Galor and Zeira (1993), Piketty (1997), Aghion and Bolton (1997)

the case when the intermediates carry the same price, then $X_s = B_t z_t^{1-\eta} H_t^\eta$, where profit maximization in the capital goods market implies $z(j) = z$ is the average quantity of capital goods and B_t is an index of the state of technology. Capital goods last for one period, and are produced with one unit of capital k .¹¹ Production cost is thus $1 + r_t = R_t$ where r_t is the real interest rate. Perfect competition implies marginal cost pricing, hence the amount of good j produced at t is

$$z(j) = \left(\frac{p_s(1-\eta)B_t}{R_t} \right)^{1/\eta} H^P \quad (3)$$

which is the same for all types of intermediaries used in sector s , i.e. $z(j) = z, \forall j$.

The technology for producing new patents, assumes that human capital and knowledge are the only inputs that influence the research output:

$$B_{t+1} - B_t = B_t \delta \phi(A_t/B_t) H_t^R \quad (4)$$

where $B_{t+1} - B_t$ are the newly invented products, H_t^R are the skilled workers employed in R&D, δ measures the productivity of labour in the research lab, and $\phi(A_t/B_t)$ is a function representing technological spillovers. Research productivity varies with the stock of knowledge capital B_t . B_t is the range of products known in the country and A_t is the frontier of the most advanced goods available in developed countries. Borrowing from Grossman and Helpman (1991) and Pissarides (1997) I assume that the level of technology in the North improves through original expensive research and that a lower level of technology in the South improves through cheaper imitation of the North's technology. To simplify the analysis, I assume that the level of technology in the North is independent of the activities of firms in the South and improves at an exogenous growth rate g_A . If trade does not allow knowledge spillovers or reverse engineering or if there is no trade $\phi(\cdot) = 1$, the same is true if $A_t = B_t$. Research is financed by a public entity that raises revenues through tax collection on skilled labor τ .¹² When the government undertakes R & D, the blue-prints are put in the public domain and can be used at no cost. Research is financed by tax revenues and the fiscal budget is always balanced. Skilled workers can be used either in production of the high skill good or in the research sector $H_t = H_t^P + H_t^R$, consequently the budget constraint is then $\tau w_s H_t = w_s H_t^R$. Given the budget constraint and the skilled labor market constraint, the number of skilled workers that contribute to R& D and to production is given by

$$H_t^R = \tau H_t \quad (5)$$

$$H_t^P = (1 - \tau) H_t \quad (6)$$

¹¹Total capital in the economy is thus $K_t = B_t z$.

¹²This simplifies the research sector and follows Grossman and Helpman (1991).

The low tech intermediate good, uses old blueprints and unskilled labor. ξ is a parameter to identify the inefficient use of machines by unskilled labor.

$$X^u = B_{t-1}\xi U_t \quad (7)$$

Given the above production structure for the two industries, perfect competition implies the following relative demand for human capital.

$$\frac{w_s}{w_u} = \frac{p^s}{p^u} \frac{B_t}{B_{t-1}\xi} z_t^{1-\eta} ((1-\tau)H_t)^{\eta-1} \quad (8)$$

$$\frac{w_s}{w_u} = \frac{p^s}{p^u \xi} (1 + \delta\phi(A_{t-1}/B_{t-1})\tau H_{t-1}) z_t^{1-\eta} ((1-\tau)H_t)^{\eta-1} \quad (9)$$

Equation (8) shows that, on the production side, the relative wage is determined by relative productivity. The latter is determined by technological change. An increase in the relative supply of skilled workers lowers the relative wage, while an increase in the rate of technological change raises it. Depending on the strength of each factor, the effects of an increase in technological change may well outweigh the effects of concurrent increases in the skilled labor force.

1.2.2 Factor supply

This section outlines the incentives and the opportunities to invest in education, given the relative returns to skilled and unskilled labor, the credit constraints and the wealth accumulated by households. Agents live for two periods, but for the sake of simplicity consume only when old. In each cohort agents differ along two dimensions: because of the amount of wealth inherited $a_i \in [\underline{a}, \bar{a}]$ and their ability q_i . Each infinite parent-child chain forms a dynasty.

Parents care about their children and leave them a bequest. Parents have warm glow preferences over bequest. Apart from being analytically tractable, the warm glow preference for bequests formulation seems to have better microfoundations than the Ricardian formulation (see Andreoni (1989)). Agents maximize an increasing, smooth and strictly concave utility function

$$U(t_c) = C_{t+1}^\beta a_{t+1}^{(1-\beta)} \quad (10)$$

where C is consumption while a is the bequest left to the offspring.

There is no population growth, and each cohort size is normalized to 1. The labor constraints in period t then becomes

$$1 = S_t + U_t \quad (11)$$

$$H_{t+1} = h(S_t, x_t) \quad (12)$$

where S_t denote the share in the population which decides to invest in education (i.e. students), while x_t denotes the investment in human capital they intend to do. H_{t+1} is the stock of efficient human capital in the economy given by those agents who decide to invest in education and increase their productivity to $S_t h(x_t) = H_{t+1}$.

In each period t , young agents learn the amount of their inheritances a and their ability q and decide if they want to invest in education or to work as unskilled workers. To finance human capital investment, students borrow setting as a collateral their inheritances. The cost of education takes the following form $c_t q$ and is determined by two components: there is a direct cost c_t , due to either tuition or forgone wages during the time spent in education, and of the students' ability cost q .

The direct cost of education is a constant fraction of technology progress $c_t = c(B_t)$. This accounts for the fixed costs in the education process, such as physical structures which need to be upgraded with the new technologies. The initial cost of investing in human capital depends on the talent that an individual is born with. Talented children will incur in a lower cost of education. The costs incurred in acquiring education, or the talent (the inverse of ability), denoted q , are assumed to be uniformly distributed in the population between \underline{q} and \bar{q} . Abilities are uncorrelated with inherited wealth and are not correlated over time, (i.e. are i.i.d.).

After paying $c(B_t, q)$ each individual can then increase his efficiency h , investing an amount x in education. However, even in the absence of real expenditure x , individuals who paid tuition fees c acquire one efficiency unit of labor - basic skills. The number of efficiency units of labour a student i of generation t in period $t + 1$, h_{t+1} , is a strictly concave function of the individual's real expenditure on education in period t , x_t .

$$h_{t+1} = h(x_t) \tag{13}$$

where $h(0) = 1$, $\lim_{x_t \rightarrow 0^+} h'(x_t) = \gamma < \infty$, and $\lim_{x_t \rightarrow \infty} h'(x_t) = 0$

If agents get trained they will become skilled and earn $w_s h$.

If the agent does not invest in education he works and saves, while if he invests in education, he might need to borrow L_t to finance this investment.

The unskilled agent is subject to the following budget constraint:

$$c_{t+1,u} + a_{t+1,u} = R_{t+1}(a_t + w_{u,t}) \tag{14}$$

Where $R_t = 1 + r_t$ represents the interest factor. While the skilled agent is subject to the following budget constraint:

$$c_{t+1,s} + a_{t+1,s} = (1 - \tau)w_{s,t+1}h_{t+1} - R_{t+1}(L - a_t) \tag{15}$$

where L_t is the debt incurred to afford education investment that in presence of credit market imperfections depends on the amount of collateral, inherited wealth a_t . Let us first consider the decision if to pay school tuition fees or not (thus $x_t = 0$ and $h_{t+1} = 1$). If credit markets are perfect and agents do not default, then an individual decides to acquire skill or to remain unskilled depending solely on his ability. For given R_t, w_s, w_u the decision to invest or not will be based on a lifetime utility comparison V_s if skilled V_u if unskilled.

$$V_s = \kappa((1 - \tau)w_{s,t+1} - R_{t+1}(L + a_t)) \quad (16)$$

$$V_u = \kappa(R_{t+1}(w_{u,t} + a_t)) \quad (17)$$

where κ is a constant representing the utility function parameters. In equilibrium the marginal individual is indifferent between acquiring skill and remaining unskilled: $V_s^i = V_u^i$. This implies a threshold level of ability, q^* given by:

$$(1 - \tau)w_{s,t+1} - R_{t+1}(L(x, q^*, B_t) - a_t) = R_{t+1}(w_{u,t} + a_t) \quad (18)$$

such that all individuals with $q_i < q^*$ do invest in human capital by going to school, while the others remain unskilled. The threshold depends on the bequest received, the return to education, and the imperfections in the credit market as explained in the following. In the absence of credit constraints, only the return to education would matter. Credit constraints introduce a wealth effect in the choice of educational decision. The higher the bequest of an individual, the lower the talent required to invest in education for any given level of future wages.

Unconstrained optimal real expenditure on education.

Let us now consider the investment decision of those students who decide to supplement the tuition fees with a capital investment in education.

Given that the indirect utility function is a strictly increasing function of the individual's second period wealth, the unconstrained optimal real expenditure on education in every period t , x_t , from the viewpoint of individual i of generation t , maximizes the second period wealth:

$$x_t = \arg \max [w_{s,t+1}h(x_t) - R_{t+1}(L(x, q^*, B_t) - a_t)] \quad (19)$$

Hence, as follows from the properties of $h(x_t)$, the optimal unconstrained real expenditure on education in every period t , x_t is unique and identical across members of generation t . If $R_{t+1} > w_{s,t+1}$ then $x_t = 0$, otherwise x_t^{opt} is given by

$$w_{s,t+1}h'(x_t) = R_{t+1} \quad (20)$$

Moreover, since $w_{s,t+1} = w_s(k_{t+1})$ (where $k = K/H$) and $R_{t+1} = R(k_{t+1})$ it follows that $x_t = x(k_{t+1})$.

There exist a capital -skilled labor ratio \bar{k} , below which individuals do not invest in human capital. That is $R(\bar{k}) = w_s(\bar{k})$.¹³

Assumption 1 *In the following it is assumed that: $k_0 > \bar{k}$ The constrained human capital investment is between 0 and x^{opt} .*

1.2.3 Endogenous credit constraints.

Borrowing constraints are modeled following Banerjee and Newman (1993). The capital market is limited by a moral hazard problem. Students can borrow L , to pay for the initial educational cost (ability and technology varieties $B_t q$) and for the human capital investment x , but they must put up their inheritance a as a collateral. After finishing the educational process they can abscond, losing $R_{t+1}a_t$, but escaping the repayment obligation $R_{t+1}L$. If absconders are apprehended, which they are with probability π , they will loose all their second period income. With homogeneous preferences, borrowers would renege if the expected utility of absconding is higher than the repaying option.

$$\kappa((1 - \tau)w_{s,t+1}h_{t+1} - R_{t+1}(L - a_t)) \geq \kappa((1 - \pi)(1 - \tau)w_{s,t+1}h_{t+1}) \quad (21)$$

where κ is a constant which depends only on the parameters of the utility function. Recognizing this, lenders only make loans that satisfy $L \leq a_t + \pi(1 - \tau)w_{s,t+1}/R_{t+1}$, where π is a measure of credit market imperfections. The higher the probability that the absconders are apprehended π the higher the loan granted. Therefore a scarce enforcement of rules limits the credit allowed in the market.

For an agent with inherited wealth a to invest in education, he must draw an ability q that is less than $a_t + \pi(1 - \tau)w_{s,t+1}h_{t+1}/R_{t+1}$. This defines another threshold of ability called $\tilde{q}(a)$, increasing in π and a .

$$\tilde{q}(a) = (a_t + \pi(1 - \tau)w_{s,t+1}h/R_{t+1} - x) \quad (22)$$

Individuals having $q < q^*$ but $q > \tilde{q}$ are credit constrained, they would like to invest in human capital but cannot borrow adequately to do so. If $\pi = 0$ absconders are never apprehended, thus credit contracts are simply not possible, and bequests are the only possible way to finance human capital investments. From (22) it is clear that the threshold level of collateral is decreasing in the ability of individuals for the simple fact that high ability individuals have a lower initial cost of education to finance. Thus the educational investment of an agent with

¹³In a similar model Galor and Moav (2004) consider two phases of development of a credit constrained economy: before reaching \bar{k} , the economy's growth is determined by physical capital accumulation, while when the economy has reached this threshold, the growth process is determined by human capital accumulation. In the following it is assumed that the threshold \bar{k} has already been reached.

inherited a who is willing and able to invest in education is given by

$$e(a) = \min[a_t + \pi(1 - \tau)w_{s,t+1}h_{t+1}/R_{t+1}, q^*(a, w_u)] \quad (23)$$

individuals talented have a low initial educational cost, $q < e(a)$ and invest in human capital; others remain unskilled. A certain share of the population will always be constraint if $q^* > \tilde{q}$

Lemma 1.1 *The investment in education $e(a, p, w_u)$ is increasing and also concave in the bequest a , decreasing in the credit market imperfections π , decreasing in the interest rate R , and $\lim_{a \rightarrow \infty} e_a(a, p, w_u) = 0$.*

For the lowest possible level of bequests \underline{a} , let us define $\hat{q} < e(\underline{a})$ as those individuals highly talented who are never constrained.

Individual's ability is unrelated to that of his parent. Thus the amount that an individual receives as a transfer serves as a sufficient statistic to summarize the entire history of the dynasty. The bequest an individual gives is a function of that individual's bequest receipts and net labor income (income after paying for education). The individual's net labor income is in turn a function of his ability and transfer receipt, as well as of the wage structure. Denoting the bequest function by $b(a, q)$, the evolution of lineage wealth can be written as

$$a_{t+1} = b(a_t, q_t) \quad (24)$$

Further, using the superscript u to denote the bequest of an unskilled parent and s to denote the bequest of a skilled parent, $b(a, q)$ can be written as

$$b^u(a) = (1 - \beta)R(a + w_u) \quad \text{if } q > \min[\tilde{q}(a), q^*] \quad (25)$$

$$b^s(a, q) = (1 - \beta)((1 - \tau)w_s h - R(L - a)) \quad \text{if } q \leq \min[\tilde{q}(a), q^*] \quad (26)$$

The bequest of an unskilled parent does not depend on his level of ability. It is further assumed that $(1 - \beta)R_t < 1$.¹⁴ For a given set of wages and interest rates, eqs(25) and (26) define a Markov process where the probability of inheriting a particular value a_{t+1} is conditioned on the value a_t .

Then as the distribution of q is bounded over the support $[\underline{q}, \bar{q}]$, $(1 - \beta)R_t < 1$, and h is a decreasing return function, it can be shown that there exist a recurrent distribution of a that will also be bounded.

¹⁴This a standard assumption to avoid exploding patterns.

1.3 Macroeconomic equilibrium

1.3.1 Autarchy

In autarchy, intermediate prices are determined by the maximization of (1). Substituting the relative prices in the skill premia in equation (8) obtains the following equation:

$$\frac{w_s}{w_u} = \frac{\alpha}{(1-\alpha)} \left(\frac{U_t}{(1-\tau)H_t} \right) \quad (27)$$

In autarchy, the technology effect is not present. An increase in skilled labor generates an oversupply of skilled good and, given homothetic demand, lower skill good's price. Thus in an autarchic equilibrium, wage rates are simply determined by the relative supply of labor. Let $G(\cdot)$ denote time t distribution of inheritances and $H(\cdot)$ the distribution of abilities q . Then integrating the optimal decisions of agents over their types, (a, q) , yields the following aggregates:

$$\begin{aligned} H_{t+1} &= \int \int_0^{e(a,p,w_s)} h(a, q) H_t(dq) G_t(da) \\ U_t &= \int \int_{e(a,p,w_u)}^{\bar{q}} H(dq) G(da) \\ E_t &= \int \int_0^{e(a,p,w_u)} (x + B_t q) H_t(dq) G_t(da) \\ K_{t+1} &= \int \int_{e(a,p,w_u)}^{\bar{q}} (w_{ut} + a_t) H(dq) G(da) - \int \int_0^{e(a,p,w_u)} L(q, a) H_t(dq) G_t(da) \end{aligned}$$

where H_{t+1} represent the skilled workers in the economy; U_t the unskilled workers; E_t the costs of education and K_{t+1} is the accumulated capital. These aggregates are time-varying functions of the wages and the interest rate because they also depend on the distribution of inherited wealth. Capital K_{t+1} accumulation is given by the net savings of the whole population in each period. As agents consume only in the second period of their life, savings correspond to net income of the first period: income and wealth of the low skilled workers net of the students' borrowing. A competitive equilibrium for an economy with inheritance distribution $G_t(\cdot)$ is a tuple $\{w_s, w_u, R, U, S\}$ such that:

- given the wages and the interest rate, an agent of type (a, q) selects its education level to maximize utility;
- type (a, q) skilled workers choose how much to invest;
- markets clear.

In this kind of economies 2 types of equilibria are possible.¹⁵

In the *dual economy, poverty trap economy* there is no mobility between the classes. This arises if the initial stock of educated workers is sufficiently small. With few educated workers, the wages of skilled workers will be sufficiently high that even the least able child of an educated parent will both receive a sufficient transfer and find it profitable to get educated. Similarly the wages of unskilled workers will be sufficiently low that no child of uneducated parents will be able to afford an education. At this stage of development, technological change is weak thus the labor supply effect dominates: the low supply of skilled workers drives the skill premium high.

In an *advanced economy* equilibrium there is both upward and downward mobility across the classes.

From (27) it is clear that in a closed economy the following relations between human capital and wages hold:

$$\lim_{S \rightarrow 0} w_u = 0 \quad \text{and} \quad \lim_{S \rightarrow 0} w_s = \infty \quad (28)$$

For values of S close enough to 0, or sufficiently small, the equilibrium with no mobility constitutes a stable steady state. Credit market imperfections raise the probability that individuals are constrained and the economy is an poverty trap. In the case credit constraints bind at least for some individuals for $\pi < 1$ then it must be that $q^* > \tilde{q}(a)$. The probability of agents being credit constrained for a particular a is $H(q^*) - H(\tilde{q}(a))$. The higher the agent's wealth the lower the probability of being credit constraint.

The lower π (the higher the credit market imperfections) the lower is $\tilde{q}(a)$ (from (22), $\partial \tilde{q} / \partial \pi > 0$) thus the more individuals are borrowing constrained. Therefore, each lineage has lower wealth for a longer time. This establishes a direct relationship between the degree of credit market imperfections π and the economy wealth distribution.

Lemma 1.2 *Let π_i be the degree of credit market imperfections in country i . If country 2 has otherwise the same characteristics as country 1 but better financial institutions $\pi_2 > \pi_1$ then the steady state distribution of wealth in country 2 dominates the steady state distribution of wealth in country 1 in the first order stochastic dominance sense: $G_{\pi_1}(a) \geq G_{\pi_2}(a)$.*

The impact of a greater degree of credit market imperfections on the investments in human capital is summarized by Lemma 1.1. The educational investment is decreasing in the degree of credit market imperfection π .

¹⁵The steady state is defined as a condition where w_u, w_s, r and U are constant and the distribution of bequests a across individuals is unchanging from generation to generation. Note that even when the economy is in a steady state, individual dynasties will experience movements within the income and wealth distribution due to shocks to ability. The proof of the existence of these two equilibria is a straightforward application of Hopenhayn and Prescott's (1992) analysis of existence, uniqueness and convergence properties for monotonic stochastic processes and is given in the appendix.

Lemma 1.3 *If country 2 has otherwise the same characteristics as country 1 but better financial institutions $\pi_2 > \pi_1$ then country 2 has greater skill endowment in the steady state.*

Lemma 1.3 summarizes the link between an institutional variable like the degree of credit market imperfections and the human capital skill endowment of the economy.

It is straightforward to show that if the distribution of talent in one economy dominates that in another economy in a first order stochastic sense, then the former has a greater investment in human capital and greater skill endowment in efficiency units.

I next analyze the role of the interest rate. The market clearing interest rate reflects the simple supply and demand for credit by individuals. The larger supply of unskilled labor, the lower the interest rate. The more binding the credit constraint, the lower the supply of skilled labor, the lower the demand for funds and the interest rate.

$$1 + r_t = (1 - \eta)B_t z_t^{-\eta} ((1 - \tau)H_t)^\eta \quad (29)$$

Credit constraints generate distributional effects not only related to skill premia. Those excluded from education because of credit constraints become lenders and lose not only because they earn a low wage but also because of the lower interest rate. Those who can still borrow to purchase education gain in two ways from credit constraints: the skilled wage is higher (relative to unconstrained economies) and the interest rate falls.¹⁶ So the presence of credit constraints not only has efficiency costs by distorting educational choice, but also widens the wealth gap between the skilled and the unskilled. In this model capital complements skilled labor, thus the wage gap is increased by the higher capital-labor ratio resulting from this oversupply of savings.¹⁷

Consider the steady state behavior of the autarchic economy. In steady state, $H_{t-1} = H_t = H$. To obtain the rate of output growth, note that in steady state all inputs except the number of intermediate goods available is constant. The steady state growth rate, g is then given by

$$g = \frac{Y_t - Y_{t-1}}{Y_t} = \frac{B_t - B_{t-1}}{B_t} = \delta\tau H \quad (30)$$

and hence determined by the level of human capital in the economy.

This result combined with equations (1.3) and (29) implies that

Proposition 1.4 *If country 2 has otherwise the same characteristics as country 1 but better financial institutions $\pi_2 > \pi_1$ then*

¹⁶According to Matsuyama (2004) credit market imperfections can indeed explain capital flows from poor to rich economies.

¹⁷See Fender and Wang (2003) for a similar model. They find that the effect of credit rationing on the real rate of interest depends crucially on whether the rationing applies to loans to finance investment in human capital or physical capital. In this model, investments in capital are tied to human capital investments.

- i) *country 2 technological progress and growth rate is higher, $g_2 > g_1$;*
- ii) *its interest rate is higher $r_2 > r_1$;*
- iii) *its income inequality is higher.*

Proposition 1.4 summarizes the effects of credit market imperfections on the autarky equilibrium. Credit constraints limit some agents' opportunities to become educated despite its desirability; as human capital drives technological progress, this translates in a lower growth rate. Like in Fender and Wang (2003) or in Matsuyama (2004) credit constraints mean a lower real interest rate. In this economy where the uneducated are savers, moral-hazard induced credit constraints imply that education falls and some agents switch from borrowing to lending. For this reason savings rise and, with capital-skilled labor complementarity, the marginal product of capital and real interest rate fall. This result differs radically from the investment loan models, such as Aghion and Bolton's (1997), in which credit constraints limit investment, leading to a higher marginal product of capital and real interest rate.

The distributional implications of credit constraints are thus determined both by the low human capital investment and the related skill premia and by the low interest rate which damages the unskilled lenders.

1.4 Trade and technology spillovers

The degree of credit market imperfections determines the amount of skilled labor in the country, the productivity of the research sector and thus of technology progress. The lowest the share of skilled labor the lowest the number of varieties of intermediate goods produced at home and the higher the number of varieties $A_t - B_t$ that will be imported. However, the bigger the difference between domestic and foreign research productivity, the more the research sector will gain in productivity upon opening to trade. As the research, or imitating sector, only employs skilled labor, opening to trade implies an increase in the wage premium as long as changes in relative intermediate goods prices are not too important. This is not to say that equalizing forces coming from Heckscher-Ohlin effects do not take place but that they might be dominated by the increased demand for skills created by a technology transfer induced by trade.¹⁸ Other than technology spillovers, critical to the small country analysis is the perfectly elastic demand on the world market, which immediately implies that the rates of technological change, growth and return to education are no longer constrained by the autarky demand (prices).

¹⁸Wood (1997) argues that the entry of large low-income exporters such as China, India, Bangladesh, Indonesia, and Pakistan in the 1980s and 1990s has reduced the relative price of less skill intensive exports thereby driving the price of unskilled goods down.

Proposition 1.5 *Following the opening to international trade and technology flows of the economy in a poverty trap, the economy passes through two phases of transition to a new equilibrium:*

phase 1 *Skilled wage increases, human capital and interest rates increase. Incomes and wealths grow in the first order stochastic sense. Inequality increases.*

phase 2 *Eventually all those who have a talent high enough (low cost of education) invest in human capital, the others become lenders. Incomes and bequests grow in the second order sense.*

Following the exogenous increase in skilled wage, incentives to educate for agents with sufficiently low educational costs increase, at the same time a higher skilled wage implies the possibility to take a higher loan, thus for increases in w_s higher than the increase in interest rate, students will invest more in education. The associated increase in capital demand raises the interest rate. At the end of their lives skilled and unskilled workers bequeath more than what they received. The increase in wealth encourages more agents in the following cohort to engage in education and on a greater scale. This will raise the demand for capital and thus the interest rate allowing more unskilled to accumulate their wealth. Moreover, increased research activity increases the wage premium of the skill sector giving to workers a higher incentive to invest in education. In the absence of international offsetting movements of prices, the new equilibrium of the economy is found when eventually return to education is equal to the interest rate (eq(20)). The returns to human and physical capital are equalized and inequality is eventually reduced.

The economy will specialize in the high technology good if this equality in human and physical capital return is reached after all the individuals have invested in human capital.

Equation (20) defines an upper bound to the ratio skilled wages and interest rate. It follows that the transitional dynamics governing the distribution of wealth converge to a stationary Markov process. This process satisfies Hopenhayn and Prescott's (1992) Monotone Mixing Condition, so that the distribution of wealth and income converge to a unique limiting distribution.

1.4.1 Numerical example

In the following section the model is simulated using the above specification. The economy is analyzed in a perfect foresight environment, i.e. agents are not subject to any form of risk idiosyncratic nor aggregate. They observe their ability before making any choice. The cost of education is modelled following Eicher and Garcia-Penalosa (2001): $c_t(B_t, q) = \zeta B_t q$ where $\zeta = 0.6$ gives a proportion of the growing technological progress translating into higher

educational costs. The parameters are such that before liberalization everyone wants to invest in human capital. However, due to credit market imperfections ($\pi = 0.7$, the probability to be apprehended after absconding) the economy is in a poverty trap.¹⁹ The initial stock of skilled labor is about 10% of the working population; this is consistent with Barro and Lee (2000) data on labor endowment by educational levels; in Latin America in the mid Eighties (before trade liberalization) less than 15% of the working force (older than 25) had a high school degree and only about 7% had some tertiary education. Accordingly the initial ratio between skilled and unskilled wages is about 3.4; this is consistent with de Ferranti, Perry, Ferreira and Walton (2003) average wage gap between high and low skilled workers for the Latin American countries at the beginning of the Nineties.²⁰ The labor share parameter for market production η used in the calibration is 0.5 this is consistent with the values found by Elias (1992) for Latin American countries. The remaining parameters are , the inefficiency parameter of unskilled workers $\xi = 0.8$, the share of skilled workers employed in the research sector $\tau = 0.33$, the input share of high/low skilled goods in the production of the final good $\alpha = 0.5$; a change of these parameters does not affect the results. the initial steady state is found in the following way:

- Create a grid of possible capital holdings associated with a schooling cost q . Each grid point represent an agent, this agent can be skilled or not.
- For an initial guess on the capital holdings and skill distribution calculate $K = K_i$, $H = H_j$, $L_{u,j}$ with $i = 0, j = 0$ With these compute from the firm optimization condition r, w_s, w_u and then solve the household's optimum problem.
- Stack all possible agents, for capital level, and educational attainment. Use the decision rules to determine the stationary distribution of agents over the educational levels and the capital holdings.
- Compute the new levels of skilled H_j^* and unskilled labor force $L_{u,j}^*$.
- For a fixed "relaxation parameter" $\mu \in (0, 1)$, compute new estimates of H , L_u from

¹⁹ The value of π does not correspond to any existing index; it might be useful to think about the rule of law index constructed by the worldbank in the World Business Environment Survey (WBES). Available at: <http://info.worldbank.org/governance/wbes/> The index ranges from 1 to 0. Larger values mean higher rule of law. The average for developing countries is 0.5 compared to 0.8 for developed countries.

²⁰they report a Latin American average wage gap between high and low educated workers of about 3.5. Low educated are workers with 8 years of education, high educated workers have more than 14 years of education.

method

$$\begin{aligned} H_{j+1} &= \mu H_j + (1 - \mu) H_j^* \\ L_{u,j+1} &= \mu L_{u,j} + (1 - \mu) L_{u,j}^* \end{aligned}$$

- Iterate on this scheme to convergence.
- Compute the aggregate value of capital K_i^* found in the previous step.
- For a fixed "relaxation parameter" $\mu \in (0, 1)$, compute new estimates of K

$$K_{i+1} = \mu K_i + (1 - \mu) K_i^*$$

- Iterate on this scheme to convergence giving each new iteration a new distribution of abilities.

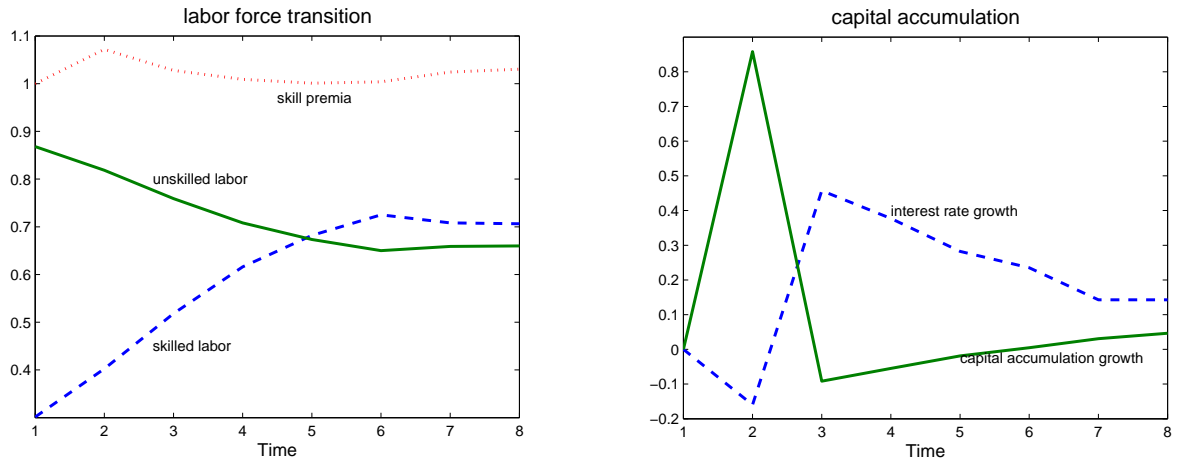
Once found the stationary equilibrium for a given level of prices the transition is computed using the laws of motion of capital, the above scheme is repeated at each period. Given the next period capital (derived from the optimal choice of this period) and a possible guess on the human capital decision agents maximize their utility, prices are adjusted and the maximization repeated until convergence over each period. The new steady state is found when human and physical capital do not change anymore. Prices are kept at the initial steady state level.

Figure (1) shows the transition of a constrained economy. Given an exogenous productivity shock on the first period wages, skilled agents who already made their investment decision will at first only be able to pass on to their descendants a higher bequest without immediately adjusting to the new prices. Thus the new increased capital will - in the first period - let the interest rate drop while the skilled wages raise.

This clearly favors educational investments: on the one side higher skilled wages imply higher incentives to invest in human capital and on the other side lower interest rates mean lower borrowing constraints. The first generation of children will then increase investment on the intensive margin (those who belonged to a "skilled family" but could not afford to increase their skill- efficiency investment) and on the extensive margin (those who due to lower interest rates can afford a loan).

The demand of skilled labor will at first be sustained by the exogenous productivity growth determined by the differential between foreign A and domestic B technology. When the country eventually reached the growth rate of the North, skilled labor demand will clearly be driven by domestic technology growth. Agents start investing in human capital, increasing the demand for loans. The increased demand for capital raises the interest rate, making the

Figure 1: Transition



opportunity cost of investing in education higher. In the first panel it is depicted also the skill premia the first increase in the skill premia is followed by a drop due to human capital adjustment, however it raises again when reaching the new equilibrium. The trade induced productivity shock thus releases the economy from a poverty trap and sets the economy on a high growth - high skill premia path.

1.5 Conclusions

Previous literature (Cartiglia (1997), or Ranjan (2001)) has shown that trade liberalization can release a developing country from a poverty trap if trade liberalization induces a fall in the skill premia. However, while the model of trade liberalization inducing both a fall in skill premia and human capital convergence might be considered consistent with the experience of East Asian economies, many other episodes of trade liberalization did not follow the same path. In particular, trade liberalization has been concurrent with increases in skill premia in many Latin American countries (Attanasio, Goldberg and Pavnik (2004), Robbins (1995), Goldberg and Pavnik (2007), Robbins (1996), Wood (1997)).

Many channels have been theorized for this phenomena. Empirically the evidence supports some form of technological transfer, due to spillover, foreign direct investments or for some countries outsourcing (notably Mexico). In the present paper an investigation of the effect of trade related technology spillovers is carried out. The mechanism through which productivity shocks spillover to the whole economy has not been analyzed before in the context of human capital investments. While credit constraints are quite common with regards to educational investments, few have considered the interactions between physical and human capital investments due to these imperfections.

An economy afflicted by credit constraints is shown to have a lower human capital stock and higher physical capital, and thus higher skilled wage, lower technological progress and lower interest rate than an economy not suffering from credit market imperfections. Agents who are not talented enough or do not have enough capital to invest in education become lenders to skilled agents. In the model presented the human capital stock determines both the degree of income inequality and the rate of growth. Technologies are generated by skilled workers, which implies that the relative demand for labor, and hence the skill premium, is not monotonically decreasing in the stock of skills in the economy. A higher demand for human capital, and a consequent increase in the interest rate allow the economy to escape the poverty trap. This in turn will set the economy on a high productivity - high skill premia path.

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1.6 APPENDIX

1.6.1 Equilibrium existence and stability

For the proof of existence and stability of the two steady states - the dual economy and the advanced economy - the following theorem by Hopenhayn and Prescott (1992) is needed:

Hopenhayn and Prescott (1992) Theorem 2: Suppose the transition function $P(a, B)$ is increasing, $\tilde{a} \in (\underline{a}, \bar{a})$ and the following condition is satisfied: Monotone Mixing Condition: There exist a point \tilde{a} and an integer m such that $P^m(\underline{a}, [\tilde{a}, \bar{a}]) > 0$ and $P^m(\bar{a}, [\underline{a}, \tilde{a}]) > 0$. Then there is a unique stationary distribution G for process P and for any initial measure μ , $T^n \mu = \int P^n(\tilde{a}, \cdot) \mu(d\tilde{a})$ converges to G .

A) There is unique equilibrium when there is twoway mobility between classes.

Let $P^n(\tilde{a}, \cdot)$ give the transition probabilities from wealth \tilde{a} after n generations, noting that:

1. P is increasing. The monotonicity of P can be shown by examining eqs (25) and (26) and noting that increasing a_t results in an increase of a_{t+1} for every realization of q_i .
2. The upper bound of the distribution of wealth is $\max(\bar{a}, a^*)$ and the lower bound of the distribution of wealth is $\min(\underline{a}, a^{**})$ where a^* is the largest inheritance received by any individual at $t = 0$ and a^{**} is the smallest inheritance received by any individual at time $t = 0$. \bar{a} and \underline{a} are the upper and lower bounds of the recurrent distribution
3. the Monotone Mixing Condition applies when there is mobility between classes. Since ability is i.i.d. among individuals, there is complete wealth mobility within a class

then Theorem 2 by Hopenhayn and Prescott (1992) can be applied to show that the distribution of wealth converges to a unique distribution.

B) There is an infinite number of steady states when there is no mobility (poverty trap).

let A be the set of all possible transfers from educated parents and B the set of all possible transfers from uneducated parents. When there is no mobility between classes, $P^N(a_1, [b_1, b_2]) = 0$ and $P^N(b_1, [a_1, a_2]) = 0$ for all $b_1, b_2 \in B$ and $a_1, a_2 \in A$ and $N \geq 1$. As shown in part (A), $P^N([a_1, a_2], [a_2, a_3]) > 0$ for all $a_1, a_2, a_3 \in A$ and $P^N([b_1, b_2], [b_2, b_3]) > 0$ for all $b_1, b_2, b_3 \in B$. Thus, when there is no mobility between classes, the state space can be divided into two ergodic sets, A and B . which in turn correspond to two invariant measures. An invariant measure over the entire state space will be a convex combination of these two invariant measures. Since there are infinite number of convex combinations, there are an infinite number of invariant measures and thus of distributions of wealth. Since $H_{t+1} = H_t$ in steady state, the flow into skilled labor must equal the flow out of skilled labor. This

is only possible if either there is no intergenerational mobility as in case B) or if there is twoway mobility as in case A).

Proof of Lemma 1.1. Let \tilde{a} denote the inheritance below which the marginal entrepreneur is constrained on the extensive margin, so that $e = \tilde{a} + p\pi/R_{t-1}$. Let \hat{a} denote the inheritance level above which marginal entrepreneurs are unconstrained so that $z = q$. Then if

$$\begin{aligned} a \in [0, \tilde{a}] & : e_a = 1, e_{aa} = 0 \\ a \in [\tilde{a}, \hat{a}] & : e_a = \frac{w_s h_x - R}{w_s h_x} > 0, e_{aa} < 0 \\ a \in [\hat{a}, \infty] & : e_a = e_{aa} = 0 \end{aligned}$$

Since $e_a(a, w_s, w_u) = 0$ for all $a > \hat{a}$, it follows that $\lim_{a \rightarrow \infty} e_a(a, w_s, w_u) = 0$.

Proof of Lemma 1.2. Let T_π and $T_{\pi'}$ be the Markov operators associated with the degrees of market imperfections π and π' , respectively. Similarly, denote the distributions associated with the degrees of credit market imperfections π and π' by $G_\pi(a)$ and $G_{\pi'}(a)$. Using the transition function defined above

$$T_\pi G_{\pi'}(x) - T_{\pi'} G_{\pi'}(x) = \int_a [P_\pi(a, [\underline{a}, x]) - P_{\pi'}(a, [\underline{a}, x])] dG_{\pi'}(a) \quad (\text{A-1})$$

It is first shown that $P_\pi(a, [\underline{a}, x]) \geq P_{\pi'}(a, [\underline{a}, x]), \forall a$. Consider the level of ability $q''(a)$ such that $b^s(a, q''(a)) = x$. Also since $b^s(a, q''(a))$ is increasing in a , if $a' \geq a$, then $q''(a') \geq q''(a)$. Then the transition function can be written

$$P_\pi(a, [a, x]) = 1 - F(e_\pi(a)) + F(e_\pi(a)) - F(q''(a)) \quad (\text{A-2})$$

where the first term on the right hand side refers to unskilled workers and the second term to skilled workers. $P_{\pi'}(a, [a, x])$ can be defined analogously. Consider the different cases

Case I $q''(a) < e_{\pi'} = 0$ and $q''(a) < e_\pi = 0$, then $P_\pi(a, [a, x]) - P_{\pi'}(a, [a, x]) = F(e_{\pi'}(a)) - F(e_\pi(a)) \geq 0$

Case II $q''(a) < e_{\pi'} = 1$ and $q''(a) < e_\pi = 1$, then $P_\pi(a, [a, x]) - P_{\pi'}(a, [a, x]) = 0$

Case III $q''(a) < e_{\pi'} = 1$ and $q''(a) < e_\pi = 0$, then $P_\pi(a, [a, x]) - P_{\pi'}(a, [a, x]) = F(q''(a)) - F(e_{\pi'}(a)) \geq 0$ because $e_\pi(a) > q''(a) > e_{\pi'}(a)$

Case IV $q''(a) < e_{\pi'} = 0$ and $q''(a) < e_\pi = 0$, then $P_\pi(a, [a, x]) - P_{\pi'}(a, [a, x]) = F(q''(a)) - F(e_\pi(a)) \geq 0$ because $e_{\pi'}(a) > q''(a) > e_\pi(a)$

Therefore $P_\pi(a, [a, x]) - P_{\pi'}(a, [a, x]) \geq 0 \forall a$. Thus $T_\pi G_{\pi'}(x) - T_{\pi'} G_{\pi'}(x) \geq 0$ or $G_{\pi'}(x) = T_\pi G_{\pi'}(x) \leq T_\pi G_{\pi'}(x)$. Since the Markov operator T_π is increasing and the transition function is increasing, then $G_{\pi'}(x) \leq (T_\pi)^n G_{\pi'}(x)$, where $(T_\pi)^n$ is the n th iterate of T_π . Then

from the previous proof on stationary equilibria, for $n \rightarrow \infty (T_\pi)^n G_{\pi'}(x)$ converges to $G_\pi(x)$. Therefore $G_\pi(x) \leq G_{\pi'}(x)$.

Proof of Lemma 1.3. Given Lemmas 1.1 and 1.2 and the following theorem by Hadar and Russel (1971) $H_{\pi'} \geq H_\pi$.

Theorem 1.6 (Hadar and Russel (1971)) Let $M_g = \int \mu(a)G(da)$, where $\mu_a(a) \geq 0, \forall a$; $\mu_a(a) > 0$ for an interval. If $G(a)$ first order stochastically dominates $F(a)$ then $M_g > M_f$.

Theorem 1.7 (Hadar and Russel (1971)) Let $M_g = \int \mu(a)G(da)$, where $\mu_{aa}(a) \leq 0$, $\mu_{aa}(a) < 0$ for some a . If $G(a)$ second order stochastically dominates $F(a)$ then $M_g > M_f$.

Proof of Proposition 1.4. Given Lemma 1.3, and equations (4), (28) (29) , and (30) the result follows.

Proof of Proposition 1.5. The following analysis is influenced by Lloyd-Ellis and Bernhardt (2000).

Phase 1 Denote by $\Phi_t(y)$ the distribution of income. Let $\hat{q}(y^*, a, w_{u,t}, r_{t+1})$ be the value of q such that income of skilled workers is $y_s(a, q, w_{s,t+1}, r_{t+1}) = y^*$. Then the distribution of income conditional on inherited wealth and the equilibrium obtaining at time t can be represented by the cumulative distribution function

$$\Phi(y|a, w_s, w_u, r) = \left\{ \begin{array}{ll} 1 - H(e(a, w_u, \pi)) & \text{if } w_{u,t} \leq y < \underline{y}_s(a, r, w_s, w_u) \\ 1 - H(x^{opt}(y, a, w_s, r)) & \text{if } \underline{y}_s(a, r, w_s) \leq y \leq \bar{y}_s(a, r, w_s) \\ 1 & \text{otherwise.} \end{array} \right\} \quad (\text{A-3})$$

where $\underline{y}_s(a, r, w_s) = \max[w_u, y_s(a, \tilde{q}, r)]$ is the lower support on skilled workers income (where the education investment is determined by credit constraints $e = \tilde{q}$).

$\bar{y}_s(a, r, w_s) = y_s(a, r, \bar{q})$ is the upper support. The unconditional distribution of incomes is therefore $\Phi(y) = \int \Phi(y|a, w_s, w_{u,t}, r)G_t(da)$. Let \hat{q} be implicitly defined by $y_s(a, \hat{q}, w_s) = y$. Total differentiation reveals that $\hat{q}_a \geq 0$

Suppose that for some t , $G_t(\cdot)$ First Order Stochastically Dominates (FSD) $G_{t-1}(\cdot)$. Then the resulting change in the distribution of income for any y equals.

$$\Phi_t(y) - \Phi_{t-1}(y) = \int \Phi_a(y|a, w_s, w_u, r)[G_{t-1}(a) - G_t(a)]da \quad (\text{A-4})$$

But $\Phi_a(y|a, w_s, w_u, r) \leq 0$. Hence from Theorem 1.6 by Hadar and Russel (1971), $\Phi_t(a)$ FSD $\Phi_{t-1}(a)$. Analogous results hold for the distribution of final wealth and, hence, bequests: $G_{t+1}(a)$ FSD $G_t(a)$. Since $G_1(a)$ FSD $G_0(a)$, the first part of the proposition follows by induction. Income inequality is increasing as technological progress is faster (equation (4)) and thus the skill premia increases.

Phase 2 Increasing human capital raises the interest rate allowing unskilled lenders to accumulate enough to invest in education. As the incentive to invest in education (the skill premia) increases over time, and relative prices are exogenous in free trade, the economy will tend to specialize in the high skill good. As credit constraints are no more binding, the optimal investment in education is determined by the return to capital as in eq. (20). This will be the new educational investment for everyone, thus inequality decreases.

Chapter 2

Factors affecting the schooling performance of secondary school pupils - the cost of high unemployment and imperfect financial markets

This is joint with Lidia Farre

ABSTRACT

This paper investigates the implications of major financial markets crises for the human capital accumulation decisions of households. We use data for Argentinean households over the period 1995-2002 to examine households' response to negative idiosyncratic income shocks in different macroeconomic scenarios. In particular we study how teenagers' school progress responds to household head unemployment during periods of high economic growth and compare it to the response during recession years, when families are more likely to be financially constrained. After accounting for the potential endogeneity of household head unemployment we find that school failure in response to unemployment shocks increases during periods of economic instability. Further we find that for first born boys this results from a greater involvement in labor market activities. Our results add to the existing literature on the long term cost of macroeconomic crises.

2.1 Introduction

Under the assumption that households have access to a complete market in contingent claims, marginal utilities of consumption and of human capital investments are not affected by purely idiosyncratic shocks. Accordingly investment decisions, including those in human capital, are determined solely by rates of return. However, in the presence of credit and insurance market imperfections, labor market shocks and fluctuations can have a deep impact in household consumption and time allocation behavior (Jacoby and Skoufias (1997)). Self-insurance strategies or informal arrangements to cope with unexpected shocks might include the liquidation of physical assets or the reallocation of time of family-members towards income-earning activities, and possibly a decrease in human capital investments. As a consequence income shocks might increase the transmission of poverty across generations and have long term consequences on inequality.

This paper examines the consequences of credit market imperfections for households' human capital investment in Argentina during the economic crisis of the late 1990's and early 2000's. We use data over the period 1995 - 2002 to cover both a recessionary and a growth period. During periods of aggregate instability families are likely to experience difficulties accessing credit; as a consequence, negative shocks to household income may lead to a higher involvement in productive activities by household members. If young household members are those who increase participation in home and market production they will have to sacrifice part of their time at school and consequently reduce their investment in human capital. By comparing the response of human capital investment decisions to negative household income shocks in different macroeconomic scenarios we can test for the presence of credit market imperfections.

For developing countries there is growing empirical evidence that these concerns apply to rural areas and affect child labor supply. Jacoby and Skoufias (1997) and Jacoby (1994) find that Indian agrarian households lacking access to formal financial markets are found to draw upon the labor of their children when faced with an income shortfall. A wide literature also examines the consequences of the macroeconomic crisis suffered by Indonesia. Frankenberg, Smith and Thomas (2003) find that household's labor supply increase during the crisis while Thomas, Beegle, Frankenberg, Sikoki, Strauss and Teruel (2004) find evidence of a negative effect of the macroeconomic shock on the attendance rate of younger children with older siblings in the household. However, Indonesia had a very large rural sector in which to work during the crisis.

Evidence of whether the same concerns are relevant for the relatively wealthier urban areas typically characterized by a wide heterogeneity in the nature and effectiveness of formal

safety nets is remarkably rare.¹ Based on panel data from urban Brazil, Duryea (1998) examines the role of transitory shocks to household income in children's advancement through school in Brazil. Her results show that children's time is used to buffer rare transitory income shocks to households in ways that are consistent with education models that incorporate insurance or credit market imperfections. On the same data Duryea, Lam and Levinson (2007) find that unemployment shocks significantly increase the probability that a child enters the labor force, drops out of school and fails to advance. In particular teenage girls are the most affected by the household shock. Looking to the Mexican peso crisis Parker and Skoufias (2006) find that while significant added-worker effects are in place for adult females, for teenage males there is no significant evidence that labor force participation, school attendance and the likelihood of advancing to the next school grade are influenced by the event of unemployment of the household head. This is in contrast to Attanasio and Székely (2004) findings that show that Mexican households tend to react to idiosyncratic shocks reducing human capital expenditures. Finally, consistent with the hypothesis of income effects driving the labor market incentives of children, Schady (2002) finds positive effects on schooling attainment of urban peruvian children aged 11 to 17 years old during the macroeconomic crisis of 1988-1992.

Evidence based on urban data is more mixed than in rural areas partly because macroeconomic circumstances also influence the incentives of child labor. In particular as the labor market conditions determine the likelihood that the household heads loose their job, they also determine the average wage children can expect to receive entering the labor market, thus affecting the opportunity cost of schooling.² A change in the wage that a child can earn has both income and substitution effects on children's time allocation decisions. Children who work to meet a standard of consumption will work fewer hours when their wage increases (income effect), while the substitution effect implies that children will work more when wages increases.

This paper examines the labor market and educational behavior of teens both during recession and high growth years in urban areas of Argentina. We focus on teenage children both because recent efforts to increase schooling attendance have been targeted at this group and also because teenagers may be in a better position to contribute to household income than younger children. Our analysis focuses mainly on the educational and work behavior of boys as previous research suggests that they are more likely than girls to participate in

¹Fafchamps and Wahba (2006) find that Nepalese children residing in or near urban centers attend school more and work less in total but are more likely to be involved in wage work or in a small business. The larger the urban center, the stronger the effect is.

² Clearly also children' probability of finding a job is affected by general conditions, depending on the separation of the two labor markets or the substitutability of adult work with child work.

market activities to insure the household (UNICEF (1997), EANNA (2004)).³ However, for comparison purposes, we replicate the same empirical analysis for girls.

In our empirical investigation the presence of negative idiosyncratic income shocks is measured by unemployment spells affecting the household head. There may be the concern that interruptions in the work career of the head are not exogenous to the educational and labor market performance of teenagers in the household. Accordingly we need to find a valid instrumental variable to estimate the causal effect of idiosyncratic shocks on teenagers behavior. In rural settings natural events, typically rainfalls, are used as a source of exogenous variation for household head's unemployment spells. In urban settings it is more difficult to find a valid instrument. In this paper we use a trade related measure, namely export prices interacted with the structure of the different production sectors in which the household head works, as a source of exogenous variation for the unemployment probability. This is because the effect of the crisis was very heterogeneous in its impact across groups defined by different sectors and firms size (Pessino and Andres (2003)).⁴ The instrument is shown to be highly correlated with unemployment spells while not being a choice variable of the worker.

We find evidence that during periods of economic deceleration unemployment spells by the household head have a negative effect on boys and girls' human capital investment. In contrast, these spells do not affect schooling progress during growth periods. Our study of labor market behavior suggests that at least for the oldest male sibling in the family schooling failure results from their greater involvement in market activities. For girls, we do not find evidence that the failure is produced by a similar mechanism. This result is consistent with previous research where girls' time is more likely to be employed in home production. On the whole, our results indicate that during periods of economic instability, when access to credit is more difficult, households use teens' time to insure themselves against negative labor market shocks. Accordingly macroeconomic crisis and related financial market failures have important costs in terms of human capital investment by teens.

The paper proceeds as follows: in the next section we outline the macroeconomic conditions of Argentina during the period under study. Section 3 presents the data and empirical strategy and section 4 discusses the results followed by some concluding remarks.

³Studies which do have access to information about children's time use (Levison, Moe and Knaul (2001), Cigno and Rosati (2005), or Emerson and Souza (2008)), show that while for girls the traditional work - school tradeoff is far from resolved, the relevant work activity to be considered in the analysis of girls' time use is house chores work.

⁴For example, job creation occurred in construction and destruction in services and government sector. In the short-run though services and medium and small firms appeared to benefit (Pessino and Andres (2003)).

2.2 Argentina economy and education system

2.2.1 The economy

After a decade of recurring debt crisis and stagnating growth, in 1991 Argentina implemented a wide ranging set of reforms such as liberalizing the country to foreign capital and trade, as well as reforming the labor market and fixing the exchange rate to the dollar. Economic opening and regional integration increased both exports and imports. In general, trade opening led to a higher surge in imports than in exports, that produced a structural negative trade balances. The currency board was partly responsible for this disappointing performance since it kept the price of exported goods artificially high. As a matter of fact exports recovered after the 2001 crisis, supported by the strong devaluation of the local currency. The impact of the increase in imports during the 1990s was negative as a result of the industrial restructuring and a rise in labour productivity (Galiani and Hopenhayn (2003)). The unemployment rose from nearly 6% at the end of the 1980s to around 15% at the end of the 1990s and over 20% during the 2001-2002 crisis.⁵

Table (A-1) shows some key macroeconomic indicators over the period 1995-2002. This period is of particular interest as it includes 3 years of high growth 1996, 1997, 1998 after which Argentina entered in a prolonged recession coupled with 3 years of deflation.

2.2.2 The education system and child labor

Since 1884 Argentina established mandatory primary school: this involved 7 years of education for children aged 6 to 12. Secondary school (nivel medio) followed from age 13 to 17. Both primary and secondary schooling have traditionally been public and free.⁶ In 1993 the mandatory years of schooling increased from 7 to 10. Last year of pre-school at age 5 and the first two of high school (age 13 and 14) became obligatory.

Table (A-2) describes upgrading and repetition rates by grade and year. All the rates reported- promotion, repetition, lagging behind and dropping out- show a dramatic change passing from grade 7 (the old primary school - mandatory school) to grade 8 (old secondary school). However, the reform seems to have had some effect as all the rates improve over time, in spite of adverse economic conditions.

Argentinean legislation prohibits work to children younger than 14 years old (law on work contract 1976) and strictly limits the hours of work and working conditions of the children aged 14 to 17 years old. The Children's and Teenagers' Activities survey (Encuesta de

⁵Calvo, Izquierdo and Talvi (2003) explain in detail the macroeconomic context of the crisis. For a review on the effects on workers/ households see McKenzie (2004) or Giovagnoli, Fiszbein and Adriz (2003).

⁶ According to official statistics from the Argentinean Ministry of Education for the period 1996-2000, only 20% of primary school pupils and roughly 27-28% of secondary school pupils attended private schools.

Actividades de Niñas, Niños y Adolescentes, EANNA) designed to measure the incidence of child labor in Argentina found that in 2004, 6.5% of children aged 5 to 13 years old worked at least an hour in the market or doing house work, while this figure was about 20% for the children aged 14 to 17 years old. These percentages are much higher than the figures found in our sample as they include hours of homework, and they include rural areas, where helping in the parents' farm is a relatively common task.

According to the EANNA, the most common activity for boys aged 5 to 17 in urban areas is to work in shops and workshops, while for girls the main occupation is housework taking care of younger children, elderly and sick persons. This is why in our analysis, we will consider primarily boys, as girls's opportunity cost of schooling is badly represented by market wage. Both home and market work clearly affect the schooling performance of children. This is evident from table (A-4) constructed with the information in our sample.⁷

2.3 Data and empirical strategy

Our main source of data is the Permanent Household Survey (Encuesta Permanente de Hogares, EPH) from 1995 to 2002. This is a national socioeconomic survey collected by the Argentinean Statistical Institute (INDEC) in the major urban areas of Argentina. In its most recent wave the survey covers 29 urban centers, which represent 70% of urban national population and 61% of the national population.⁸ The EPH is the only survey that covers the whole country for a long period of time.

The survey is conducted twice per year, in May and October. The survey, identical in both waves, contains an individual questionnaire and a household questionnaire surveying the family characteristics and standards of living. Since the academic year in Argentina runs between March and November, the two waves contain information on schooling attendance during the third and eight month of the academic year, respectively.

The survey is designed as a rotating panel. Each household is interviewed in four consecutive waves, after the fourth round it is removed and replaced by a new household. The design is such that in any given cross section of EPH, 25% of the households are in their first interview, 25% are in their second interview and so on. We construct two years panels following each 25% of households from May to May.

Although the length of the panel at the household level is short, the data allows us to follow teens attendance and progress in school over a year time, and at the same time track the employment and earnings experiences of their family members. The sample is restricted

⁷The corresponding statistics from EANNA in 2004 are broadly comparable in magnitude taking in account the fact that our data only considers market labor activities.

⁸Note that the rural population in Argentina represents less than 10% of total population.

to young members in the household aged 12 to 18 years old over the period 1995-2002, who are enrolled, cohabit with their parents and whose household head is employed at the time of the first interview (May). Household heads who are currently unemployed in the first observation may have already experienced a shock and, therefore, be deviated from their long run path. We restrict our analysis to household heads employed as salaried workers excluding self employed or employers. This is to exclude children collaborating in the family's enterprise as unpaid workers. This situation would invalidate our instrument.

To test for the presence of credit market imperfections we take as a theoretical framework of reference the model in Jacoby and Skoufias (1997). This model predicts that if households can fully insure against risk, changes in their consumption and investment decisions depend on changes in the collective resources but not on changes in the distribution of resources among households. Thus testing for the presence of credit market imperfection simply requires examining cross-section correlation between changes in their economic decision and changes in their resources. In this paper we test for the presence of full insurance by examining the response of children's human capital investment and labor market participation to idiosyncratic household's shocks, which we proxy by unemployment spells of the household head over the academic year.

To measure changes in human capital investment decisions we focus on whether the child has successfully completed the grade in which he/she was enrolled at the time of the first interview (i.e. beginning of the academic year). We define upgrading individuals as those who in the third observation (i.e. May of the year after the household was first interviewed) declare to be enrolled in a higher grade respective to the previous year or have completed the grade they were enrolled in. To complete our empirical analysis we also track these individuals labor market behavior from the first to the third observation. For the household head we reconstruct working histories using questions on the duration of the employment or of the unemployment spell. We can therefore classify heads as always employed if in the three observations they declare to be employed and their experience or tenure in the second year is greater than in the first observation. All other cases, excluding voluntary changes in occupation, are categorized as events creating a negative shock to the household's income.⁹ With two waves per year over 8 years, we have an average of 600-800 boys (girls) per year and thus our final sample contains roughly 5,800 observations for each gender. We do not include information in surveys before 1995 as the sample design is different and households are not easily tracked over a year time.

⁹ We follow the official definition of employment participation in which an individual is considered to be in the workforce if he or she was employed for 1 hour or more of paid work in the week of reference; or if he or she did work for 15 hours or more without a pay; or if he or she did not work in the reference week for reasons due to leave, vacation, strike, or illness but maintained his or her employment status.

Tables (A-3) and (A-5) present some descriptive statistics for our sample. Table (A-3) shows the probabilities that the household head remains employed throughout the academic year by educational level. We can identify three different levels of education: only primary or less than primary education, at most secondary and more than secondary school. The probability of remaining employed increases in the educational level attained suggesting that unemployment risk and volatility is unequally distributed and that low skilled heads are more likely to experience unemployment spells. The time trend and timing of the crisis are also clear from this table. Table (A-5) shows the labor market participation rate of children younger than 15, - thus subject to the mandatory schooling rule - and older than 15, both for household heads who are always employed throughout the period examined and those who experience an unemployment spell. The table suggests that older children are much more likely to participate in market activities and that children of household heads experiencing unemployment spells have higher chances of entering the labor force. However mandatory schooling seems successful in limiting labor market participation among the youngest when the head becomes unemployed. These patterns characterize the labor market behavior of boys as well as that of girls. Thus the figures in this table indicates that the Argentinean economic crisis in the late 1990's and early 2000's seems to have interrupted the improving trend into reductions of child labor participation and school interruption. Next we explore the contribution of financial market incompleteness in explaining these trends in children and teens educational behavior.

Progress to a higher grade can be thought to be a function of the child's effort spent on schoolwork. This effort, e_{it}^c *, can not be observed; however it can be considered a latent variable that influences the likelihood of upgrading. Accordingly we model the upgrading probability using an indicator variable ΔS_{it}^{child} that takes value 1 if e_{it}^c * exceeds an unobservable threshold and therefore the child is promoted to the next grade, and 0 otherwise. We test for credit market imperfections in a model of children's schooling progress where the employment status of the household head is included as an explanatory variable. The coefficient on this variable can be interpreted as an indicator for the presence of imperfect insurance markets. To investigate whether the degree of financial market imperfections changes with the macroeconomic conditions we interact the employment status variable with an indicator that takes value one during recessionary years.

The economic literature has widely documented that the economic behavior of children resembles that of their parents (see Mulligan (1997); Solon (1999)). Thus we need to control for the presence of unobserved factors affecting both the schooling outcomes of children and the employment status of their parents. We estimate a linear probability model for the child's upgrading behavior, and adjust for the potential endogeneity of parental employment

using a two-stage least squares procedure.¹⁰ In the 2SLS instrumental variable approach trade related measures are used as exclusion restrictions. The empirical model for the child's schooling behavior is:

$$\Delta S_{it}^c = \begin{cases} 1 & \text{if } e_{it}^{c*} = \alpha_S + \gamma_{1S} E_{it}^{hh} + \varsigma_{1S} cr + \gamma_{2S} E_{it}^{hh} cr + \beta_S \Delta \ln W_{it} + \delta_S X_i + \varsigma_{2S} R_{it} + \varsigma_{3S} Y_{it} + \varepsilon_{it}^S > 0 \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

where ΔS_{it}^c is the indicator of progression in school for child i . E_{it}^{hh} is an indicator variable taking value 1 if the head in child i 's household has not experienced an unemployment spell during the academic year and 0 otherwise. The variable cr is a crisis indicator that takes value 1 if the year, t , of the observation is 1995, and 1999 to 2002, and 0 otherwise.¹¹ The variable $E_{it}^{hh} cr$ captures the interaction between the employment status of the household head and the crisis indicator cr . The coefficient on the indicator for the employment status of the household head and that on the interaction with the crisis indicator, cr allow us to test for full insurance. The instrument employed to identify the causal effect of both the household head employment status and the additional effect during crisis years is carefully discussed at the end of this section.

Education in Argentina is free thus the only cost of schooling is represented mainly by foregone production or earnings. Accordingly we include in equation (1) the log wages of children and teens in the year of reference, $\Delta \ln W_{it}$. This variable captures the effect of changes in the opportunity cost of secondary school. The variable is constructed as the mean wage in the individual's cell, where cells are defined on the basis of region, gender and an indicator for whether he/she is older than the minimum school-leaving age (i.e. 15 years old). Real mean wages at the cell level are computed from the entire sample of individuals between 12 and 18 years old in the EPH survey in each semester and not just the subsample of households in our panel.¹²

Note that the model in equation (1) is in differences thus it should not include any variable that is constant over time. However, individuals or families may have different preferences for education. Accordingly the schooling model includes a set of preference shifters to allow children's schooling progress to vary with the characteristics of the family X_i . The preference shifters are represented by dummy variables to control for the level of parental education. We also include a vector of child's characteristics, such as child's age and an indicator for

¹⁰While a biprobit estimation is more efficient, a simple 2SLS imposes less restrictive assumptions on the error structure while being consistent (Altonji, Elder and Taber (2002), Angrist (2001)).

¹¹In 1995 the country suffered from the Mexican tequila crisis, with unemployment reaching 15% for the first time in two decades.

¹² The nominal wage for each individual in any given semester was deflated by the simple average of the value of the national consumer price index (CPI) prevailing in each month of the academic year. The monthly CPI was obtained from the INDEC website.

being subject to school obligation or not. In addition both the schooling and the employment equation include a set of year, Y_{it} , and regional dummies, R_{it} . Year dummies are used to control for the role of common aggregate shocks and to absorb potential changes in the real interest rate $r(t)$ faced by households.

In the presence of unobserved factors shared by children and their parents, identifying the causal effect of household head's unemployment in equation (1) requires the use of instrumental variables. Here we propose the use of an instrument that is likely to have affected the demand for labor in Argentina during the period, but not the supply side. Thus not being a choice variable for the worker. The instrument we propose is related to Argentinean trade performance and how this differently affected the sectors of the economy. Argentina liberalized its trade regime at the beginning of the 1990's. Total trade almost quadrupled between 1990 and 1998. According to traditional trade theory, economic liberalization is meant to increase trade, accelerate technological change, efficiency gains and growth. It is argued that a more efficient allocation of resources due to trade liberalization will, in the long run, lead to increased welfare and will have a positive impact on employment as well as on poverty and inequality. However negative employment effects in specific sectors are expected during the transition period.

The proposed instrument is an index of export prices interacted with the sectoral share of firms with more than 25 employee as measured in 1993. The size threshold is particularly relevant as according to the Argentinean labor market legislation, firms with less of 25 employees are subject to less restrictive norms, often resulting in much more dynamic enterprises. On the other hand, for many sectors, size is an important indicator of competitiveness and employment stability. This partly explains the differential impact of devaluation across groups formed by sectors and firms' size. For example during the period 1995 – 2002 while services and public administration lost jobs, small and medium services were particularly active creating new jobs (Pessino and Andres (2003)).¹³

There are several reasons to support the conjecture that the price of Argentinean exports is determined in the worldwide market, without much influence of its own economic conditions. First, Argentina is a relatively small open country, thus it is not supposed to influence world market prices. Second, the bulk of Argentinean exports are agricultural goods, petroleum and combustibles, which are traded on relatively free international commodities markets. Last, but not least, Argentina adopted a currency board policy during the 1990's, that prevented exchange rate manipulations to favor exports.

Our measure of export prices is obtained from the Argentinean Statistics Office that provides export price indexes for major product industries. The indices are constructed in

¹³see Corbacho, Garcia-Escribano and Inchauste (2007) for an extensive analysis of the role of the public sector during Argentinean's crisis.

different ways depending on the product type. For primary products or products not highly elaborated, the prices used to construct the index refer to unit values available from the customs registry for any tariff item. Primary products constitute the leading Argentinean export sectors, and can thus be decomposed in rather precise price indexes, as each product is listed under a certain tariff. For more elaborated goods, like capital goods or durable goods, customs registries cannot be used. This is because the various parts of these products, or the different models of the same product can be subject to different tariffs. Thus for these goods, the unit values reported in the customs registry can reflect both changes in export prices and the application of different tariffs. To construct price indexes for these sectors, prices of international market leaders are used. Thus for these kind of goods, only more aggregated price indexes are available.¹⁴ For services, public sector/non traded sectors we use the general export price level, meant to be valid for the whole economy's exports. The interaction of export sectors and size groups allows us to define about 30 groups each year.

Note that the model in equation (1) is in differences, thus in estimation individual characteristics constant over time drop from the error term. Accordingly our instrument will be valid as long as it is uncorrelated with children and teens' unobserved characteristics changing over time. While preferences for education and working habits might change with the economic context, they also have a large persistent component that is inherited from previous generations (Toledo (2008)) and will not immediately adjust to the new economy. However, as a robustness check for our identification strategy, we estimate the schooling model using as instrument lagged values of export prices in the sector where the household head is employed. While export prices in the previous period are likely to be correlated with the current employment level, they are certainly uncorrelated with contemporaneous idiosyncratic shocks at the individual level.

The model in equation (1) allows us to analyze the effect of household head's unemployment on children's schooling outcomes and test for the presence of credit market imperfections. To further investigate the mechanism behind this relationship we explore the implications of household head's unemployment for children and teens' labor market behavior. The labor supply of young household members can be used as an informal mechanism to insure households against unexpected and negative idiosyncratic shocks such as unemployment spells. However the time that children and teens spend on various activities such as work and school is likely to be simultaneously determined. Thus it is reasonable to expect that an increase in the number of hours a child is employed will reduce time for other activities and negatively affect their schooling outcomes.

To investigate the previous conjecture we regress the change in the child's labor market

¹⁴ These prices are already expressed in real terms referring to 1993 prices, we thus do not need to adjust for inflation.

status over the academic year on the same set of explanatory variables included in the schooling model in equation (1). The model for the change in the child's labor market behavior is:

$$\Delta P_{it} = \alpha_P + \gamma_P E_{it}^{hh} + \varsigma_{1P} CR + \gamma_{2P} E_{it}^{hh} CR + \beta_P \Delta \ln W_{it} + \delta_P X_i + \varsigma_{1P} R_{it} + \varsigma_{2P} Y_{it} + \varepsilon_{it}^P \quad (2)$$

where P_{it} is an indicator value that takes value 1 if the child works in period t and 0 otherwise. Thus the dependent variable in the model can take the values -1, 0 or 1, and it is obtained from comparing the child's labor market status in May of two consecutive years. We estimate the model in equation (2) by two-stage least squares using the previous instrument to control for the potential endogeneity of head's unemployment.

2.4 Results

In this section we examine the implications of credit market imperfections for human capital investment decisions. In the presence of full insurance we expect discontinuities in the work career of the household head not to have any effect on the schooling progress of other household members. In contrast, if households do not fully share risk, interrupted work careers by the head will negatively affect the human capital investment decisions of other household members, if, for example, they have to increase their degree of labor market involvement to insure the household against income drops. To test this conjecture we first estimate the schooling model in equations (1) for all the years available in the sample. However imperfections in financial markets are likely to vary depending on the aggregate state of the economy, thus we re-estimate the schooling model by including the interaction between the employment status of the household head and the crisis year indicator.¹⁵ The results separately for both boys and girls appear in table (1).

Column (1) in Table (1) reports the OLS estimates of the linear probability model for boys while column (5) reports the results for girls. The coefficient on the indicator for the absence of discontinuities in the work career of the household head is not statistically significant on the boys' likelihood of upgrading. For girls, the indicator of the employment status of the household head is marginally significant at the 10% level. To investigate whether the effect of parental employment status is different conditional on the macroeconomic scenario we include in the empirical model a crisis year indicator and an interaction between this indicator and the employment status of the household head. The results for this alternative specification for boys appear in column (2) of Table (1) and those for girls in column (6). While the coefficient on the crisis year indicator is always negative and highly significant its

¹⁵This indicator takes value 1 if the observation belongs to years 1995, and from 1999 to 2002, and 0 otherwise.

interaction with the indicator of the employment status of the household head is not (both for boys and girls).

As mentioned in the previous section the estimation results in columns (1)-(2) and (5)-(6) do not reflect the causal impact of household head unemployment in the presence of unobserved factors associated both with parents' and children's schooling and labor market performance. To account for the potential endogeneity of parental unemployment we estimate the model in equation (1) by two-stage least squares using as exclusion restrictions the instruments discussed in the previous section. Table (2) displays the first stage estimates for the parental employment probability. The size of the t-statistic suggests that the instrument is very informative in all the specifications and take this result as evidence that the export price index satisfies the conditions required to identify the effect of head's job losses on schooling progress.

In Table (1) columns (3) and (7) present the *2SLS* estimates of the upgrading linear probability model respectively for boys and girls. In both columns the adjusted coefficient on the indicator variable for the employment status of the household head is higher in magnitude than the OLS estimate but it remains statistically insignificant. We next investigate whether the effect of employment discontinuities by the household head on human capital accumulation decisions varies conditional on the macroeconomic scenario. The *2SLS* estimates for the specification that includes the interaction between the employment status of the head and the crisis year indicator appear in column (4) for boys and (6) for girls. The coefficient on the employment status of the head, though positive, remains statistically insignificant. However the coefficient on the interaction is now positive and highly significant for boys. The point estimate suggest that continuous work career by the household head during recessionary periods increase the chances of school upgrading by about 60 percentage points relative to growth periods. Our results provide strong evidence that while the employment status of the household head does not affect the upgrading probability during growth periods, the absence of work career interruptions by the household head mitigates the negative effects of recessionary periods for the households' human capital accumulation decisions.

The results for girls reveal a similar story. The coefficient on the employment status of the head is statistically insignificant; however that on the interaction is positive and statistically significant at 10% level. The point estimate indicates that the probability of schooling upgrading increases by about 33 percentage points if the head is continuously employed during periods of aggregate economic instability relative to periods of economic prosperity. The effect for girls is half of what we find for boys suggesting that the latter are at a higher risk of schooling failure if the household head loses the job. This evidence is consistent with the work by Emerson and Souza (2008), Cardoso and Verner (2007) and

Sedlacek, da Costa, de Carvalho, Gustafsson-Wright and Neri (2000) on Brazilian children or Thomas et al. (2004) on Indonesian children, where boys present a higher response to households' income shocks than girls due to the higher opportunity cost of staying at school. That pattern does however contrast to evidence found for other Latin American countries (Duryea et al. (2007) for urban Brazilian, Parker and Skoufias (2006) for Mexican children).

We further investigate the educational response to household head unemployment of the oldest child in the household. The fact that earlier born children may have higher innate abilities may mean that their return to education is greater than that of later born children which might lead to the decision to withhold them from the labor market.¹⁶ During the 1998 crisis in Indonesia poorer households apparently sought to protect investments in the schooling of older children at the expense of the education of younger children (Thomas et al. (2004)). This would be consistent with the previous literature on birth order effects.

On the other hand, these same abilities may mean that they are able to command higher wages as children on the labor market than their later born siblings and thus are more likely to be sent to work as children. Also, older children can command higher wages than younger children, this also could lead to earlier born children being sent to work rather than their later born siblings. Thus, when examined in an emerging economy context, where child labor is widespread, the effects of birth order may be distinctly different than has been previously assumed.

Previous work in developing countries has found that the oldest siblings are those more involved in the household surviving strategies. For example Emerson and Souza (2008) find that Brazilian male firstborn children are less likely to attend school than their later born siblings and that male last-born children are less likely to work as child laborers than their earlier born siblings. For female children, first-borns are less likely to go to school than their later born counterparts.¹⁷

The results for the oldest siblings are reported in Table (3) for both boys and girls. Obviously the sample size has decreased but the results in this table reinforce those obtained on the whole sample. That is, while the coefficient on the indicator of the employment status of the household head is statistically insignificant, its interaction with the crisis year indicator is positive. Thus continuous work careers by the head during periods of aggregate instability has a positive effect on the upgrading probability of the oldest siblings. Notice that the

¹⁶A large body of empirical evidence finds that first-born children have higher IQs and cognitive abilities than their later-born siblings. See for example Black, Devereux and Salvanes (2008) or Behrman and Taubman (1986). However, most of this evidence is based on developed nations' results.

¹⁷Edmonds (2006) analyzes the effect of rice's price liberalization in Vietnam on child labor. The author finds that household composition attributes that are associated with higher levels of child labor are also associated with larger declines in child labor when rice price increases. See also Edmonds (2004), Emerson and Souza (2007)

effect is now statistically significant at the 5% level for both boys and girls and that the magnitude of the effect is substantially larger than that for the whole sample. This evidence reinforces the view that oldest siblings are at higher risk of acting as insurance mechanism during periods of financial difficulties.¹⁸

One confounding factor in the literature on birth order is usually the family size. Family size has been found to have negative developmental effects likely due to the fact that family resources are spread more thinly the larger the family. The size of the family may also be an important factor in the labor force participation and school attendance of children. It may be that larger families increase the likelihood of the household being impoverished and thus large families are more likely to need the additional income a child who works in the labor market can provide. Or it may be - most likely in agricultural environments - that families increase the number of children they bear as a response to poverty so that the family's income may be supplemented by sending some children to work or having them provide labor within the household. Looking at short term shocks, these long run effects should be ruled out. However, to avoid confounding effects in the robustness checks we present regressions which include family size as an additional control.¹⁹

Some of the other estimated coefficients in Table (1) and (3) also deserve some attention. The estimates indicate that children with more educated parents have higher chances of being successful at school and less likely to participate in market activities. This result indicates that intergenerational mobility, at least in education, is low in Argentina. The coefficient on the variable capturing changes in wages is negatively correlated with the probability of schooling progress for boys. This is evidence that male teens' educational choices respond to the opportunity cost of staying at school. Accordingly an increase in the opportunity cost of school, as measured by the wage rate, increases the chances that individuals drop out from school to participate in market activities. In contrast the effect of the wage differential is positive for girls. This could indicate different incentives, i.e. income effects, for girls' time allocation decisions.

The most important feature in table (1) is the implicit negative response of children's school progress to household's idiosyncratic shocks during recessionary periods. This finding clearly lead us to reject the full market insurance hypothesis in periods of aggregate instability. We now investigate the potential mechanisms behind the observed academic failure. The data allows us to explore whether it is due to a reduction in schooling effort motivated by a higher degree of children's labor market involvement. To investigate this possibility we estimate the model in equation (2).

¹⁸First born children are only minimally older and have an average age of 15.02 compared to the mean 14.58 years of the total sample.

¹⁹As child labor is mostly a phenomena related to familial poverty (Basu and Van. (1998)), we also included in the controls familial per capita income decile. The results are not reported as they were not affected.

Table (4) reports the OLS and the IV estimates of the linear probability model for the labor market behavior of both boys and girls. The OLS estimates suggest an increase in the labor market involvement of boys in response to job losses by the head. The IV estimates reveal a significant impact of household head employment on boys labor for the whole period but do not find a statistically significant difference during recessionary years. Note however that the point estimate of the coefficient of the head's employment status during the crisis would be -0.337 significant at the 1% level; this implies that children living in families where the household head is continuously employed during the school year are about a third less likely to enter the labor market during the crisis.

In contrast, for girls we do not find any significant effect on labor market activities.

For the sample of oldest siblings we find that, at least for boys, the higher schooling failure during recessionary periods responds to an increase in labor market involvement to insure the household in response to job losses by the household head. The point estimate suggests that boys are 40 percentage points more likely to be working during recessionary periods relative to growth periods if the household head becomes unemployed. This differential effect that only appears for oldest male siblings is in line with the findings in other studies on birth order, school attendance and child labor (Emerson and Souza (2008), Emerson and Souza (2007), and Edmonds (2006), Edmonds (2004)) and confirms that in moments of general economic distress, when insurance markets fail, households turn to self insuring strategies resorting to children work and that oldest siblings are at higher risk of reducing their educational effort to contribute to the household economy. A similar effect is not found for girls, suggesting that they are more likely to be involved in home production to replace other household members who go to work.

A striking result from table (4) is that wages do not seem to provide any incentive to enter the labor market. It is rather the educational level of the parents the most significant variables associated with children labor market activities. Parental education can be interpreted as a proxy for permanent income. Thus the previous result suggests that the decision to let children participate in the labor market is more related to credit constraints or financial difficulties than to the opportunity cost of schooling.

On the whole our empirical findings reveal important adverse effects on human capital accumulation by Argentinean youth due to the presence of credit market imperfections during the economic crisis of the late 1990's and early 2000's. We find evidence that household heads' job losses were associated with higher levels of labor market involvement, in particular for oldest male siblings, who then reduced their schooling performance. For girls unemployment spells by the head also led to reductions in schooling effort and upgrading probabilities, however, girls' time was most likely employed in home rather than market production. Our results suggests potential mechanisms to understand the poor schooling

performance of Argentinean children and teens during recessionary years.

2.4.1 Robustness checks

The instrument proposed will be valid as long as it is uncorrelated with children and teens' unobserved characteristics changing over time. As a robustness check for our identification strategy, we estimate the schooling model using as instrument lagged values of export prices where the household head is employed interacted with the a measure of the average size of the sector. The 2sls estimates for the relevant variables are shown in tables (6) and (7). Coefficients are slightly bigger and even more precisely estimated than in the base results.

In tables (8) and (9) we add additional controls: maternal educational level, family size, ownership of the household's housing, number of room. As already mentioned, family size could be an important factor to explain both educational success and child labor. However, the results are not relevantly affected.

Many studies consider 2002 as the first year of economic recovery. In this case this would affect the classification of crisis years we did. Tables (10) and (11) the 2SLS estimates of the relevant variables discarding the observations belonging to 2002. Again results are not significantly altered.

2.5 Conclusions

This paper examines the implications of credit market failures for human capital investment decisions in Argentina during the period from 1995 to 2002. Our results suggest a remarkable negative and statistically significant effect of household heads' work career interruptions on the schooling progress of children during years of economic distress. We also find evidence that during periods of economic instability, in response to household head unemployment shocks, boys increase their involvement in labor market activities whereas girls seem to increase participation in home production. We interpret these results as evidence that during the Argentinean economic recession between 1999 and 2002, credit markets collapsed significantly affecting households' insurance strategies and investment decisions.

Our findings indicate that macroeconomic crises can potentially have a persistent effect on the well-being of subsequent generations. If children left behind as a result of parental job losses do not catch up with their cohort counterparts, macroeconomic shocks will have a persistent effect on the level of inequality of younger generations. Therefore policies designed to protect and boost the schooling enrollment of children during periods of economic turbulence would be desirable to prevent temporary shocks affecting the current working population to have a permanent effect on subsequent generations.

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Table 1: Probability of school progression

	BOYS				GIRLS			
	OLS		IV		OLS		IV	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
E_{it}^{hh}	0.006	-0.013	0.129	-0.232	0.032	0.01	0.145	-0.063
	[0.017]	[0.027]	[0.091]	[0.164]	[0.016]*	[0.026]	[0.085]*	[0.127]
$E_{it}^{hh} * crisis$		0.032		0.569		0.035		0.331
		[0.035]		[0.261]**		[0.034]		[0.172]*
crisis		0.000		-0.664		-0.155		-0.421
		[0.000]		[0.247]***		[0.037]***		[0.160]***
age child	-0.318	0.008	-0.32	-0.324	-0.121	-0.121	-0.118	0.022
	[0.054]***	[0.008]	[0.058]***	[0.008]	[0.050]**	[0.050]**	[0.039]***	[0.039]***
age child ²	0.01	0.01	0.01	0.01	0.003	0.003	0.002	0.003
	[0.002]***	[0.002]***	[0.002]***	[0.002]***	[0.002]	[0.002]	[0.001]*	[0.001]*
age hh	0.008	-0.318	0.006	0.005	0.024	0.024	0.022	-0.124
	[0.008]	[0.054]***	[0.007]	[0.065]***	[0.008]***	[0.008]***	[0.007]***	[0.007]***
age hh ²	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]***	[0.000]***	[0.000]***	[0.000]***
school obbl.	0.048	0.048	0.047	0.05	-0.07	-0.069	-0.07	-0.066
	[0.027]*	[0.027]*	[0.034]	[0.037]	[0.025]***	[0.025]***	[0.023]***	[0.022]***
hh gender	0.057	0.057	0.059	0.064	0.025	0.025	0.024	0.027
	[0.017]***	[0.017]***	[0.014]***	[0.015]***	[0.015]*	[0.015]*	[0.010]**	[0.011]**
hh no ed.	-0.19	-0.19	-0.166	-0.166	-0.051	-0.05	-0.035	-0.028
	[0.066]***	[0.066]***	[0.077]**	[0.079]**	[0.054]	[0.054]	[0.072]	[0.077]
hh primary	-0.109	-0.108	-0.104	-0.099	-0.082	-0.082	-0.075	-0.073
	[0.015]***	[0.015]***	[0.014]***	[0.014]***	[0.014]***	[0.014]***	[0.019]***	[0.020]***
hh second.	-0.042	-0.042	-0.038	-0.04	-0.034	-0.034	-0.03	-0.027
	[0.015]***	[0.015]***	[0.011]***	[0.011]***	[0.014]**	[0.014]**	[0.015]**	[0.015]*
work sp.	0.008	0.007	0.009	0.003	-0.002	-0.002	-0.001	-0.004
	[0.012]	[0.012]	[0.009]	[0.010]	[0.011]	[0.011]	[0.013]	[0.014]
$\Delta \ln W_t$	-0.036	-0.036	-0.037	-0.036	0.061	0.06	0.061	0.058
	[0.023]	[0.023]	[0.021]*	[0.021]*	[0.023]***	[0.023]***	[0.028]**	[0.027]**
region d.	Y	Y	Y	Y	Y	Y	Y	Y
year d.	Y	Y	Y	Y	Y	Y	Y	Y
Obs.	5856	5856	5856	5856	5838	5838	5838	5838
R^2	0.05	0.05			0.05	0.05		

notes: Standard errors in brackets. Significance levels: * 10%, ** 5%, *** 1%.

In the first stage regression errors are clustered by household head's sector of employment.

Table 2: First stage regression

	BOYS			GIRLS		
	E_{it}^{hh}	E_{it}^{hh}	$E_{it}^{hh} * crisis$	E_{it}^{hh}	E_{it}^{hh}	$E_{it}^{hh} * crisis$
Exp. price	0.002 [.000]***	0.001 [.000]***		0.002 [.000]***	0.002 [.000]***	
(Exp. price)*crisis			0.002 [.001]***			0.002 [.001]***
F- stat	15.06	12.28	5.27	30.85	16.85	13.8
partial R	0.0154	0.0166	0.0215	0.0209	0.022	0.0273

notes: Standard errors in brackets. Significance levels: * 10%, ** 5%, *** 1%.

Errors are clustered by household head's sector of employment.

Table 3: Probability of school promotion oldest siblings

	BOYS				GIRLS			
	OLS		IV		OLS		IV	
E_{it}^{hh}	0.017 [0.021]	-0.013 [0.032]	0.135 [0.116]	-0.48 [0.211]**	0.037 [0.021]*	0.03 [0.033]	0.17 [0.132]	-0.149 [0.204]
$E_{it}^{hh} * crisis$		0.049 [0.042]		0.946 [0.340]***		0.012 [0.042]		0.518 [0.226]**
crisis		-0.217 [0.047]***		-1.028 [0.321]***		0.000 [0.000]		-0.594 [0.210]***
age child	-0.328 [0.061]***	0.01 [0.061]***	-0.333 [0.060]***	0.007 [0.073]***	0.026 [0.058]**	0.026 [0.058]**	0.025 [0.008]***	0.024 [0.009]***
age child ²	0.01 [0.002]***	0.01 [0.002]***	0.011 [0.002]***	0.011 [0.003]***	0.003 [0.002]	0.003 [0.002]	0.003 [0.002]	0.003 [0.002]*
age hh	0.01 [0.009]	-0.328 [0.009]	0.008 [0.008]	-0.332 [0.010]	-0.121 [0.009]***	-0.121 [0.009]***	-0.119 [0.047]**	-0.129 [0.048]***
age hh ²	0 [0.000]	0 [0.000]	0 [0.000]	0 [0.000]	0 [0.000]***	0 [0.000]***	0 [0.000]***	0 [0.000]***
school obbl.	0.06 [0.030]**	0.061 [0.030]**	0.059 [0.042]	0.068 [0.044]	-0.059 [0.028]**	-0.059 [0.028]**	-0.062 [0.024]**	-0.059 [0.023]***
hh gender	0.055 [0.020]***	0.056 [0.020]***	0.057 [0.019]***	0.067 [0.019]***	0.016 [0.018]	0.016 [0.018]	0.015 [0.015]	0.02 [0.018]
hh no educ.	-0.165 [0.073]**	-0.166 [0.074]**	-0.139 [0.075]*	-0.158 [0.088]*	-0.042 [0.065]	-0.042 [0.065]	-0.034 [0.077]	-0.015 [0.077]
hh primary	-0.111 [0.019]***	-0.111 [0.019]***	-0.107 [0.014]***	-0.097 [0.016]***	-0.085 [0.018]***	-0.085 [0.018]***	-0.077 [0.021]***	-0.077 [0.022]***
hh second.	-0.055 [0.018]***	-0.055 [0.018]***	-0.051 [0.014]***	-0.054 [0.016]***	-0.04 [0.018]**	-0.04 [0.018]**	-0.035 [0.015]**	-0.03 [0.016]*
work sp.	0.007 [0.015]	0.006 [0.015]	0.008 [0.012]	-0.001 [0.012]	0.004 [0.014]	0.004 [0.014]	0.005 [0.015]	-0.001 [0.016]
$\Delta \ln W_t$	-0.045 [0.029]	-0.045 [0.029]	-0.045 [0.028]	-0.038 [0.028]	0.112 [0.029]***	0.111 [0.029]***	0.113 [0.025]***	0.104 [0.025]***
region d.	Y	Y	Y	Y	Y	Y	Y	Y
year d.	Y	Y	Y	Y	Y	Y	Y	Y
Obs.	4080	4080	4080	4080	4042	4042	4042	4042
R ²	0.04	0.05			0.05	0.05		

notes: Standard errors in brackets. Significance levels: * 10%, ** 5%, *** 1%.

In the first stage regression errors are clustered by household head's sector of employment.

Table 4: Probability of working on the market

	BOYS				GIRLS			
	OLS		IV		OLS		IV	
E_{it}^{hh}	0.003	0.029	-0.31	-0.264	-0.007	-0.018	0.065	0.068
	[0.012]	[0.018]	[0.099]***	[0.166]	[0.008]	[0.015]	[0.041]	[0.096]
$E_{it}^{hh} * crisis$		-0.043		-0.073		0.018		-0.005
		[0.023]*		[0.149]		[0.018]		[0.129]
crisis		0.000		0.073		0.000		-0.006
		[0.000]		[0.138]		[0.000]		[0.115]
age child	-0.086	-0.002	-0.08	-0.079	-0.034	-0.007	-0.033	-0.008
	[0.041]**	[0.041]**	[0.033]**	[0.004]	[0.031]	[0.031]	[0.018]*	[0.004]**
age child ²	0.004	0.004	0.003	0.003	0.001	0.002	0.001	0.001
	[0.001]**	[0.001]**	[0.001]***	[0.001]***	[0.001]	[0.001]	[0.001]**	[0.001]**
age hh	-0.002	-0.085	0.003	0.003	-0.007	-0.035	-0.008	-0.033
	[0.004]	[0.004]	[0.004]	[0.033]**	[0.004]*	[0.004]*	[0.004]**	[0.017]*
age hh ²	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]*	[0.000]*	[0.000]*	[0.000]*
school obbl.	0.014	0.014	0.017	0.017	-0.006	-0.005	-0.006	-0.006
	[0.017]	[0.017]	[0.016]	[0.016]	[0.013]	[0.013]	[0.010]	[0.010]
hh gender	-0.027	-0.028	-0.032	-0.033	-0.01	-0.01	-0.01	-0.01
	[0.011]**	[0.011]**	[0.008]***	[0.008]***	[0.008]	[0.008]	[0.008]	[0.008]
hh no educ.	0.076	0.076	0.013	0.013	-0.007	-0.006	0.003	0.003
	[0.038]**	[0.038]**	[0.046]	[0.047]	[0.036]	[0.036]	[0.039]	[0.038]
hh primary	0.042	0.041	0.031	0.031	0.019	0.019	0.023	0.023
	[0.009]***	[0.008]***	[0.010]***	[0.010]***	[0.007]***	[0.007]***	[0.005]***	[0.006]***
hh second.	0.007	0.007	-0.003	-0.003	0.001	0.002	0.004	0.004
	[0.007]	[0.007]	[0.013]	[0.013]	[0.006]	[0.006]	[0.003]	[0.003]
work sp.	-0.002	-0.001	-0.005	-0.004	-0.005	-0.005	-0.005	-0.005
	[0.007]	[0.007]	[0.010]	[0.010]	[0.005]	[0.005]	[0.005]	[0.005]
$\Delta \ln W_t$	0.005	0.005	0.006	0.006	-0.009	-0.009	-0.009	-0.009
	[0.012]	[0.012]	[0.012]	[0.012]	[0.010]	[0.010]	[0.011]	[0.011]
region d.	Y	Y	Y	Y	Y	Y	Y	Y
year d.	Y	Y	Y	Y	Y	Y	Y	Y
Obs.	5858	5856	5856	5856	5840	5840	5840	5840
R^2	0.03	0.05			0.02	0.02		

notes: Standard errors in brackets. Significance levels: * 10%, ** 5%, *** 1%.

In the first stage regression errors are clustered by household head's sector of employment.

Table 5: Probability of working oldest siblings

	BOYS				GIRLS			
	OLS		IV		OLS		IV	
E_{it}^{hh}	-0.006 [0.015]	0.028 [0.024]	-0.343 [0.097]***	-0.025 [0.182]	-0.007 [0.011]	-0.02 [0.020]	0.14 [0.071]**	0.125 [0.153]
$E_{it}^{hh} * crisis$		-0.056 [0.031]*		-0.489 [0.232]**		0.021 [0.025]		0.026 [0.189]
crisis		0.000 [0.000]		0.465 [0.221]**		0.000 [0.000]		-0.022 [0.165]
age child	-0.09 [0.045]**	-0.003 [0.005]	-0.075 [0.038]*	0.003 [0.038]**	-0.008 [0.005]*	-0.008 [0.005]*	-0.01 [0.004]**	-0.019 [0.004]**
age child ²	0.004 [0.002]**	0.004 [0.002]**	0.003 [0.001]**	0.003 [0.001]**	0.001 [0.001]	0.001 [0.001]	0.001 [0.001]	0.001 [0.001]
age hh	-0.003 [0.005]	-0.09 [0.045]**	0.003 [0.004]	-0.076 [0.005]	-0.021 [0.035]	-0.021 [0.035]	-0.019 [0.017]	-0.01 [0.018]
age hh ²	0.000 [0.000]	0.000 [0.000]	0.000 [0.000]	0.000 [0.000]	0.000 [0.000]	0.000 [0.000]	0.000 [0.000]**	0.000 [0.000]**
school obbl.	0.02 [0.019]	0.02 [0.019]	0.023 [0.016]	0.019 [0.016]	-0.014 [0.014]	-0.014 [0.014]	-0.016 [0.014]	-0.016 [0.014]
hh gender	-0.036 [0.014]***	-0.037 [0.014]***	-0.04 [0.010]***	-0.046 [0.013]***	-0.015 [0.011]	-0.015 [0.011]	-0.016 [0.011]	-0.016 [0.011]
hh no educ.	0.099 [0.048]**	0.1 [0.049]**	0.023 [0.060]	0.033 [0.075]	-0.034 [0.043]	-0.033 [0.043]	-0.025 [0.048]	-0.024 [0.045]
hh primary	0.044 [0.011]***	0.043 [0.011]***	0.032 [0.011]***	0.027 [0.012]**	0.024 [0.009]***	0.024 [0.009]***	0.032 [0.007]***	0.032 [0.007]***
hh second.	0.009 [0.010]	0.009 [0.010]	-0.002 [0.014]	0.000 [0.015]	0.001 [0.009]	0.001 [0.009]	0.005 [0.006]	0.006 [0.005]
work sp.	-0.003 [0.009]	-0.002 [0.009]	-0.005 [0.010]	-0.001 [0.012]	-0.006 [0.007]	-0.006 [0.007]	-0.005 [0.007]	-0.005 [0.007]
$\Delta \ln W_t$	0.011 [0.015]	0.01 [0.015]	0.012 [0.017]	0.008 [0.017]	-0.009 [0.013]	-0.01 [0.013]	-0.008 [0.015]	-0.008 [0.013]
region d.	Y	Y	Y	Y	Y	Y	Y	Y
year d.	Y	Y	Y	Y	Y	Y	Y	Y
Obs.	4082	4082	4082	4082	4044	4044	4044	4044
R ²	0.03	0.03			0.02	0.02		

notes: Standard errors in brackets. Significance levels: * 10%, ** 5%, *** 1%.

In the first stage regression errors are clustered by household head's sector of employment.

Table 6: Probability of school progression lagged export price.

	BOYS				GIRLS			
	ALL SAMPLE		OLDEST		ALL SAMPLE		OLDEST	
E_{it}^{hh}	0.133 [0.089]	-0.223 [0.167]	0.121 [0.107]	-0.469 [0.206]**	0.162 [0.082]**	-0.027 [0.119]	0.204 [0.131]	-0.069 [0.194]
$E_{it}^{hh} * crisis$		0.564 [0.271]**		0.921 [0.344]***		0.301 [0.165]*		0.445 [0.217]**
obs	5856	5856	4080	4080	5838	5838	4042	4042

notes: 2SLS. Standard errors in brackets. Significance levels: * 10%, ** 5%, *** 1%.

In the first stage regression errors are clustered by household head's sector of employment. The controls are: child's and household head's age and gender, household head's education, work status of the spouse.

Table 7: Probability of working lagged export price.

	BOYS				GIRLS			
	ALL SAMPLE		OLDEST		ALL SAMPLE		OLDEST	
E_{it}^{hh}	-0.292	-0.234	-0.32	0.008	0.067	0.062	0.145	0.118
	[0.098]***	[0.166]	[0.094]***	[0.179]	[0.043]	[0.095]	[0.073]**	[0.149]
$E_{it}^{hh} * crisis$		-0.091		-0.511		0.009		0.044
		[0.148]		[0.231]**		[0.129]		[0.188]
obs	5858	5858	4082	4082	5840	5840	4044	4044

notes: 2SLS. Standard errors in brackets. Significance levels: * 10%, ** 5%, *** 1%.

In the first stage regression errors are clustered by household head's sector of employment. The controls are: child's and household head's age and gender, household head's education, work status of the spouse.

Table 8: Probability of school progression additional controls

	BOYS				GIRLS			
	ALL SAMPLE		OLDEST		ALL SAMPLE		OLDEST	
E_{it}^{hh}	0.113	-0.242	0.111	-0.501	0.151	-0.048	0.165	-0.157
	[0.101]	[0.157]	[0.117]	[0.202]**	[0.084]*	[0.124]	[0.133]	[0.203]
$E_{it}^{hh} * crisis$		0.56		0.944		0.319		0.528
		[0.241]**		[0.327]***		[0.173]*		[0.225]**
obs	5856	5856	4080	4080	5838	5838	4042	4042

notes: 2SLS. Standard errors in brackets. Significance levels: * 10%, ** 5%, *** 1%.

In the first stage regression errors are clustered by household head's sector of employment. The controls are: child's and household head's age and gender, household head's and spouse's education, work status of the spouse, family size, ownership of housing, number of rooms.

Table 9: Probability of working additional controls

	BOYS				GIRLS			
	ALL SAMPLE		OLDEST		ALL SAMPLE		OLDEST	
E_{it}^{hh}	-0.301	-0.248	-0.333	-0.013	0.071	0.072	0.149	0.13
	[0.100]***	[0.172]	[0.099]***	[0.186]	[0.042]*	[0.094]	[0.073]**	[0.149]
$E_{it}^{hh} * crisis$		-0.084		-0.492		-0.002		0.032
		[0.155]		[0.230]**		[0.125]		[0.184]
obs	5858	5858	4082	4082	5840	5840	4044	4044

notes: 2SLS. Standard errors in brackets. Significance levels: * 10%, ** 5%, *** 1%.

In the first stage regression errors are clustered by household head's sector of employment. The controls are: child's and household head's age and gender, household head's and spouse's education, work status of the spouse, family size, ownership of housing, number of rooms.

Table 10: Probability of school progression discarding the observations of year 2002.

	BOYS				GIRLS			
	ALL SAMPLE		OLDEST		ALL SAMPLE		OLDEST	
E_{it}^{hh}	0.114	-0.22	0.116	-0.469	0.116	-0.064	0.154	-0.143
	[0.080]	[0.174]	[0.100]	[0.204]**	[0.088]*	[0.125]	[0.129]	[0.198]
$E_{it}^{hh} * crisis$		0.557		0.958		0.311		0.534
		[0.258]**		[0.353]***		[0.165]*		[0.246]**
obs	5369	5369	3741	3741	5337	5337	3681	3681

notes: 2SLS. Standard errors in brackets. Significance levels: * 10%, ** 5%, *** 1%.

In the first stage regression errors are clustered by household head's sector of employment. The controls are: child's and household head's age and gender, household head's education, work status of the spouse.

Table 11: Probability of working discarding the observations of year 2002.

	BOYS				GIRLS			
	ALL SAMPLE		OLDEST		ALL SAMPLE		OLDEST	
E_{it}^{hh}	-0.301	-0.261	-0.351	-0.038	0.07	0.072	0.148	0.132
	[0.094]***	[0.158]*	[0.107]***	[0.170]	[0.045]	[0.099]	[0.080]*	[0.157]
$E_{it}^{hh} * crisis$		-0.067		-0.511		-0.002		0.029
		[0.132]		[0.214]**		[0.137]		[0.202]
obs	5370	5370	3742	3742	5339	5339	3683	3683

notes: 2SLS. Standard errors in brackets. Significance levels: * 10%, ** 5%, *** 1%.

In the first stage regression errors are clustered by household head's sector of employment. The controls are: child's and household head's age and gender, household head's education, work status of the spouse.

2.6 APPENDIX A - Data appendix

Table A-1: Macroeconomic summary

Indicator	1995	1996	1997	1998	1999	2000	2001	2002
Real GDP growth	-2.8	5.5	8.1	3.9	-3.4	-0.8	-4.4	-10.9
Urban unempl, Oct.	16.6	17.3	13.7	12.4	13.8	14.7	18.3	17.8
Consumer Price Index	3.4	0.2	0.5	0.9	-1.2	-0.9	-1.1	25.9
Imports growth	-9.8	17.5	26.9	8.4	-11.3	-0.2	-13.9	-50.1
Exports growth	22.5	7.6	12.2	10.6	-1.3	2.7	2.7	3.1
Export price index	108.8	115.9	111.9	100.3	89.1	98.0	94.7	91.0

Source: INDEC. All indicators except export price index are in percentage.

Export price index refers to 1993= 100.

Table A-2: Educational statistics by grade years 1996-2002.

promotion rates by grade and year												
	mandatory schooling - EGB									Polimodal		
	gr. 1	gr. 2	gr. 3	gr. 4	gr. 5	gr. 6	gr. 7	gr. 8	gr. 9	gr.10	gr.11	gr.12
1996	88.34	91.03	92.67	93.06	93.28	93.62	92.11	67.19	68.32	78.46	85.21	72.85
1997	88.57	91.77	93.04	93.69	93.83	93.38	99.27	76.79	68.08	81.84	86.43	73.40
1998	88.15	91.97	92.50	93.42	93.69	93.50	99.02	76.35	77.08	81.39	86.88	74.39
1999	87.59	91.76	92.61	93.19	93.33	92.88	96.52	78.97	76.35	80.86	88.52	74.16
2000	87.11	91.62	92.46	92.85	93.26	90.66	94.55	79.16	75.86	79.18	84.33	65.23
2001	86.88	91.71	92.50	93.07	93.60	92.79	93.17	80.30	80.13	80.51	85.07	77.11
2002	86.92	91.64	92.47	92.68	93.08	92.87	92.66	79.77	79.84	77.40	81.95	77.17

repetition rates by grade and year												
	mandatory schooling - EGB									Polimodal		
	gr. 1	gr. 2	gr. 3	gr. 4	gr. 5	gr. 6	gr. 7	gr. 8	gr. 9	gr.10	gr.11	gr.12
1996	9.13	7.37	5.64	4.92	3.91	3.03	2.03	10.79	13.91	9.07	5.21	1.12
1997	9.00	6.76	5.64	4.55	3.77	2.97	2.64	11.63	12.11	9.51	4.86	1.06
1998	9.51	6.76	6.26	5.02	4.20	3.44	3.48	11.42	9.87	8.95	4.76	0.95
1999	9.93	7.06	6.10	5.23	4.61	3.78	4.41	10.69	9.51	8.09	3.95	0.99
2000	10.38	7.25	6.38	5.56	4.72	3.87	5.14	10.81	9.26	8.23	5.73	0.83
2001	9.94	7.05	6.15	5.20	4.30	3.60	5.07	9.70	8.01	7.24	5.31	0.78
2002	9.95	7.05	6.17	5.53	4.70	3.82	5.70	10.35	8.85	8.42	6.40	0.55

percentage of lagging behind children - older than the "on-time" age												
	mandatory schooling - EGB									Polimodal		
	gr. 1	gr. 2	gr. 3	gr. 4	gr. 5	gr. 6	gr. 7	gr. 8	gr. 9	gr.10	gr.11	gr.12
1996	13.57	20.31	23.10	25.11	25.29	25.62	26.56	40.39	42.05	38.76	37.13	32.00
1997	13.6	20.3	23.1	25.1	25.3	25.6	26.6	40.4	42.1	38.8	37.1	32.0
1998	14.5	18.9	23.3	25.1	26.4	26.1	26.4	38.1	40.7	40.1	36.7	33.3
1999	15.1	19.2	21.1	23.9	24.7	25.7	26.2	36.0	36.9	40.2	37.4	32.5
2000	15.1	20.1	21.8	22.4	24.4	25.1	27.3	34.8	35.5	37.8	37.3	33.8
2001	15.09	20.17	23.07	23.79	23.59	25.03	27.85	35.14	35.16	37.59	36.66	34.00
2002	16.31	20.80	23.91	25.55	25.63	25.12	28.58	35.14	35.78	37.84	36.69	32.91

percentage of drop outs by grade and year												
	mandatory schooling - EGB									Polimodal		
	gr. 1	gr. 2	gr. 3	gr. 4	gr. 5	gr. 6	gr. 7	gr. 8	gr. 9	gr.10	gr.11	gr.12
1996	2.53	1.60	1.69	2.02	2.81	3.34	5.86	22.03	17.77	12.46	9.57	26.03
1997	2.42	1.47	1.32	1.76	2.41	3.65	-1.91	11.58	19.81	8.65	8.72	25.53
1998	2.34	1.27	1.24	1.56	2.11	3.06	-2.51	12.23	13.05	9.66	8.36	24.66
1999	2.48	1.18	1.29	1.59	2.06	3.34	-0.94	10.34	14.13	11.06	7.53	24.85
2000	2.51	1.12	1.15	1.59	2.02	5.46	0.31	10.03	14.88	12.59	9.94	33.94
2001	3.18	1.25	1.35	1.73	2.11	3.61	1.76	10.00	11.86	12.24	9.62	22.11
2002	3.12	1.31	1.36	1.79	2.21	3.31	1.64	9.87	11.31	14.18	11.66	22.29

Source: Ministry of Education of Argentina

Table A-3: Percentage of household heads not suffering unemployment spells during the year by level of education.

year	primary school	secondary school	tertiary education
1995	86.25	87	94.49
1996	84.62	85.74	89.32
1997	86.42	86.44	91.59
1998	84	87.79	89.16
1999	80.36	85.67	87.5
2000	79.46	85.15	88.44
2001	73.85	82.33	88.01
2002	82.80	85.27	87

Source: EPH selected sample.

Table A-4: School promotion by labor market participation, BOYS. Years 1995-2002

year	<i>younger than 15 years</i>		<i>older than 15 years</i>	
	Non active	Active	Non active	Active
1995	73.42	41.53	65.10	40.57
1996	77.87	66.66	68.40	50
1997	80.61	72	72.09	61.53
1998	84.76	74.41	79.73	74.66
1999	83.23	73.80	76.58	65.71
2000	81.85	56.25	73.77	65
2001	80.66	53.57	73.77	72.13
2002	79.44	64.70	75.56	59.52

Source: EPH selected sample.

Table A-5: Sample statistics

Percentage of labor force participation								
year	HH HEAD ALWAYS EMPLOYED				HH HEAD NOT ALWAYS EMPLOYED			
	<i>younger than 15</i>		<i>older than 15</i>		<i>younger than 15</i>		<i>older than 15</i>	
	female	male	female	male	female	male	female	male
1995	2.05	6.88	16.28	15.78	0	16.85	20	31.91
1996	2.59	6.35	10.59	22	4.27	6.73	13.69	17.14
1997	2.50	5.99	11.23	23.10	3.12	7.54	14	25.64
1998	3.17	5.68	11.11	20.88	2.70	4.21	13.46	14
1999	2.54	8.03	13.11	19.41	2.41	5.02	11.11	17.77
2000	2.39	3.66	9.15	15.22	4.13	8.10	10	30.43
2001	1.19	4.04	10.50	15.86	2.23	2.85	9.67	23.80
2002	1.22	3.29	7.27	16.50	1.31	5.71	14.28	13.95

Percentage of school progress								
year	HH HEAD ALWAYS EMPLOYED				HH HEAD NOT ALWAYS EMPLOYED			
	<i>younger than 15</i>		<i>older than 15</i>		<i>younger than 15</i>		<i>older than 15</i>	
	female	male	female	male	female	male	female	male
1995	77.27	70.53	60.28	62.53	72.81	73.03	62.5	55.31
1996	81.85	76.98	70.28	64.54	77.77	76.92	75.34	61.42
1997	84.63	80.65	76.96	70.21	81.25	75.47	72	64.10
1998	86.32	84.48	80.99	83.78	80.23	83.15	75	86
1999	83.81	82.74	82.89	77.02	87.09	84.82	79.36	64.44
2000	81.54	82	81.01	71.97	82.06	74.77	84	69.56
2001	83.10	79.57	78.59	75.64	80.59	80.71	70.96	65.07
2002	86.24	79.74	80.90	72.51	73.68	80	65.71	72.09

Source: EPH selected sample.

Chapter 3

Labor protection policies, informal labor markets and wage dispersion

ABSTRACT

Argentina experienced an important increase of informal employment and wage dispersion in the last 20 years.

This paper extend a search model with exogenous human capital accumulation to include an informal sector. The model is parametrized such to fit Argentinean data in order to investigate the effect of employment protection measures on informality, employment and wage dispersion under two different macroeconomic conditions. I find that for low educated workers both severance pay and minimum wages increase informality. In the presence of a wage floor severance payments do not affect employment but only shift marginal workers from the covered sector to the unregulated one. I find that a decrease in the return to human capital skills increases the incentives to seek informal employment. Labor market protection measures and declining human capital return are able to explain most of the increase in informality and much of the increase in wage dispersion.

3.1 Introduction

During the last two decades Argentina has witnessed an increasing trend in wage inequality both across and within educational groups coupled with a rise of informality measured by the degree of unprotected or unregulated work. In this paper I formulate a search model with an informal sector and show that these trends can be accounted for by the combined effect of restrictive labor protection policies enacted by the government in the aftermath of the crisis and a reduction in labor productivity.

Over the Nineties, the debate on labor market reform has been at the center of economic policy debate in Argentina. In spite of the growing unemployment rate, attempts to reduce dismissal costs have faced strong opposition and reform attempts were never successful. Given the dramatic social consequences of the early 2000's crisis, with open unemployment reaching over 21% in May 2002, an "emergency" measure taken in that year doubled compensation for unfair dismissal. It was expected that this would moderate unemployment growth. Real wages fell dramatically during the crisis (see McKenzie (2004)) and recovered pre-crisis levels only in the recent years. To improve working conditions, minimum wages, which had been held constant throughout the Nineties, were raised. While the recovery of the economy has been accompanied by a decline in unemployment, informality and wage dispersion are still above their before crisis levels.

I show that these labor market policies have been key determinants of the changes in unemployment and in employment composition in Argentina once one accounts for the presence of a large unprotected or "informal" sector. Furthermore, the results suggest that most of the rise in the residual wage dispersion can be accounted for by an increase in the share of employment that takes place in the informal sectors of the economy. The key mechanism at work is a self selection of workers into the informal sector brought about by a decrease in expected wage growth.

I examine these issues in a general equilibrium search model with human capital accumulation. Following Ljungqvist and Sargent (1998), I assume that workers can accumulate skills while working while unemployment spells are associated with depreciation of human capital. In order to address both within and across group wage dispersion, the model allows for ex-ante worker heterogeneity as in Amaral (2008). This feature enables me to address the differential impact of labor protection provisions across educational/income groups.

Importantly, the analysis extends existing general equilibrium search models with a dual labor market. The duality derives from the coexistence of formal and informal sectors which are assumed to differ in terms of search costs, wage distributions and labor market legislation compliance. Search costs on the informal sector are assumed to be lower than on the formal sector and are increasing in the human capital accumulated. This latter feature captures the idea that workers without experience may find it easier to find a temporary or unprotected

job rather than a formal job.¹ Unemployed workers are assumed to self select into one of the two sectors on the basis of their accumulated human capital and depending on the search costs associated with the two sectors.² The dual sector aspect of the economy is key when evaluating the impact of labor market regulation since minimum wage and employment protection legislation apply only to the formal sectors of the economy.³

The model is parametrized such as to replicate key moments of the Argentinean labor market both in the formal and informal sector and for two educational groups of workers - college educated and non college educated workers - in the years from 1996 to 1998. I estimate key parameters with an indirect inference approach. The results imply that increases in severance pay in the presence of binding minimum wages do not reduce unemployment, not even for formal workers. This is because minimum wages constitute a wage floor which introduces further rigidities in the economy. An increase of the minimum wage leads to a significant increase in the incidence of unemployment for workers in the formal sector. At the same time, higher minimum wages give rise to an increase of informality, and a small decline in informal sector unemployment and in wage dispersion. This is consistent with the empirical results of Maloney and Nunez-Mendez (2003) regarding the impact of minimum wages on employment and formality in Latin America. These results are mainly driven by non college educated workers. For college educated workers these two policies have little impacts apart from an increase in the number of workers selecting into the informal sector.

The increase in unemployment and the cross-sectoral reallocation of the labor force also give rise to a drop in human capital accumulation. Workers that lose their jobs disproportionately reallocate to the informal sector. This implies an increase in within group inequality as the wage of workers that reallocate to the informal sector (working below the minimum wage) falls relative to the workers that manage to retain their jobs in the formal sector. Accordingly, the increase of informality gives rise to a sharp increase in wage dispersion. I

¹This is in accordance with empirical evidence which shows that in developing economies, workers employed in untaxed, unregulated, sectors tend to be younger, have less education, and earn less than their counterparts in the formal sector. Middle aged and older worker are more likely to work in the formal sector or to be self-employed, though many still end up as informal employees (WorldBank, 2008). Fig. (A-5) confirms a similar age structure of informal workers in Argentina.

²A growing body of theoretical literature relates the rising proportion of unprotected employment to the worker's decision to participate in the informal labor market. Albrecht, Navarro and Vroman (2006), Boeri and Garibaldi (2006), model workers' self sorting into informal employment on the basis of their productivity. Kolm and Larsen (2003) focus on the impact of education. Fugazza and Jaques (2002) instead highlight the moral costs of operating on the informal sector. Alternatively, other types of models endogenize the firm's choice see for example Bosch (2007) or Kugler (1999).

³In a related paper, Dolado, Jansen and Jimeno (2005) present a model where labor legislation applies only to target groups (e.g. young). They highlight how labor market regulation may spill-over to other parts of the labor force.

show that the labor market policies combined with the fall in human capital accumulation allows one to explain all of the increase in informality and a large share of the increase in wage dispersion observed in Argentina in the period considered.

The paper brings together the literature on labor market regulation and dual economy aspects. Previous contributions to the literature have instead tended to examine the impact of these two aspects of labor market regulation separately. Bosch (2007), Kugler (1999) and Albrecht et al. (2006) show that higher firing costs, while reducing job separation rates of formal jobs, increase the employment share of the informal sector. Pages-Serra and Montenegro (1999) develop a model in which tenure-related job security biases employment against young workers and in favor of older ones. None of these papers however, consider possible interactions with minimum wages.⁴ Empirical evidence for Latin American countries (see for example Saavedra and Torero (2000), Mondino and Montoya (2000), Hopenhayn (2004) or de Barros and Corseuil (2000)) supports the hypothesis that job security lowers employment and job turnover rates for formal workers.⁵ Theoretical debates about the use of minimum wages focus on the trade off poverty reduction and redistribute income and the concern of introducing new rigidities in the labor market reducing employment opportunities. While empirical evidence in developed countries suggests that minimum wages have only negligible effects on employment and positive effects on poverty (see for example Brown (1999) or Krueger (1994)), the evidence for Latin America overall suggests large negative employment effects in countries where the minimum wage is binding (Freeman and Freeman (1991), Bell (1997), Maloney and Nunez-Mendez (2003)).⁶ This empirical research cast doubts on the claim that minimum wages are innocuous, even in countries with large informal sectors.

The paper also adds to the literature on residual wage dispersion. Recent theoretical debate about residual wage dispersion has focused on developed countries and the relation between technology growth and workers' skill loss upon job displacement (see for example Violante (2002), Kambourov and Manovskii (2008), Guvenen and Kuruscu (2006), or Shi (2002)). I highlight a new mechanism to match the increase of residual wage dispersion over recessionary periods: falling human capital accumulation rates increase informality while reducing reservation wages and consequently inducing a leftwards widening of the earnings distribution. This new mechanism is key for understanding the changes in wage dispersion in Argentina and other countries with significant informal sector employment.

⁴ Earlier models (see for example Bertola (1990), Bentolila and Bertola (1990), Bentolila and Saint-Paul (1994), Risager and Sorensen. (1997), or Hopenhayn and Rogerson (1993)) do not analyze compositional effects and focus on the impact on employment: Firing costs would reduce unemployment rates in recessions and lower turnover rates but reduce hirings during the recovery.

⁵ See Heckman and Pages-Serra (2003) for a review of literature.

⁶ See Devereux (2005) for a review of the empirical evidence on the impact of minimum wages in developing countries.

The structure of the paper is the following: next section outlines the macroeconomic and legal context of Argentina during the period under study. Section 3 presents the theoretical model, Section 4 describes the parametrization and the data, while Section 5 presents the results. Section 6 concludes.

3.2 The Argentinean context

During the 1990s, the Argentine economy experienced profound transformations, which affected its labor market. Structural reforms were adopted as a result of the Washington consensus (liberalization, privatization and market deregulation), new technologies emerged and labour regulations underwent significant changes, within the framework of a financial liberalization process that was to become one of the chief factors in the crisis which began during the fourth quarter of 1998 (Stiglitz (2003)).⁷

In spite of the high GDP growth, Argentina has experienced sharp increases in unemployment and degree of informality in the 1990s. Unemployment rose from a low of 6.5 percent in 1991 to a high of 21 percent during the economic crisis. While the recent recovery of the economy has been accompanied by a decline in unemployment, the rate still hovers between 8 to 10 percent, considerably higher than the rate at the beginning of the 1990s. The quality of jobs, as measured by the degree of informal sector work has also declined. Informal workers are defined as a person who declares not to have retirement benefits in its main occupation. This definition is mostly used in studies of informality in Argentina (Gasparini (2002), Pratap and Quintin (2003)). While at the beginning of the 1990s the share of salaried workers employed outside the regulated market was about 30 percent, the figure was about 45 percent in 2003 and still above 40 percent at the end of 2006.

Figure (1) reports the unemployment rate and share of informal workers separately for college educated and non college educated salaried workers aged 20-65.⁸ After 1995 both unemployment and size of the informal sector rose considerably for both educational groups, reaching a peak during the macroeconomic crisis 2000/2001. However, while unemployment rates reduced substantially after the economic recession, the size of the informal sector shrank only marginally.

The definition of informality adopted in this paper includes not only non-protected wage employment but also temporary, probatory contracts not subject to social security. As a consequence labor reforms aimed at increasing labor market flexibility clearly influenced the

⁷Calvo et al. (2003) explain in detail the macroeconomic context of the crisis. For a review on the effects on workers/ households see McKenzie (2004) or Giovagnoli et al. (2003).

⁸In 2002 the government introduced a form of subsidy /unemployment benefit for unemployed household heads. The beneficiaries are recorded as workers in the EPH. Nevertheless in all the graphs presented beneficiaries of the program Jefe de Hogar have been excluded.

share of informality in the country.⁹ Labor market reforms dealt with temporary contracts and their associated social security costs (1991, 1995, 2000), dismissals (1991, 1998), and non-wage labour costs in general (1994). Officially, the rationale behind these reforms was that, by facilitating flexible contracts and dismissals and by cutting down non-wage labour costs, they would stimulate employment creation and also help to reduce non-compliance and precarious employment relations (Marshall (2004)). The 1991 law reinstated a ceiling to lay-off compensation, and introduced "promoted" temporary employment contracts, which were exempted, partially or totally, from payment of social security contributions. In 1995, the conditions under which employers could use "probatory" contracts were extended, while the 1998 and the 2000 reforms tried to limit their use. In particular the 2000 labour code reform made the trial period contract fully subject to social security contributions and other mandatory benefits, but maintained exemption from lay-off compensation.¹⁰

Dismissal costs were constant throughout the 1990s until the 1998 reform which lowered the cost of unfair dismissals for newly employed workers by reducing advance notice and compensation. Nevertheless, the cost of dismissal due to economic reasons was increased relatively, from one half the compensation for unfair dismissal to two thirds (Beccaria and Galin (2002)).

Given the dramatic social consequences of the early 2000s crisis, with open unemployment reaching over 21% in May 2002, an "emergency" measure taken in that year doubled compensation for unfair dismissal. It was expected that this would moderate unemployment growth. Other decrees limited lay-offs due to force majeure or to lack or decrease of work (Beccaria and Galin (2002)). These emergency laws have been abolished only in 2007 after the unemployment rate fell under 10% for the first time since the beginning of the 1990s (Ministerio del Trabajo, Empleo y Seguridad Social).

Heckman and Pages-Serra (2000) construct a cardinal measure of firing costs across Latin America, the Caribbean, and OECD countries. This measure computes the expected cost, at the time a full-time indefinite worker is hired, of future dismissal due to unfavorable economic conditions.¹¹ The index includes the cost of providing statutory advance notice and severance pay and is computed for the years in the late 1990s, after the labor market reforms undertaken by Latin American countries.¹² The job security index is reported in

⁹Hopenhayn (2004) discusses the impact of temporary contracts on the Argentine labor market. He finds that these contracts induce an increase in hiring and a substitution away from long term employment toward short-term unprotected employment.

¹⁰See Beccaria and Galin (2002) for further details on the Nineties' reforms.

¹¹As such it does not capture the effects of the reforms mentioned above that have made temporary and fixed-term contracts widely available in Argentina.

¹²For Argentina, the index computed by the authors in 1999 is the same as the one they do calculate for the 1990. This suggests that the 1990s reforms did not affect this measure of labor protection for tenured workers.

table (A-1) for selected countries. Among the countries considered by the authors the country with the lowest job security index is the US, while the most protected is Bolivia. Argentina as well as other Latin American countries have higher job protection indexes with respect to OECD countries (with the exception of Spain); in particular the expected dismissal cost in Argentina is roughly 3 monthly payments, or 24,8% of the yearly income.¹³

From August 1993 to June 2003 the nominal wage rate has been fixed at 200 pesos per month, or 1 peso per hour. Given that until 2002 there was virtually no inflation this meant a constant real minimum wage throughout the Nineties (Grimshaw and Miozzo (2003)). After 2003 the minimum wage has been constantly upwardly adjusted in an attempt to raise workers conditions and limiting inequality. This was also partly necessary due to the raising inflationary process associated with the recovery started in 2002.

Figure (A-2) reports the evolution of consumer price index (IPC), nominal and real minimum wage over the period 1996-2006. By the end of 2006 the real minimum wage more than doubled its value. The average real minimum wage in the period 2003-2006 was roughly 46% higher than during the Nineties. Over the same period average real hourly wages of both formal and informal workers declined by 21.5% (25.5% for informal workers, 11.45% for formal workers). See table B-1.

In the sample considered, during the 1996-1998 period, less than 1% of formal workers had an hourly wage of less than 1 peso. At the contrary, as many as 15% of informal workers were receiving an hourly wage below the minimum wage. This corroborates Saget's (2001) analysis that the minimum wage often does not represent a lower bound for wages in the informal sector. In the following I will also assume that minimum wage does not apply to the informal sector.

The reforms and the macroeconomic developments are considered the main determinants both of the increase in informality and of wage dispersion both between and across educational groups the country experienced since the beginning of the 1990s (see for example Galiani and Sanguinetti (2003) Acosta and Gasparini (2007), and Bustos (2007)).

Figures (A-3) and (A-4) analyze salaried wage dispersion in the country. Figure (A-3) shows a decomposition of the log hourly real wage variances in between inequality, due to changes in relative prices, and within inequality, or residual/unobserved inequality for the area of Great Buenos Aires.¹⁴ Total wage variance and both within and between inequality

¹³Surprisingly, Argentina and Mexico exhibit lower job security than Chile, which has traditionally been considered to have a more flexible labor market. This divergence arises because this index only measures one component of labor market rigidities. While Argentina and Mexico have stronger unions than Chile, and therefore are likely to have higher wage rigidity, Chile has higher individual job security provisions (Heckman and Pages-Serra (2000)).

¹⁴I estimate standard log wage equations where the dependent variable is log real hourly wage and the independent variables include 6 educational dummies, age, age squared, a gender dummy, dummies for two

are steadily growing since the beginning of the 1990s. Observable characteristics can explain only a minimal part of the wage dispersion and do not capture moments of economic distress: the recession in occasion of the Mexican tequila crisis in 1995 or the latest macroeconomic crisis, which are on the contrary fully mirrored in the residual inequality. After the 2000-2001 crisis while between inequality keeps relatively constant, within inequality maintain its growing path.

The same rising path in residuals' dispersion is evident from Figure (A-4). This figure shows the standard deviation of the residuals for each educational group used in the model: workers with more than secondary schooling and with at most secondary schooling.¹⁵ The growing path is worrying as it does not show a decreasing trend since the economy's recovery.

Finally, figure (A-5) shows the percentage of informality for salaried workers over age in the period 1996-1998 in Argentina. This picture suggests that temporary, informal jobs are a point of entry for young workers without experience. The percentage of informality decreases for middle aged workers and then increases again for older workers, supposedly not skilled enough to find a formal job or become independent.

3.3 Model

This paper extend a Ljungqvist and Sargent (1998) type of search model with exogenous human capital accumulation to include a) ex-ante worker's heterogeneity b) an informal sector c) for formally employed workers severance pay and minimum wages.

There is a continuum of workers with geometrically distributed life spans, indexed on the unit interval with births equaling deaths. Each period an individual faces a probability $\alpha \in (0, 1)$ of dying and not remaining in the labor force for next period.

There are two types of individuals indexed by $i = c, nc$: college educated and not college educated. Individuals do not choose their type. The measure of each type is time invariant and their sum is equal to $\mu_c + \mu_{nc} = 1$.

For both types of workers the economic environment is defined as follows. At any point in time employed and unemployed workers have a skill level $h \in H$. There is a finite number of skill levels with transition probabilities from skill level h to h' denoted by $\pi_u(h, h')$ and $\pi_e(h, h')$ for an unemployed and an employed worker, respectively. That is, an unemployed worker with skill level h faces a probability $\pi_u(h, h')$ that his skill level is h' next period,

big regions, GBA and the rest of the country, and for the industry sector, secondary and tertiary (Katz and Autor (1999)).

¹⁵For each group I regress log hourly real wages on dummies for each level of education and related completion. This means for the non college group: no education, primary incomplete, primary, secondary incomplete, secondary complete. While for the skilled group: specialization degree, and university degree both complete or incomplete.

contingent on not dying. Similarly, $\pi_e(h, h')$ is the probability that an employed worker with skill level h sees his skill level change to h' at the beginning of next period, contingent on not dying and not being laid off. In the event of a layoff, the transition probability is given by $\pi_l(h, h')$. After this initial period of a layoff, the stochastic skill level of the unemployed worker is again governed by the transition probability $\pi_u(h, h')$. All newborn workers begin with the lowest skill level. The laws of motion governing skill accumulation for the college and not college educated populations are different.¹⁶ In particular, college educated workers accumulate skills faster.

When unemployed workers can decide in which sector to search employment: the regular sector and the informal sector $s = inf, f$. On both markets searching is a time consuming activity with disutility $c(e_t(h))$ increasing in the effort e_t . Search costs in the informal sector are lower than on the formal market, i.e. $c_{inf}(e_t(h)) < c_f(e_t(h))$, $\forall h$. In the formal sector the cost of searching is constant across human capital levels, while in the informal sector search costs increase with the level of human capital accumulated $c_{inf}'(e_t(h)) > 0$. This creates a relative advantage in searching on the informal sector for unexperienced workers.

An unemployed agent observes his new skill level at the beginning of a period before taking any decision: choosing on which sector to search, choosing a search intensity or accepting a new wage offer. In particular unemployed agents observe expected values of searching on the different sectors, for each level of human capital. The choice of searching and working in one sector is based on the maximisation of the relative expected unemployment utilities.

On both labor markets, search may or may not generate a wage offer in the next period. With probability $p(e_t(h))$, which is assumed to be increasing in the search effort $e_t(h)$, an unemployed worker receives one wage offer from the distribution $F_{inf,f}(w) = Prob(w_{t+1} \leq w)$. With probability $1 - p(e_t(h))$, the worker receives no offer in period $t + 1$.

An informal worker draws his wage offer from the distribution $F_{inf}(W)$; accepting a wage offer w_{t+1} means that the worker will earn that wage (per unit of skill) for each period he is alive, and has not being laid off. Informal employment is a full time activity and precludes on the job search for a formal-sector job. Accordingly, transitions from one sector to the other are possible only during unemployment spells.

A formal worker draws his wage offer from the distribution $F_f(W)$; accepting a wage offer w_{t+1} means that he will earn that wage in period $t + 1$, and thereafter will receive a Markov

¹⁶In light of the ongoing debate on whether human capital accumulation is more job (or firm or occupation) specific, or more general (experience), this model's skill accumulation process encompasses both job tenure and experience. The available evidence on this topic is mixed. Altonji and Williams (2005) find small tenure effects, while Topel (1991) and Buchinsky, Fougere, Kramarz and Tchernis (2002) find large tenure and experience effects. Dustmann and Meghir (2005) distinguish between skilled and unskilled workers finding important returns to firm tenure for unskilled, positive returns to firm and experience for skilled.

wage process $G(w'|w) = Prob(w_{t+i+1} \leq w' | w_{t+i} = w)$ for each period he has not retired and has not been laid off.

Reservation wages on the formal market cannot be lower than the minimum wage $w_{f,t+1} \geq MW$.

Earnings of an individual with skill level h , matched with wage w are *earnings* $= wh$. The probability of being laid off at the beginning of the period, $\lambda_{inf,f} \in (1, 0)$, is higher in the informal market $\lambda_{inf} > \lambda_f$.¹⁷

Each formal worker who is laid off has to pay a tax K .¹⁸

The objective of each worker is to maximize the expected value $E_t \sum_{i=0}^{\infty} \beta^i (1 - \alpha)^i c_{i+1}$ where E_t is the expectation operator conditioned at information at time t , β is the subjective discount factor, and $(1 - \alpha)$ is the probability of surviving between two consecutive periods; c_{i+1} is consumption. The linear utility assumption means that the private bonds market can be ignored. This is to allow a clear focus of the model on the incentives present on the labor market. More importantly, under the assumption of risk neutrality, each worker can be treated as self-employed and liable for any lay-off tax (Ljungqvist (2002)).

The individuals' earnings are assumed to be equal to the surplus generated by the match. The purpose of this assumption is to avoid issues regarding surplus sharing that are fundamentally linked to the nature of the firm and are not the main focus of this analysis.

The model maintains Ljungqvist and Sargent's (1998) assumptions about the individual's transition probabilities:

Assumption 1. *Laws of motion for employed:* $\pi_e(h, h') = 0$ for all $h' < h$. Skill level evolution is weakly increasing for employed individuals. This implies that when an individual reaches the maximum skill level, h_{max} , she will remain there while employed.

Assumption 2. *Laws of motion for unemployed:* $\pi_u(h, h') = 0$ for all $h' > h$. Skill evolution is weakly decreasing for unemployed individuals. This implies that once an individual reaches the minimum skill level, h_{min} , she will remain there while unemployed.

Assumption 3. *Laws of motion for job losers:* $\pi_l(h, h') = 0$ for all $h' > h$. Job losers face skill losses.

Assumptions 2 and 3 imply that when a separation occurs individuals do not lose all

¹⁷The model does not distinguish between voluntary job quits and involuntary job losses (see e.g. Ljungqvist and Sargent (2004) or Amaral (2008)). The distinction is potentially very important as in most countries voluntary job to job flows are characterized by wage increases while involuntary job to job flows are usually associated with wage losses (see Jolivet, Postel-Vinay and Robin (2005)). The EPH allows to identify job quitters, asking the reason for a job interruption, however, almost no worker reports voluntary job interruptions, being most of the layoffs related to employers' conditions.

¹⁸It is irrelevant for the analysis of employment whether this tax constitutes a deadweight loss or whether the tax proceeds are handed back lump sum to all workers. Lump-sum transfers would not affect workers' decision rules for reservation wages and search intensities.

their accumulated skills, but they lose them over time the longer they are unemployed. In this sense, as explained above, the model's skill accumulation encompasses both job specific skills as well as more general skills.

3.3.1 Equilibrium

Let $V_{i,s}^u(h)$ denote the discounted expected utility of an unemployed agent of type i (college educated or not), in sector s (formal/informal), with skill level h .

$$V_{i,s}^u(h) = \max_e \left\{ -c_{i,s}(e) + \beta(1-\alpha) \left\{ \sum_{h'} \pi_{u,i}(h, h') \left[p_{i,s}(e) \int V_{i,s}(h', w) F_{i,s}(w) + (1-p_{i,s}(e)) U_i(h') \right] \right\} \right\} \quad (1)$$

where $c_{i,s}(e)$ is the cost of searching. Given the search costs, the expected income and their skill level, unemployed workers choose on which sector to search. $U_i(h')$ is the maximum of the expected unemployment utility on the two sectors.

$$U_i(h') = \max[V_{i,f}^u(h'), V_{i,inf}^u(h')] \quad (2)$$

$V_{i,f}(h, w)$ denotes the discounted expected utility of an individual of type i , in the formal sector f , with skill h , that has a wage offer $w > 0$, and is given by:

$$V_{i,f}(h, w) = \max \left\{ U_i(h) - K, wh + \beta(1-\alpha) \left[(1-\lambda_f) \sum_{h'} \pi_{e,i}(h, h') \int V_{i,f}(h', w', wh) dG(w'|w) + \lambda_f \sum_{h'} \pi_{u,i}(h, h') U_i(h') - \lambda_f K \right] \right\} \quad (3)$$

$V_{i,inf}(h, w)$ is the Bellman equation of informal workers:

$$V_{i,inf}(h, w) = \max \left\{ U_i(h), wh + \beta(1-\alpha) \left[(1-\lambda_{inf}) \sum_{h'} \pi_{e,i}(h, h') V_{i,inf}(h', w) + \lambda_{inf} \sum_{h'} \pi_{u,i}(h, h') U_i(h') \right] \right\} \quad (4)$$

A worker who receives a wage offer can accept it or reject it. In case of rejection the individual is unemployed this period, and the value of that is $U_i(h)$, if he was formally employed he pays K . If he is an informal worker and accept the wage offer, he will receive wh until he is not laid off. In case he is a formal worker, this period he receives wh and from next period onwards he will receive a Markov process $G(w'|w)$.

Associated with the equations (1), (2), (3), and (4) are the functions $(e_{i,s}(h), \underline{w}_{i,s}(h), \text{ and } I_s(h))$, giving the optimal search intensity, the reservation wage, and the search sector for an individual of type i , in sector s , with skill h .

$U_i(h)$ is the maximum value for each skill level h of $V_{i,f}^u(h), V_{i,inf}^u(h)$. The differences in the two curves (over different levels of h) are driven by the wage distributions, the search costs, the different coverage of labor market policies and the separation rates. In this respect it is assumed the following:

Assumption 4. *Search costs in the formal market are higher than on the informal market for each level of skill $c_{inf_i}(e(h)) > c_{f_i}(e(h)) \forall h$*

Assumption 5. *Search costs in the informal market are increasing in the level of skill $c_{inf_i}'(e(h)) > 0$*

Assumptions 4 and 5 imply that high skilled workers face relatively lower search costs on the formal market. This captures the fact that workers at the beginning of their career, or who, because of long unemployment spells have lost their human capital, have a higher chance to find employment in the informal market.

Given the individuals' optimal policies the steady state distribution of individuals can be derived. Let $\mu_{f_t}(i, h, w)$ denote the period t measure of individuals of type i , with skill level h , a strictly positive wage offer w , employed in the formal sector. Let $\mu_{inf_t}(i, h, w)$ denote the measure of individuals of type i , with skill level h , a positive wage offer w , but employed in the informal sector. $\mu_t(i, h, 0)$ denotes those individuals with wage offer $w = 0$. For every period t ,

$$\sum_i \sum_h \left[\mu_t(i, h, 0) + \int_{w_{min}}^{w_{max}} \mu_{f_t}(i, h, x) d(x) + \int_{w_{min}}^{w_{max}} \mu_{inf_t}(i, h, x) d(x) \right] = 1 \quad (5)$$

For this equation to hold over time, the measure of individuals entering the labor force has to equal the measure leaving it, given by α . Letting $\mu_{s,t+1}(i, h', w')$ denote next period's measure of sector s workers:

$$\begin{aligned} \mu_{s,t+1}(i, h', w') &= (1 - \alpha) \left[(1 - \lambda_s) \sum_h \pi_{ei}(h, h') \mu_{s,t}(i, h, w') \chi_{(w' \geq w_i(h))} I_{s'=s} \right. \\ &+ f_{s,i}(w') \sum_h p_s(e_i(h)) \pi_{ui}(h, h') \mu_t(i, h, 0) I_{s'=s} \\ &+ \left. f_{s,i}(w') \sum_h p_s(e_i(h)) \pi_{ui}(h, h') \left(\int_{w_{min}}^{w_{s,i}} \mu_{s,t}(i, h, x) dx \right) I_{s'=s} \right] \end{aligned} \quad (6)$$

where $\chi_{(w' \geq w_i(h))}$ is an indicator function that equals one when wage is above the reservation wage, otherwise it zero. $I_{s'=s}$ is an indicator function for the chosen sector of search for unemployed workers.

The three lines of the above equation define the three possible individuals' origins regarding their previous period's state. The first line refers to those individuals that were employed the previous period at wage w' and evolved to skill level h' . Only a fraction $(1 - \lambda_s)$ of these actually gets the same wage offer. The second line refers to those individuals that had wage

offer $w = 0$ the previous period, evolved to skill level h' , and chose to search in the sector s . Only a fraction $f_{s,i}(w')$ will have an offer of w' . Finally, the third line captures all those that had a strictly positive wage offer the previous period, but rejected it and evolved to skill level h' . Again, only a fraction $f_{s,i}(w')$ will have an offer of w' .

Some individuals lose their job, while others simply do not get a job offer after rejecting one or after having lost their job. These are the people that have a wage offer $w = 0$. The evolution of the measure of these individuals is given by:

$$\begin{aligned} \mu_{t+1}(i, h', 0) &= \alpha \chi_{h'=h_{min}} + (1 - \alpha) \left[\sum_s \lambda_s \sum_h \pi_{l,i}(h, h') \int_{\underline{w}_{s,i}}^{w_{max}} \mu_{s,t}(i, h, x) dx \right. & (7) \\ &+ \sum_s \sum_h (1 - p_s(e_i(h))) \pi_{u,i}(h, h') \mu_t(i, h, 0) I_{s'=s} \\ &+ \left. \sum_s \sum_h (1 - p_s(e_i(h))) \pi_{u,i}(h, h') \int_{w_{min}}^{\underline{w}_{s,i}} \mu_{s,t}(i, h, x) dx \right] \end{aligned}$$

The first term of the equation above is the measure of people entering the labor force the first time. The first line inside the bracket includes all individuals that were employed in the previous period, but lost their job and evolved to skill level h' . The second line refers to those individuals that had a wage offer $w = 0$ the previous period and evolved to skill level h' . Note that the probabilities to enter unemployment depend from the search effort and the reservation wage and are thus different for the two sectors. Finally, the last line captures all those that had a wage offer $w > 0$ the previous period but rejected it and evolved to skill level h' . A steady-state equilibrium is defined by the optimal individuals' policies and associated invariant probability measures such that:

1. $\underline{w}_{i,s}(h)$ are the optimal policies for (3) and (4), for each type i , each skill level h , and each sector s ;
2. given $\underline{w}_{i,s}(h)$, $\mu_{s,t+1}(i, h', w)$, and $\mu_{t+1}(i, h', 0)$ solve (5), (6), and (7)

3.4 Parametrization

In this section I will illustrate the parameters used in the model, next section will describe their data counterpart. The model period is set to a month.

I partition the set of parameters into two groups. The first group is composed of $\alpha, \beta, \lambda_s, K, MW$.

The probability of exiting the workforce α is set such that the expected working life is 41 years (0.002).

The discount factor, β is such that the annual interest rate corresponds to the one observed in Argentina in that period (6%).¹⁹ The value of the job loss rate for informal workers $\lambda_{i,inf}$ is set equal to the average monthly unemployment inflow rate ($\lambda_{c,inf} = 0.02614$, $\lambda_{nc,inf} = 0.04313$).²⁰ These values imply that the average expected employment duration in the informal sector is just above 3 years for college educated- and less than 2 years for non college educated workers.

The choice of λ_f is based on the fact that separation rates are unobservable for workers covered by job security provisions, since the separation rate is, itself, affected by job security. The value is chosen smaller than that foreseen for temporary contracts but bigger than the one implied by the monthly unemployment inflow (over 10 years for formal workers). I set $\lambda_f = 0.0204$ for both educational groups; this value implies an expected minimal contract duration of 4 years.

K is set equal to 24% of the earnings wh as estimated (for formal workers only) by Heckman and Pages-Serra (2000). Minimum wages for the whole period were set to 1 peso, thus $MW = 1$.²¹

The second group of parameters is

$$\theta_{i,s} = (\mu_{i,s}^w, \sigma_{i,s}^w, p_i^u, p_i^l, n_{i,s}, d_{i,s}, p_i^e)_{i \in \{c, nc\}, s \in \{f, inf\}}$$

These cannot be mapped one to one to the data, thus they are estimated by minimizing a measure of the distance between the model and the empirical moments. Let $m(\theta_{i,s})$ denote the mapping from $\theta_{i,s}$ to the model moments, and let $m_{i,s}^d$ denote the corresponding empirical estimates. The estimator $\hat{\theta}_{i,s}$ is the solution to:

$$\hat{\theta}_{i,s} = \arg \min_{\theta_{i,s}} (m(\theta_{i,s}) - m_{i,s}^d)' W^{-1} (m(\theta_{i,s}) - m_{i,s}^d)$$

where W is a diagonal matrix with the sample standard deviations of $m_{i,s}^d$ along the diagonal.

The first two parameters, $\mu_{i,s}^w, \sigma_{i,s}^w$ determine the mean and the standard deviation of the wage distributions $f_{i,s}(w)$ from which workers draw their wage offer. In the model economy, the support of these distributions is discretized and rescaled so that they integrate to one. Wage offers are drawn from a distribution discretized and evenly spaced between 0.01 (w_{min}) and 13 (w_{max}). This was done so that the maximum hourly earnings in the model are $h_{max} w_{max} = 26$, which is the maximum hourly earnings observed in the data. The parameters are set such that the first two moments of the resulting log earnings ($\ln(wh_{i,s})$) distribution match the mean and standard deviation of the data. This implies the computation of 8 moments: mean and standard deviation for two workers' types and 2 sectors.

¹⁹Source Mercosur.

²⁰The inflow rate is the monthly inflow to unemployment divided by the informal employed labor force at a point in time.

²¹Source: Ministerio del Trabajo, Empleo y Seguridad Social <http://www.trabajo.gob.ar>

p_i^u and p_i^l determine the transition probabilities across skills h_i of unemployed and newly displaced workers respectively. Note that these parameters do not change across sectors. Skill evolution, in these cases is weakly decreasing.

The set of skills H_i contains 21 points evenly spaced between 1 (h_{min}) and 2(h_{max}). I follow the theoretical construct of Ljungqvist and Sargent (1998) in which a newly displaced worker (an unemployed) experiences a reduction in his human capital modelled as a draw from a truncated left half of a normal distribution with specified variance p_l (p_u). In other words the probabilities of moving from skill level h to skill level $h' \leq h$, $\pi_{iu}(h, h')$, and $\pi_{il}(h, h')$, are distributed according to the left side of a normal distribution with mean h that is discretized and rescaled to the support $\{h_{min}, \dots, h\}$. These distributions are indexed by their variance: p_i^u and p_i^l . An increase of these variances decreases the expected skill level.²² The lowest skill level reached through depreciation is also an absorbing state until the unemployed worker gains employment. To estimate these parameters I compute from the model invariant distribution of earnings the average loss of earnings for a worker who has been unemployed for a year (p_u) and who has been just been laid off (p_l). The same moments are matched to the difference in earnings registered by workers observed before and after an unemployment spell, where the difference between these two moments (p_l and p_u) is given only by the length of the spell.

The disutility from searching and the function mapping search intensities into probabilities of obtaining a wage offer are assumed to be

$$\begin{aligned} c_{i,f}(e) &= c_{i,f}e \\ c_{i,inf}(e) &= c_{i,inf}e * h \\ p_i(e) &= e_i^{n_{i,s}} \end{aligned}$$

where $e \in [0, 1]$ is the search effort. The search cost c_i determines agents' search efforts, thus the model's job turnover rate and unemployment rate. It also determines the relative advantage in searching on one labor market with respect to the other.

$c_{i,f}(e)$ is estimated matching the aggregate (both of formal and informal workers) unemployment rate for workers of type i , while $c_{i,inf}(e)$ is matched to the share of informal workers for each educational group i .

$n_{i,s}$ determines the job finding rate, given the search effort used. For a search effort and a coefficient both < 1 , the smaller $n_{i,s}$, the higher the probability of finding a job. Note that in the model the search effort and consequently the job finding rate is different for each level of skill h , as a consequence more skilled workers have a higher search intensity and a higher

²²An increase of these variances is termed turbulence by Ljungqvist and Sargent (1998), and considered to be behind the US increase in wage dispersion. I do not find in Argentinean data any evidence of an increase of turbulence between the periods before and after the crisis.

probability of finding a job. This parameter varies across sectors to capture the different finding probabilities on the two markets; it is matched using the unemployment rates on each labor market s for each worker type i .

p_i^e determines the probabilities of skill growth while employed. The probability of moving from skill level h to skill level $h' \geq h$, $\pi_{ie}(h, h')$, is distributed according to the right side of a normal distribution with mean h that is discretized and rescaled to the support $\{h, \dots, h_{max}\}$. This distribution is indexed by its variance p_i^e and is estimated by matching the growth rate of informal wages after the first 2 years of work. This is for two main reasons: I do only have panels of 2 years, and the short duration of informal contracts does not allow to match longer time spans. From the data no big differences are found in the growth rate of wages in the formal or informal market over such a short period of time.

Unlike the previous pairs of moments, the last one cannot be computed directly from the invariant distribution of earnings. In order to generate it, a panel of 10,000 individuals (for each group) is constructed from the model's invariant distribution. I simulate their first 2 years of work life using the laws of motion described in the previous section and compute the last moment.

In the next section I describe the data moments used.

3.4.1 Data

To match Argentinean inequality characteristics I will make use of data from the Encuesta Permanente de Hogares (EPH) collected by the Instituto Nacional de Estadística y Censos (INDEC). The survey is a six-month rotating panel in which 25% of the household rotate every semester so that each of them can be followed for four periods. It is an urban survey carried out in cities over 100.000 in habitants which represent 71% of the urban areas of the country and approximately 62% of the whole population of the country. The survey gives detailed information about employment, incomes and demographic characteristics of the household. From 1974 until 2003 the EPH was done twice a year (May waves and October waves) in the most important conglomerates in the country, which were progressively incorporated to the survey. From the year 2003 some modifications were introduced in the questionnaires and the frequency in which the survey is collected is now every three months.²³ I will use EPH and EPH Continua (as it is called after 2003) between 1996 and 2006. The variables of interest are hourly earnings for salaried workers and the sector of work. Hourly wages for the principal occupation are provided by the survey for most regions and most years. Self employed, managers or employers, and workers without salary are not

²³Gasparini (2006) considers these methodological changes as not having a major influence on the quality of the data.

considered.²⁴ The choice of hourly wages for only salaried workers is meant to avoid biases caused by heterogeneity the model economy is not designed to capture.

There are two alternative views of the concept of informality. The first one refers to marginal jobs of low productivity and to subsistence economic units with low or null accumulation capacity. The alternative view emphasizes the non-regulated character of the employment relationship. Here I follow current empirical literature (Pratap and Quintin (2003), Gasparini (2002)), and adopt the second notion of informality. Specifically, an informal worker is defined as a person who declares not to have retirement benefits in its main job.²⁵ The right panel of figure (1) shows the constant increase of informal workers over the period 1995-2006. The average share of informal workers during the reference period is 16.85% and 36.13% for college and non college educated workers respectively. This share increased constantly afterwards, had a jump in occasion of the crisis and then kept on rising in spite of labor market reforms to limit the use of temporary, unprotected contracts.

The incomes were deflated by the consumer price index of the relevant month of survey collection (May or October) until 2003 and by an average of the index for the trimester of reference for the information from the latest continuous surveys (Encuesta Continua). The sample is divided into two distinct populations, those with more than secondary degree and those with at most a complete secondary degree. As a measure of relative wage earnings I take the college differential, the difference in average log hourly wages between the individuals with some college and those without. Between 1996 and 1998, the college differential averaged 0.5896 , while between 2003 and 2006 it averaged 0.5672 . The main changes occurred on the Argentinean labor market are summarized in table B-1: severance costs increased of about 25-50%, minimum wages of 46%. Wage growth due to the accumulation of skills decreased consistently both for college educated and non college educated workers. At the same time the share of informal workers and wage dispersion - measured as standard deviation of log hourly earnings - increased suggesting that labor protection policies and the reduced skills accumulation probability could have influenced these outcomes.

²⁴At the peak of the crisis (2002) the government introduced a new unemployment assistance programme targeted to low skilled unemployed head of households, called Jefe de Hogar. The programme is very inclusive, not distinguishing between former formal or informal workers. The beneficiaries were requested to provide limited amount of work while engaging in training activities and job search. Those workers/beneficiaries are excluded from the following analysis.

²⁵The perception of other social benefits derived from the labor relationship is highly correlated with the receipt of pension: 98% of the people who declare to have a pension right, states that (s)he receives an annual bonus, takes holidays, has work insurance coverage and a right to claim severance payments if fired (GBA, 1998).(Gasparini (2002))

3.4.2 Moments

The first two pairs of parameters are matched to the average log hourly earnings of formal $m_{c,f}^d(1)=1.5875$ and $m_{nc,f}^d(1)=1.0875$, and informal workers $m_{c,inf}^d(2)=1.0578$ and $m_{nc,inf}^d(2)=0.5965$.

With respect to the dispersion of earnings within groups, I use the standard deviation of log hourly earnings. Because the model economy does not distinguish between more and less educated people within each group, I regress the log hourly earnings on the different degrees and relative completion and then compute the standard deviation of the residuals of this regression.²⁶ Between 1996-1998 the average standard deviation for formal workers was $m_{c,f}^d(3)=0.5820$ for those with more than secondary degree and $m_{nc,f}^d(3)=0.5412$ for those with at most a secondary degree; for informal workers the average standard deviation of these residuals were $m_{c,inf}^d(4)=0.6810$ and $m_{nc,inf}^d(4)=0.6228$, respectively.

The transition probabilities of skills while unemployed (determined by parameter p_u) are matched calculating the earnings loss of unemployed workers after a year. I link agents over 4 consecutive surveys and calculate the difference in wages of those who are employed in the first observation and in the last one while being recorded unemployed in the 2 central ones. The resulting data moments are $m_c^d(5)=-0.4846$ for college- and $m_{nc}^d(5)=-0.1911$ for non college educated workers. These data moments reflect the skill loss after one year of unemployment.

The next parameter p_l determines the amount of earnings loss immediately after a job separation. I construct 2 years panels for each salaried worker in the survey. For those workers who report strictly positive earnings in the survey following a job separation, as well as in the survey before, I compute the difference in log hourly wage earnings before the career interruption and after: $m_c^d(6)=-0.0363$ and $m_{nc}^d(6)=-0.0163$. In the context of the model, this is an indicator of the skill change workers face immediately after losing their job.

The next parameters $c_{i,s}$ and $n_{i,s}$ are particularly important as they determine the model's reservation wage, the unemployment rate, the job turnover rate, and the share of informal workers. I first concentrate on the search cost $c_{i,s}$.

Search costs determine both the search efforts and the choice between the two sectors, consequently search costs on formal markets $c_{i,f}$ are matched with the aggregate unemployment rates: $m_c^d(7)=0.0656$ and $m_{nc}^d(7)=0.1095$. Search costs for informal workers $c_{i,inf}$ are matched with the share of informal workers for the two educational groups: $m_c^d(8)=0.1685$ and $m_{nc}^d(8)=0.3614$.

²⁶This means for the unskilled group: no education, primary incomplete, primary, secondary incomplete, secondary complete. While for the skilled group: specialization degree, and university degree both complete or incomplete.

$n_{i,s}$ determine the probabilities to find a new job offer, and are thus matched to unemployment rates in the two sectors and for the two workers' type: formal $m_{c,f}^d(9)=0.0386$ and $m_{nc,f}^d(9)=0.0692$, and informal $m_{c,inf}^d(10)=0.1790$ and $m_{nc,inf}^d(10)=0.1729$.

p_e determines the wage growth due to skills accumulation over time. As informal workers can be observed only on very limited time spans, to define wage growth I link workers over 4 periods and define the average growth rate over two years.

The last pair of moments are $m_c^d(11)=1.1578$ and $m_{nc}^d(11)=1.1415$.

Table (B-2) lists all the parameter values with standard errors and the corresponding simulated and data moments. The model can reproduce pretty closely the data moments for both the formal and the informal sector, as well as the resulting mean log wages and standard deviations of the aggregate markets for both the college educated and the non college educated workers. Figure (B-1) shows the resulting initial wage distributions of earnings; in the left panel for college educated in the right panel for non college educated workers. Data distributions are a bit more concentrated in the mean earnings for college educated, while the contrary is true for non-college educated workers.

The new hourly earnings growth rates are estimated from the data and showed in table (B-1); formal college (non college) educated workers experienced a decrease in hourly earnings growth of about 40% (33%).

Severance pay increased of 50%. However, the measure of severance costs used includes two costs: the advance notice and the compensatory amount. Heckman and Pages-Serra (2000) do not specify the weights associated to each component of the total job security cost. I assume compensatory payments constitute more than 50% accordingly the increase in job security cost would be in the order of 25% - 50% (in this last case the share of compensatory payments would be 100%)

3.5 Results

Tables B-3 to B-6 present separately for college educated and non college educated workers the results for the two policy measures analyzed. Results for non college educated workers are presented first as the labor market protection measures are exactly meant to affect low income/low educated workers' livings.

Tables B-3 and B-5 present the effect of severance pay and minimum wages under the initial human capital growth rate, while B-4 and B-6 analyze the same policies under a reduced human capital growth regime. For all tables the first column reports the baseline specification, i.e severance payment costs equal to 24% of earnings and minimum wages equal to 1 peso per hour. Columns 2 to 4 present in turn: an increase of only firing cost to 0.32 (considering that severance payment makes about the half of the total firing cost), an

increase of minimum wages to 1.46, an increase of both policies.

Each column analyzes the effect on hourly wages mean and standard deviation (row 1 and 2) of the whole group (college educated or not), and then in detail for formal and informal workers, the share of informal workers in the economy, and unemployment first for formal and informal workers and then totally.

An increase in severance pay increases the share of informal workers and slightly increases unemployment. Theoretical debate on dismissal costs has long neglected the fact that labor protection measures often are not applied to the whole working population. Only recent evidence about the growing share of informal markets has raised the attention to the possible compositional effects of these measures.

Severance payment are meant to reduce frictional unemployment by reducing reservation wages (Ljungqvist (2002)), this is because they raise the cost of ending matches. However in the presence of minimum wages this does not happen but rather an increase in severance pay shifts the human capital threshold between formal and informal workers, making formal employment less attractive to the previously marginal workers. The reason is that although jobs last longer when the severance pay is higher, the expected formal sector wage decreases. This is in accordance with what Albrecht et al. (2006) and Bosch (2007) also find.

The reduction of formal sector wages relies on the hypothesis that employers shift onto the worker the cost of job security provisions. In the model employees bear the full cost of job security measures. Evidence put forward by Mondino and Montoya (2000) for Argentina confirm that a considerable share of labor costs are passed onto workers: during the period 1975-1996 wages of non-covered workers were 8% higher than the gross wages of covered workers.

An increase in minimum wages has a wide impact on formal workers' unemployment, informality and earnings. The negative effect on formal workers' employment is only partly counterbalanced by the reduction of uncovered workers' unemployment. This is in accordance with what the conventional neoclassical position on minimum wages predicts: imposing a minimum wage above the equilibrium level increases unemployment among low-wage, low human capital workers, who are laid off by employers who comply. However, the informal sector does not show the downward wage flexibility that traditional models of labor market dualism predict. At the contrary, consistent with Maloney and Nunez-Mendez's (2003) findings, mean earnings in the informal sector slightly increase. This is because marginal workers moving from the covered to the uncovered sector do not lower their reservation wage by becoming informal workers; at the contrary they increase the average human capital of the informal sector.²⁷

²⁷This is slightly different from the "lighthouse" effect found by Maloney and Nunez-Mendez (2003) in Latin America or Devereux (2005) in Uganda. The lighthouse effect refers to the common practise found in

The effect of raising minimum wages on poverty is difficult to assess: on the one hand informality and formal unemployment raise on the other hand earnings both in the covered and the uncovered sector raise.²⁸ As a matter of fact the empirical evidence on the relation between minimum wages and poverty is controversial (see for example Lustig and McLeod (1996), Saget (2001), Maloney and Nunez-Mendez (2003)).²⁹

The combined effect of job security provision and minimum wages on unemployment and informality is more severe than the one foreseen for the single measures. This is because minimum wages introduce farther reaching rigidities in the labor market precluding formal wage adjustments to shocks and increasing unemployment both for formal and informal workers.

Thus while the introduction of minimum wages is often meant to lift workers' standard of livings, the outcome - in countries where the minimum wage is binding - is an increase in non compliance, wider inequality between formal and informal workers and higher unemployment.

The effect is bigger for non college educated workers which earn a salary closer to the minimum wage.³⁰

Comparing the first column of tables B-3 and B-4 for non college educated and B-5 and B-6 for college educated workers it is possible to understand the effect of a reduced human capital accumulation growth. Both average formal and informal earnings decrease, however the expected formal wage falls relatively more; as a consequence workers select into the informal sector, where it is easier to find a job and there are no additional costs.

This result is important as it highlights the change in workers' incentives during a period of labor productivity slowdown. It has been argued (Bosch (2007)) that in recessions informality increases because of differential job finding rates across sectors: the formal sector would experience a severe contraction in hirings while the informal sector would provide a relative time constant source of jobs. However, also workers' incentives might play a role: faced with a lower probability to experience earnings growth, longer job tenure loses its attractiveness.

As a matter of fact this could be the key to understand the often contradictory evidence on the business cycle properties of informality.

Another important finding is that given a lower human capital accumulation probability informal wage dispersion increases, and this is particularly true for college educated workers. This is because on the one hand human capital dispersion increases and on the other hand informal workers can adjust their reservation wage to the negative shock. Formal workers

some countries to refer to the minimum wage as a fair/minimal retribution also in the informal market.

²⁸Fields and Kanbur (2007) highlight the importance of family income sharing in evaluating the impact of minimum wage on poverty.

²⁹See Devereux (2005) for a comprehensive review of the literature on this topic.

³⁰See for example Freeman and Freeman (1991) or Bell (1997) for corresponding empirical evidence.

cannot adjust their reservation wage and thus just migrate to the informal sector. The resulting surge of informal work determines an increase of residual wage dispersion for each educational group.

Lower human capital accumulation is thus another possible mechanism to explain residual wage dispersion which easily matches evidence on leftwards widening of earnings distributions during economic recessions.

This channel is very different from the technology driven mechanism proposed for developed countries where residual wage dispersion is due to skill loss upon job separation and the related impossibility of transferring acquired skills across jobs (Violante (2002), Kambourov and Manovskii (2008), Guvenen and Kuruscu (2006), Shi (2002)).

The combined effect of labor market policies and reduced wage growth is shown in the last column of tables B-4 and B-6. Labor market policies and falling human capital accumulation are able to fully explain the increase in informality and the falling skill premia, but only partly - 35% for non college educated workers and about 50% for college educated workers - of the observed increase in residual inequality.

3.6 Conclusions

In this paper I construct a search model to analyze the effects of labor protection measures on inequality and informality under two different macroeconomic scenarios. In light of empirical evidence for Latin American countries, in the model, workers self select into unregulated contracts on the basis of their accumulated human capital skills.

The model is parametrized such as to replicate key labor market moments in Argentina in the period 1996-1998, before labor protection measures were raised. In the presence of binding minimum wages an increase of severance payments does not have any sizeable effect on employment but rather shifts marginal workers from the covered sector to the uncovered one.

Minimum wages have large effects on informality, unemployment and wages. Thus while the introduction of minimum wages is often meant to lift workers' standard of livings, the outcome - in countries where the minimum wage is binding - is an increase in non compliance, wider inequality between formal and informal workers and higher unemployment.

A reduction in human capital accumulation rate increases wage dispersion and further raises informality. This highlights the change in workers' incentives during a period of labor productivity slowdown and constitute an interesting perspective to investigate the business cycle properties both of informal work and residual wage dispersion.

The combination of the labor protection measures and the fall in human capital accumulation rate are able to explain all of the informality increase and 30 to 50% of the increase

in wage dispersion occurred in Argentina after the last macroeconomic crisis.

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3.7 APPENDIX A

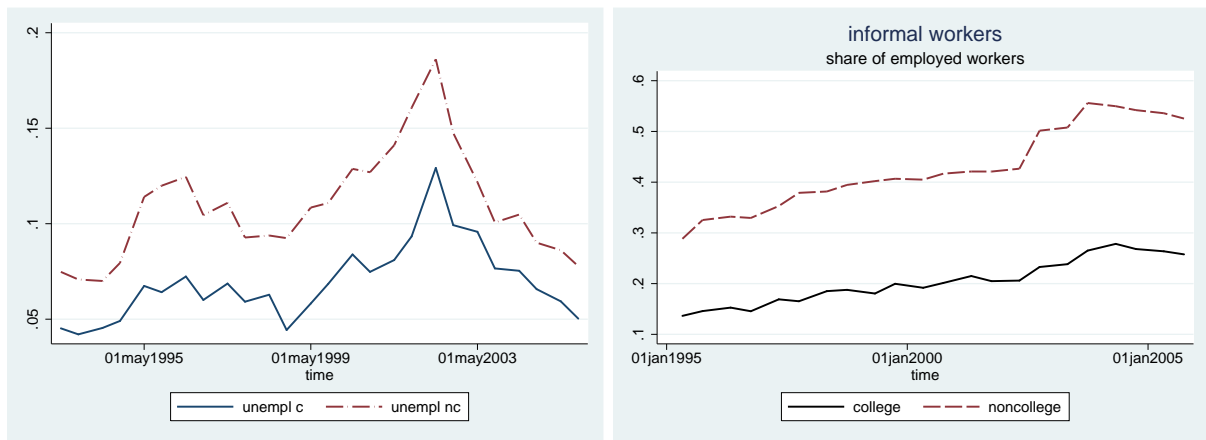


Figure A-1: Unemployment rates and share of informal workers for individuals with some college education "c" and without "nc", only salaried workers, aged 20-65.

Table A-1: Job Security Index selected countries, Late 1990s

Country	Job security index (monthly wages)	Annual wage (percent)	ranking
United States	0.000	0.000	1
Germany	1.140	9.498	6
United Kingdom	1.457	12.144	10
Brazil	1.785	14.871	13
Argentina	2.977	24.808	24
Mexico	3.126	26.005	25
Spain	3.156	26.300	28
Bolivia	4.756	39.637	36

Source: Heckman and Pages-Serra (2000)

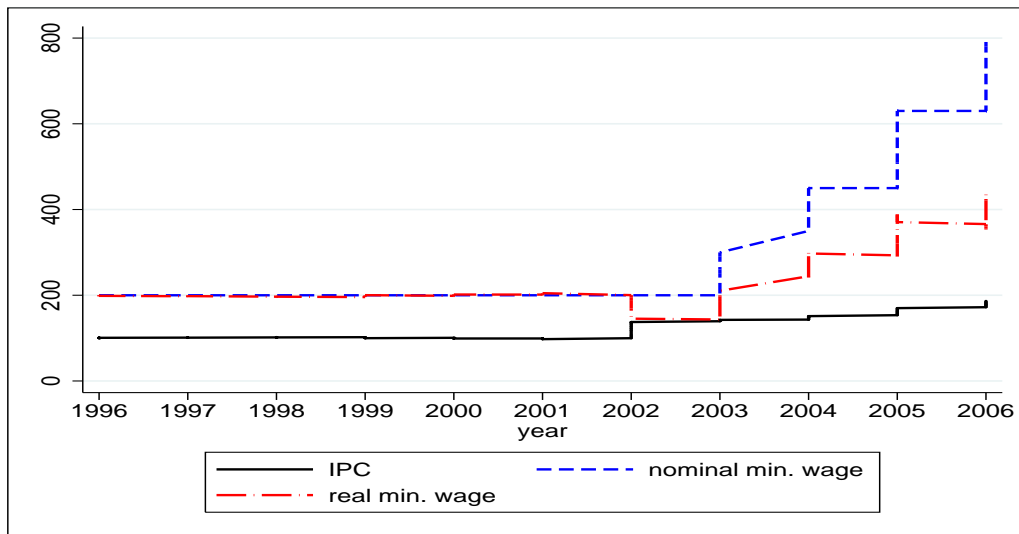


Figure A-2: Evolution of nominal and real minimum wage in Argentina

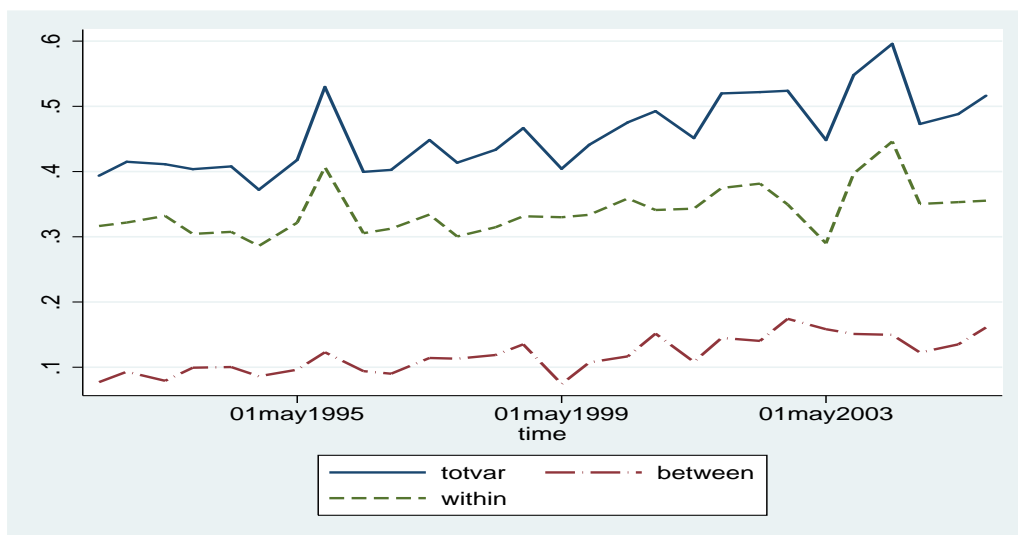


Figure A-3: Decomposition of log hourly wage variances for salaried workers, aged 20-65.

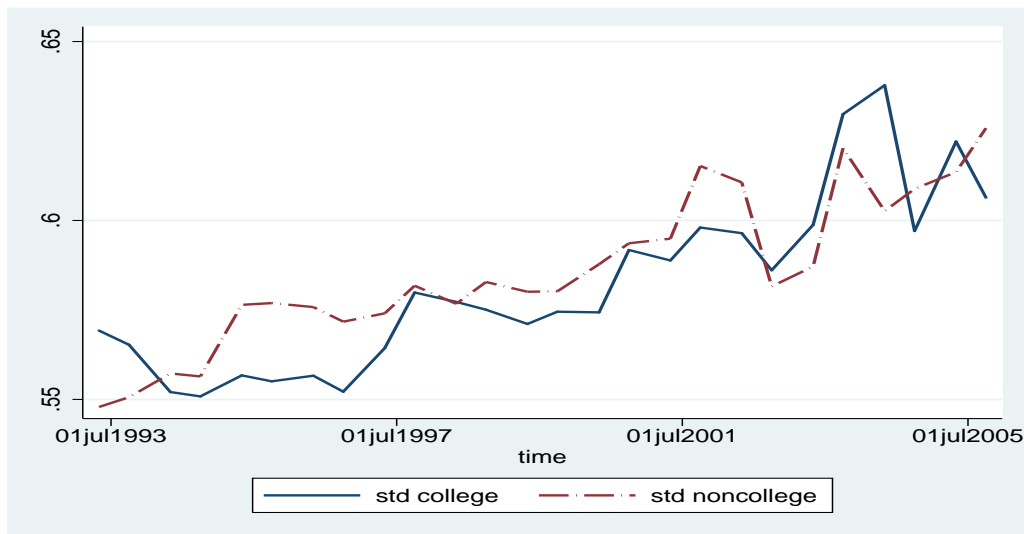


Figure A-4: Residuals standard deviation for salaried workers, aged 20-65, with some tertiary education "c", without "nc".

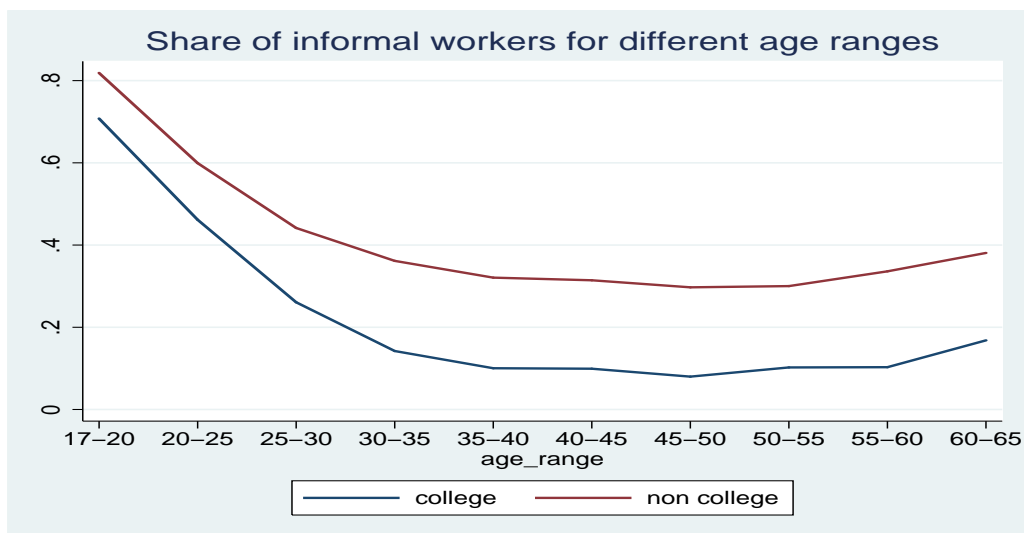


Figure A-5: Percentage of salaried workers in the informal sector by age. Years 1996-1998.

3.8 APPENDIX B

Table B-1: Main changes in the Argentinean labor market

	1996-1998	2003-2006	% change
severance pay K	0.24 * wh	0.30-0.36	25-50
minimum wage MW	1	1.46	46
wage growth $c p_e$	$2.48e - 4$	$1.5e - 5$	-40.32
wage growth $nc p_e$	$2.10e - 4$	$1.4e-4$	-33.26
observed log earnings $wh c$	1.4999	1.2307	-17.95
observed log earnings $wh nc$	0.9103	0.6636	-27.11
skill premia	0.5896	0.5671	-3.80
std residuals c	0.6181	0.6491	5.01
std residuals nc	0.6054	0.6555	8.20
Unemployment rate c	0.0656	0.0680	3.70
Unemployment rate nc	0.1095	0.0988	-9.81
share of informal workers c	0.1685	0.2438	44.64
share of informal workers nc	0.3614	0.4629	28.09

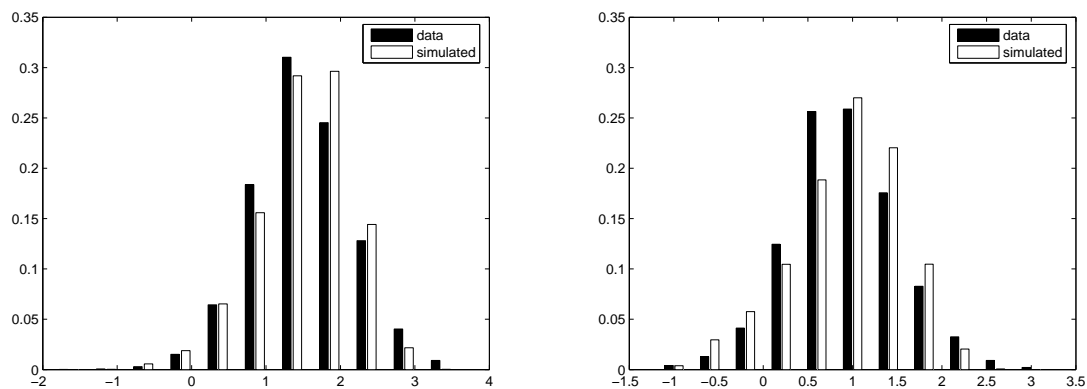


Figure B-1: Log wages distribution data and model: college educated, noncollege educated.

Table B-2: Parametrization: benchmark

Parameter	Value	std. err.	Model moment	Moment matched
β	0.9952		Annual interest rate = 0.06	
α	0.002		Expected worklife = 41 years	
$\lambda_{f,s}$	0.0204		Expected contract duration 4 years	
$\lambda_{inf,c}$	0.0261		Monthly unempl. inflow rate c informal	
$\lambda_{inf,nc}$	0.0431		Monthly unempl. inflow rate nc informal	
$\mu_{f,c}^w$	2.3990	(0.0012)	$m_{f,c}(1)=1.5878$	$m_{f,c}^d(1)=1.5875$
$\mu_{f,nc}^w$	0.1167	(0.0184)	$m_{f,nc}(1)=1.0917$	$m_{f,nc}^d(1)=1.0875$
$\mu_{inf,c}^w$	0.2043	(0.0026)	$m_{inf,c}(2)=1.0582$	$m_{inf,c}^d(2)=1.0578$
$\mu_{inf,nc}^w$	0.2083	(0.0036)	$m_{inf,nc}(2)=0.5959$	$m_{inf,nc}^d(2)=0.5965$
$\sigma_{f,c}^w$	4.2849	(0.0057)	$m_{f,c}(3)=0.5791$	$m_{f,c}^d(3)=0.5820$
$\sigma_{f,nc}^w$	2.9623	(0.0319)	$m_{f,nc}(3)=0.5265$	$m_{f,nc}^d(3)=0.5413$
$\sigma_{inf,c}^w$	9.0842	(0.0076)	$m_{inf,c}(4)=0.6795$	$m_{inf,c}^d(4)=0.6810$
$\sigma_{inf,nc}^w$	3.021	(0.0053)	$m_{inf,nc}(4)=0.6201$	$m_{inf,nc}^d(4)=0.6228$
p_c^u	0.0127	(8.1202e-5)	$m_c(5)=-0.4838$	$m_c^d(5)=-0.4846$
p_{nc}^u	1.695e-3	(1.4637e-5)	$m_{nc}(5)=-0.1915$	$m_{nc}^d(5)=-0.1911$
p_c^l	0.0039	(9.2393e-5)	$m_c(6)=-0.0349$	$m_c^d(6)=-0.0363$
p_{nc}^l	1.2459e-3	(5.8058e-5)	$m_{nc}(6)=-0.0196$	$m_{nc}^d(6)=-0.0163$
$d_{f,c}$	116.73	(0.9947)	$m_{f,c}(7)=0.0567$	$m_{f,c}^d(7)=0.0656$
$d_{f,nc}$	64.93	(0.173)	$m_{f,nc}(7)=0.1086$	$m_{f,nc}^d(7)=0.1095$
$d_{inf,c}$	80.859	(0.0118)	$m_{inf,c}(8)=0.1695$	$m_{inf,c}^d(8)=0.1685$
$d_{inf,nc}$	24.209	(0.0675)	$m_{inf,nc}(8)=0.3604$	$m_{inf,nc}^d(8)=0.3613$
$n_{f,c}^e$	0.9486	(0.1391)	$m_{f,c}(9)=0.0254$	$m_{f,c}^d(9)=0.0386$
$n_{f,nc}^e$	0.8844	(0.0096)	$m_{f,nc}(9)=0.0712$	$m_{f,nc}^d(9)=0.0692$
$n_{inf,c}^e$	0.9290	(0.0205)	$m_{inf,c}(10)=0.1848$	$m_{inf,c}^d(10)=0.1790$
$n_{inf,nc}^e$	0.8729	(3.7436e-7)	$m_{inf,nc}(10)=0.1725$	$m_{inf,nc}^d(10)=0.1729$
p_c^e	2.4792e-4	(2.8951e-7)	$m_c(11)=1.1588$	$m_c^d(11)=1.1578$
p_{nc}^e	2.0978e-4	(9.1225e-7)	$m_{nc}(11)=1.1386$	$m_{nc}^d(11)=1.1415$
mean earnings c			$\mu_c = 1.498$	$\mu_c^d = 1.4999$
mean earnings nc			$\mu_{nc} = 0.9142$	$\mu_{nc}^d = 0.9130$
std deviation c			$\sigma_c = 0.6195$	$\sigma_c^d = 0.6181$
std deviation nc			$\sigma_{nc} = 0.6103$	$\sigma_{nc}^d = 0.6058$

Table B-3: Effect of severance payment K and minimum wage MW under **high** human capital growth p_e , **non college educated** workers.

	$K = 0.24, MW = 1$	$K = 0.32, MW = 1$	$MW = 1.46, K = 0.24$	$MW = 1.46, K = 0.32$
μ_{nc}	0.9130	0.9112	0.9798	0.9768
σ_{nc}	0.6103	0.6103	0.6023	0.6027
μ_f	1.0917	1.0916	1.2251	1.2251
σ_f	0.5265	0.5264	0.439	0.4389
μ_{inf}	0.5959	0.597	0.6	0.601
σ_{inf}	0.6201	0.6189	0.6234	0.6221
share	0.3603	0.3647	0.3924	0.3978
U f	0.0712	0.0719	0.0814	0.0822
U i	0.1725	0.1733	0.1676	0.1684
U tot	0.1086	0.1098	0.1155	0.1168

Table B-4: Effect of severance payment K and minimum wage MW under **low** human capital growth p_e , **non college educated** workers.

	$K = 0.24, MW = 1$	$K = 0.32, MW = 1$	$MW = 1.46, K = 0.24$	$MW = 1.46, K = 0.32$
μ_{nc}	0.8295	0.8361	0.8981	0.8813
σ_{nc}	0.6222	0.6244	0.6221	0.6250
μ_f	1.0756	1.0776	1.2087	1.2067
σ_f	0.5238	0.5244	0.4354	0.435
μ_{inf}	0.539	0.5427	0.5408	0.5394
σ_{inf}	0.6087	0.6103	0.6127	0.6103
share	0.4361	0.4515	0.465	0.4876
U f	0.0568	0.0568	0.0655	0.063
U i	0.2147	0.2131	0.2097	0.2257
U tot	0.1278	0.1292	0.134	0.1449

Table B-5: Effect of severance payment K and minimum wage MW under **high** human capital growth p_e , **college educated** workers.

	$K = 0.24, MW = 1$	$K = 0.32, MW = 1$	$MW = 1.46, K = 0.24$	$MW = 1.46, K = 0.32$
μ_c	1.498	1.497	1.5468	1.546
σ_c	0.61953	0.6201	0.5914	0.5922
μ_f	1.5878	1.5872	1.6512	1.6515
σ_f	0.5791	0.5796	0.5138	0.5138
μ_{inf}	1.0582	1.058	1.058	1.0575
σ_{inf}	0.6795	0.6796	0.6794	0.6795
share	0.1695	0.1704	0.176	0.1777
U f	0.0254	0.0255	0.0269	0.027
U i	0.1848	0.1844	0.1842	0.1841
U tot	0.0567	0.0568	0.0588	0.0592

Table B-6: Effect of severance payment K and minimum wage MW under **low** human capital growth p_e , **college educated** workers.

	$K = 0.24, MW = 1$	$K = 0.32, MW = 1$	$MW = 1.46, K = 0.24$	$MW = 1.46, K = 0.32$
μ_c	1.3664	1.3657	1.4084	1.4075
σ_c	0.6628	0.6635	0.6383	0.6392
μ_f	1.5171	1.518	1.5856	1.5864
σ_f	0.5729	0.573	0.5052	0.5053
μ_{inf}	0.9432	0.943	0.943	0.9429
σ_{inf}	0.7129	0.7126	0.7129	0.7126
share	0.2626	0.2648	0.2757	0.2779
U f	0.0276	0.0277	0.0294	0.0296
U i	0.2279	0.229	0.2279	0.229
U tot	0.0896	0.0906	0.0937	0.0947

Chapter 4

School Entrance Age, Exposure to Pre-School, and the Evolution of Ethnic Test Score Gaps

This is joint with Christian Dustmann

ABSTRACT

In this paper we investigate test score gaps and their evolution for white and ethnic minority children aged 3 and 5 in the UK. We also analyse the effect of early school exposure on test score gaps, and differences in the effect of entry age on early school performance. Ethnic test score gaps at age 3 - when most children are not enrolled in Kindergarten yet - are large. Background characteristics (in particular exposure to the English language) explain part, but not all of this differential. Between the age of 3 and 5, the ethnic test score gap narrows. Exposure to preschool measured at age 5 - even if limited to only a few months - has a larger positive effects on test scores for those minority groups who started from a more disadvantaged position. Further, keeping exposure to pre-school constant, ethnic minority children loose less from entering pre-school at a younger age than majority individuals; for some groups, there is an overall gain from entering school early. Our findings point at a reduction in achievement gaps between minority and majority children in the UK between age 3 and age 5, which is partly due to a larger positive effect of pre-school on achievements of minorities.

4.1 Introduction

Educational attainment, early test scores, and school environment are important predictors of future labour market outcomes such as earnings, or occupational choices (see e.g. Neal and Johnson (1996), Neal (2006), Shonkoff and Phillips (2000), and Currie and Duncan (1999) for the U.S. and Robertson and Symons (1990) for the U.K.). Recent work by Heckman and co-authors argues that the development of cognitive skills may be influenced even earlier, and in the pre-school period (see e.g. Cunha and Heckman (2007), Carneiro, Heckman and Masterov (2005), Heckman (2008)). The importance of pre-school experiences for early school test results has also been emphasised by Elder and Lubotsky (2008). They argue that the positive effect of later school entry age on test scores and other outcomes, as found in many countries (see e.g. Bedard and Dhuey (2006), Puhani and Weber (2008), Fredriksson and Oeckert (2005), McEwan and Shapiro (2008)), is related to differences in pre-school learning. Elder and Lubotsky (2008) provide some convincing evidence for this hypothesis, by showing that the age advantage is higher for children from higher income families, who are more likely exposed to a higher quality pre-school environment.

Pre- and early school formation of cognitive skills may also be a key factor in explaining differences in achievements across different population groups. Recent research for the U.S., investigating the sources of Black/white or Hispanic/white racial gaps, assigns importance to parenting practises and early home and schooling experiences (see e.g. Fryer and Levitt (2004), Todd and Wolpin (2006), Hanushek and Rivkin (2006)). The evidence put forward in this literature implies that ethnic test gaps for children at preschool age can be predictive of wide and persistent socio-economic disparities along the lines of racial or ethnic characteristics.

The importance of pre-school experiences vs. exposure to early schooling seems particularly important for children from minority background. If, as suggested by Elder and Lubotsky (2008), age at school entry affects early test results through accumulation of skills prior to school entry, then a later school start may be particularly disadvantageous for population groups where pre-school skill accumulation is low.¹ In this paper, we analyse the evolution of early test early test score gaps between majority and minority children in Britain, and how this is affected by variation in exposure to pre-school household and parental characteristics, and variation in the age at which pre-school is started. Our analysis focuses on test outcomes at age 3, age 5, and after the first year of pre-school.

We first investigate the test gap between children of majority and minority descent at ages 3 and 5, and whether it disappears conditional on parental background information.

¹Consistent with Elder and Lubotsky's hypothesis, Cascio and Schanzenbach (2007) find negative age at entry effects on longer term outcomes for disadvantaged children.

For the U.S., work by Fryer and Levitt (2008) indicates that the racial gap between Blacks and Whites is hardly detectable for children aged eight to 12 months, but widens for children of all races after the age of 2. In an earlier paper (Fryer and Levitt (2004)), research by the same authors suggests that the black-white gap disappears at Kindergarten age when conditioning on a small number of covariates, but that blacks loose ground during the first two years of schooling experience.

We demonstrate large attainment gaps between whites, and all ethnic minority children at the age of 3. There are also large differences in parental learning oriented activities across groups. Although attainment gaps decrease significantly when conditioning on a large set of background information, they remain sizeable and significant. We find that before starting pre-school programs, children are mostly affected by the family environment, in particular by their parents' human capital and parental learning oriented activities. Language spoken at home explains for some groups about half of the attainment gap. Given the limited exposure children of most minority groups have to English at this age, they seem to be negatively affected by all covariates which capture this lack of exposure, like grand parents' care, and neighbourhood ethnic concentration. Likewise, test result gaps at age 5 do not disappear after controlling for a large set of background characteristics. However, when comparing test gaps between ages 3 and 5 it seems that these have not widened for most minority groups.

We then investigate whether earlier exposure to the first year of formal schooling is more advantageous for children with an ethnic minority background. Our analysis utilises - similar to papers by Elder and Lubotsky (2008), Crawford, Dearden and Meghir (2007), Puhani and Weber (2008), Fertig and Kluve (2005), Cascio and Lewis (2006), Black et al. (2008) and Bedard and Dhuey (2006) - variation in school entry age created by a single cut-off date. We analyse the effect of early school exposure on tests which are specific to our survey population, and which address a set of cognitive abilities at age 5. Other than tests usually investigated in the before-mentioned literature - which address abilities after the same exposure to school input - this test is age-adjusted and taken at different stages of pre-school exposure. It identifies the combined effect of age at school entry and exposure to early school. We use different cut-off regulations across local areas, as well as variation in birth dates, to create exogenous variation in exposure to pre-school. Our findings point at pre-school exposure between the age of 3 and 5 having a large and positive effect on test scores for both white and minority children. Further, the schooling experience - even if limited to only a few months - is found to have a larger effects on test scores, exactly for those groups who started from the most disadvantaged and segregated position. This is a result in contrast with findings in the US literature, which point to schools' poor quality to explain Black's disappointing performance in math and reading tests.² It is in line with findings

²See for instance Fryer and Levitt (2004), Hanushek and Rivkin (2006), Krueger and Whitmore (2002).

by Dustmann, Machin and Schoenberg (2008), who show that - throughout the compulsory school curriculum - the test gap between whites and minorities in the UK decreases.

We then use variation in school entry age, created through the same cut-off rules, to investigate the effect of age at school entry on measures of personal, social and emotional development after the first year of primary school. Unlike previous research, our focus is on ethnic minority groups. We find that children who are older at school entry have higher test scores. However, this effect is lower for children from ethnic minority groups; in fact, it turns negative in sign for some minority groups. One interpretation - and in line with Elder and Lubotsky (2008) - is that parental input for some minority children is of lower quality than for majority children. Those groups that gain most from early school entry are at the same time those groups that have lower exposure to the majority language, and lower parental learning oriented activities. In accordance with this hypothesis, we find that children from a background where English is not spoken gain less from entering school later than children from a background where English is spoken.

We base our analysis on data from the Millennium Cohort Study (MCS), which over-samples ethnic minority groups in Britain. The MCS Study offers large-scale information about children, and the families who are bringing them up. The sample includes a "year long" cohort of around 19,000 babies born over the 12 months starting in September 2000. The first survey recorded the circumstances of pregnancy and birth, as well as those of the all-important early months of life, and the social and economic background of the family into which the children have been born. The second survey took place with the children at around 3 years of age and collected information on parenting practices, health and neighborhood characteristics, older siblings' school performances. The third survey visited the families when the children reached age 5 and had started primary school. The data provides, similar to the data used by Fryer and Levitt (2004), detailed information about parental and school background. In addition, it contains boost samples of the largest minority groups.

The rest of the paper is structured as follows: the next section presents the data and the main variables used in the analysis. Section 3 presents and analyses the test gaps at age 3 and age 5. Section 4 investigates the causal effect of schooling on test scores. Section 5 concludes.

4.2 Background, Data and Estimation Strategy

4.2.1 Ethnic Minorities in England

Other than in the U.S., ethnic minorities in Great Britain are relatively recent populations, with larger immigrations starting only after the Second World War, when the U.K. recruited

mainly unskilled labour from their former colonies, and had lenient immigration rules towards subjects from these countries. Most of the UK minorities live in England. In 2001 only 2% of the population in Scotland were from a non-White ethnic minority background. The proportion is similar for Wales. In contrast, according to the 2001 Census ethnic minority groups account for 9.1% of the total English population, up from 6.2% in 1991. Today, the children of ethnic minorities constitute 21.9 % of the overall primary school population in England, and this trend is sharply increasing.³

The five main ethnic minority groups in the UK are Black Caribbean, Black African, Indian, Pakistani, and Bangladeshi. These are also the groups that we will distinguish in our analysis below. Individuals who belong to these groups arrived nearly exclusively in the period after the Second World War, but their arrivals have been at different stages, and were triggered by different events. While the majority of immigrants from the Caribbean arrived in the period between 1955 and 1964, the main time of arrival of Black African, Indian and Pakistani first generation groups was between 1965 and 1974 (Peach, 1996). Bangladeshi arrivals peaked in the period 1980-1984.

A detailed description of the labour market experiences of ethnic minority groups of first and higher generation throughout the 1980s and 1990s can be found in Dustmann and Theodoropoulos (2006). These authors document that ethnic minority immigrants in Britain are generally well educated, with most groups having achieved higher levels of education than their white native born counterparts. This trend continues for ethnic minorities born in the U.K. Here - again - most groups seem to have at least the same education level than their white native born comparison groups, but perform worse in the labour market, after taking account of their concentration in the London area.

4.2.2 The Millennium Cohort Study

The Millennium Cohort Study (MCS) was selected from a random sample of electoral wards, disproportionately stratified to ensure adequate representation of all four UK countries, deprived areas and areas with high concentrations of Black and Asian families. Currently, three waves of the MCS are available. The survey for the first sweep took place between June 2001 and January 2003, gathering information from the parents of 18,819 babies born in the UK over a 12-month period and living in selected UK wards at age 9 months. In England (to which we restrict our analysis, as nearly all ethnic minorities live in England),

³In maintained primary schools the percentage of pupils (of compulsory age and above) who were classified as being of a minority ethnic origin has increased from 20.6 per cent in 2006 to 21.9 per cent in 2007. A similar trend is apparent in secondary schools, where the percentage of pupils classified as minority ethnic groups increased from 16.8% in 2006 to 17.7% 2007 (Statistics of England: Schools and Pupils in England - 2007, DfES).

the sample for the first sweep included 11,695 babies born between 1 September, 2000 and 31 August, 2001, and who form an academic year cohort.

The second sweep of the survey re-interviewed parents when their children were 3 years old, while the third survey took place in 2006 when the children were 5 years old and started primary school. The survey covers a large array of household characteristics, ranging from socioeconomic indicators, health of household members, and neighbourhood characteristics, to parenting practices and parent-child interactions. It also includes cognitive, physical and non-cognitive children assessments.⁴ At age 5 school identifiers allow to match MCS children to teachers' evaluations (the Foundation Stage Profile) of their cognitive, social and emotional development. The Foundation Stage Profile (FSP) assessment is collected by the Department for Children, Schools and Families in state schools in England. Of the 9,839 children in the third wave of MCS, 8,630 children could be matched.

Geographical identifiers allow us to link MCS data to 2001 National Census statistics for precisely defined areas ranging from the electoral wards (which can include as many as 30,000 residents) to Output Areas (covering an average of 300 inhabitants) or neighbourhood.⁵ Our sample for England comprises about 10,000 observations both at age 3 and 5; the number of observations for the main ethnic groups we consider are 391 (373 at age 5) for Indians, 718 (676) for Pakistani, 278 (285) for Bangladeshi, 179 (170) for Black Caribbean, and 283 (303) for Black Africans. Our main category of comparison is "white British" while the category "Others" includes white others, black others, mixed, Chinese and not specified ethnic group.

4.2.3 Compulsory Schooling in Britain and Reception Class

In the UK, all children between the ages of 5 and 16 receive compulsory full time education. The first stage (primary school) begins with the term following the child's 5th birthday. The length of primary education is normally 7 years and until age 11 when the child moves into Secondary education.⁶

Before primary school, children enrol in reception class. The minimum age for starting reception class is set by the local education authorities (LEAs), of which there are approximately 150 in England. LEA's determine the admissions policy for all community and voluntary controlled schools in their area.⁷ There is therefore some geographical variation

⁴For a detailed description of survey design, recruitment process and fieldwork see Dex and Joshi (2005).

⁵See the UK National Statistics webpage for a broader overview of the geographic hierarchy <http://www.statistics.gov.uk/geography/soa.asp>

⁶For a complete overview of the English education system see Gillard D (2007) *Education in England: a brief history* or visit the Department for children, schools and families website: <http://www.dcsf.gov.uk/>

⁷A community school is a state school run by the local authority, which employs the teachers, owns the land and buildings, and sets the admissions criteria. A voluntary-controlled school is a state school in which the local authority employs the teachers and sets the admissions criteria, but the school and

in the age at which children born on a particular day of the year start school. However, LEAs are rapidly converging towards a single point of entry, which is in September of the academic year when the child turns five.⁸ Almost three quarters of the children in our sample is subject to this single point entry policy.

Reception class lasts for 9 months. Where reception class starts in September, children must be four years old by September 1st. Thus, the youngest in class are those children who turn 4 by August 31, and the oldest in class are those children who turn 4 at September 1st. Although reception class is not compulsory, participation rates are only slightly lower than Year 1 enrolment rates to primary school. In 2008, more than 91% of all 4 years olds were enrolled in reception class in England,⁹ a percentage very similar to the one found in our sample: 89,55%. The aim of reception class is to prepare children for a more formal education when they reach the age of five and enter primary school. The types of skills taught include rudimentary writing skills and the use of capital letters, and rudimentary counting. In our analysis below, we will examine the effect reception class has on test outcomes within, and after one year of exposure.

4.2.4 Measures of cognitive outcomes

We briefly describe the main tests we are using in our analysis. We give more details in Appendix A.

MCS Test Measures: The MCS performs two cognitive tests for children who are aged 3 and 5. The cognitive assessment tests are British Ability Scale (BAS) tests: The Naming Vocabulary test and the Bracken School Readiness test at age 3, and the Naming vocabulary test, the Picture Similarities and the Pattern Construction tests at age 5.

The BAS Naming Vocabulary test is a verbal scale for children aged 2 years 6 months to 7 years 11 months. It assesses the spoken vocabulary of young children. The test items consist of a booklet of coloured pictures of objects that the child is shown and asked to name. The scale measures expressive language ability, and successful performance depends on the child's previous development of a vocabulary of nouns.

The Bracken School Readiness Scale measures the comprehension of several functionally relevant educational concepts related to colours, shapes, letters, numbers, comparisons and sizes. The readiness concepts assessed in this test are related to early childhood education

the buildings are normally owned by a charity - often a religious organization - which also appoints some members of the governing body.

⁸Admission policies are explained more in detail in appendix B, where we also report the compliance rate by group.

⁹For statistics about early education in England see the Department for Children, School and Families (DCSF) statistical release: Provision for Children under five years of age in England; January 2008

and good predictors for readiness for more formal education.

The Picture Similarities scale is designed to be non-verbal in that the task requires minimal oral instructions (and can be demonstrated by gesture) and does not require any oral response from the child. The BAS Pattern Construction test measures spatial ability and is considered as strongly related to overall cognitive ability.

The BAS scales are intended to obtain a test score by adjusting items appropriately for the child's level of developmental ability. As items that are moderately difficult for the child provide the most information about his/her ability, children of different ages (in month) and of different abilities therefore start and stop at different points on each scale. These starting and stopping points and the difficulty of the items are flexible rather than fixed, in response to a child's performance. The tests ask a series of items which differ by child's age, so as to keep the degree of difficulty constant across different age ranges. Further, in response to the child's performance, levels of difficulty within each age scale are adjusted, with tests becoming more difficult for well-performing children. As children take different sets of items, their raw scores on a scale cannot be compared directly. The raw scores are converted into an ability score, which reflects both the raw score and the difficulty of the items being administered. Ability scores are converted into T-scores based on the values in the standardisation sample for the applicable age band. T-scores range from 20 to 80 and have a mean of 50. A child with a T-score of 50 is therefore placed at the mean value for their age. Higher scores on either scale denote an increase in cognitive ability and, conversely, lower scores indicate a reduced level of ability. Standardisation to the respective age range is achieved through reference to a large UK populations sample used in developing the assessment.¹⁰ As a result, the BAS provides an age adjusted measure of ability that allows comparison of achievements of children across different age ranges.¹¹

The Foundation Stage Profile: The Foundation Stage Profile (FSP) assessment records the child's achievement as reported by their teacher at the end of the first year of reception class for children in state schools in England. The FSP has been introduced together with a series of learning goals in 2000 and replaces statutory baseline assessment on entry to primary school.

Throughout reception class, each child's development is assessed in relation to the stepping stones and early learning goals that form part of the Curriculum guidance for the pre-school years. These assessments are made on the basis of the practitioner's accumulating observations and knowledge of the whole child. By the end of the reception class year,

¹⁰The standardization sample represents all children who are being educated in mainstream schools or in special units attached to such schools (see Elliott (1996) and Elliott, Smith and McCulloch (1997); BAS II Technical manual).

¹¹See Hill (2005) for a detailed description and history of the development of the BAS and its strength relative to other measures of ability.

the Foundation Stage Profile provides a way of summing up that knowledge.

The Foundation stage sets out six areas of learning covering children’s physical, intellectual, emotional and social development. The FSP captures the six learning goals as a set of 13 assessment scales, each of which has nine points (with 9 being the highest): three measures of personal, social and emotional development; four measures of communication, language and literacy skills; three components of mathematical development; one of their knowledge and understanding of the world; one of their physical development; and one of their creative development. The total score for the FSP comprises the sum of these 13 components, with a maximum value of 117. Within each assessment scale points are presented in approximate order of difficulty, according to evidence from trials. The points are assigned on the basis of the teacher’s assessment of the child’s typical attainment.¹²

We normalize both the BAS - and the FSP assessments to have mean 0 and standard deviation 1 across the whole sample.

4.3 Ethnic Test Score Gaps and Background Characteristics

4.3.1 Socio-economic background

In table 1 we display information for a large set of background variables. The first panel reports variables measured when the child is three, and the second when the child is five years old (obtained from wave 2 and 3 of the MCS). We report means (in bold) and standard deviations (in parentheses), where each column refers to a different ethnic group.

The first two rows report information on English usage in the household (“English used only partly” and “English never used”). The residual category is “English used always”. The figures show a remarkable difference across groups. Unsurprisingly, among the whites, English is “always used at home” in nearly 99 percent of households. However, English is never spoken at home in a large fraction of Indian, Pakistani, Bangladeshi, and African households. English is always used in only 4 percent of Pakistani households, 3 percent of Bangladeshi households, and about 8 percent of Indian households. On the other hand, English is spoken in about 95 percent of Caribbean households - which is due to English being the main language in the Caribbean. Overall, these numbers suggest that children of ethnic minority background are (with the exception of the Caribbean’s) not much exposed

¹²To complete the FSP teachers need to record children’s achievements on a booklet throughout the reception class year. For details on the FSP see the Foundation Stage Profile Handbook issued by the Department for Education and Skills in 2003 and available online (http://www.qca.org.uk/libraryAssets/media/Foundation_stage_profile_handbook_COMPLETE.pdf)

to English at home.

There is large variation in single parenthood. While 16 percent of white children have a single parent, this number is far lower for minorities from the Indian sub-continent, but much higher for Caribbean's and Africans: more than 1 in 2 children from the Caribbean group grow up in a household with a single parent, and nearly 40 % of African children. There are likewise large differences in the labour market attachment of mothers. While about 70 percent of white mothers worked before giving birth, only 16 and 13 percent of Pakistani and Bangladeshi mothers did. The numbers for the other minority groups are higher, but still lower than for whites. Three years after giving birth, mothers from all ethnic groups have a lower participation rate than during pregnancy. However while Indian and Black Caribbean mothers are similar to white mothers, Pakistani and Bangladeshi mothers are the least active. This may partly be explained by differences in fertility - Pakistani and Bangladeshi households have on average almost 3 children, compared with 2 for the other groups. Further, they have chosen different childcare arrangements - their children spend the lowest number of months in early educational institutions (see the percentage of children in formal childcare at age 3 or the average number of months spent in childcare at age 5).¹³

Differences for the partner's behaviour are less pronounced, with all ethnic groups, with the exception of the Indian one, showing a roughly 10% lower labour force participation.

Compared to whites, the age at which mothers and their partners left full time education is quite high for all groups. Black African and Indian mothers have -according to this measure- higher levels of education than white mothers. Mothers from Bangladesh and Pakistan have about 1 year less education than whites. Except for the Bangladeshis, the partners of mothers for all groups seem to have higher levels of education than whites. These numbers are similar to those reported in Dustmann and Theodoropoulos (2006), based on the British Labour Force Survey.

Despite high levels of education, all ethnic groups (except for the Indians) have higher probabilities for income and/or job seeking allowance. Particularly dramatic - about 40% - is the fraction of Black African and Black Caribbean families receiving income support or job seeking allowances. This poverty pattern is confirmed by the neighbourhood's OECD poverty indicator (defined as average neighbourhood income inferior to 60% of the average British income).¹⁴ Almost three-quarter of Bangladeshi and Pakistani children and more

¹³Early education institutions are nursery school or nursery class, playgroup or pre-school. When English children turn 3 they are entitled to 12,5 hours of childcare per week free. Thus if it were only an economic concern, we would expect to see a higher share of Asian children in early education (average age in the MCS2 is about 3 years and 2 months).

¹⁴The statistics is provided by MCS. With neighbourhood here is meant the Lower Super Output Area (LSOA). Lower Super Output Areas are a geographic hierarchy with an average of 1500 residents. The size is consistent across the whole UK. For further details see Office of National Statistics webpage

than half of Black children live in poor neighbourhoods, compared to 26% of white children.

The ethnic concentration variable reflects the percentage of individuals of the same race in the neighbourhood as provided by the Census statistics.¹⁵ For comparison the next row reports the percentage of the different ethnic groups in the overall population as reported by the 2001 Census. While all ethnic groups tend to segregate, segregation is particularly pronounced for Bangladeshis, Pakistanis and Indians.¹⁶

4.3.2 Parental Learning Oriented Activities

The MCS includes a battery of questions about the activities parents undertake with their children. Some of these items can be directly linked to cognitive achievements, as they are related to learning-specific skills. Mothers are asked how often they read to their child, and how often someone in the household helps them learn the alphabet, count, learn songs, draw or, at age 5, learn math, writing and reading.

In Table A-1 in Appendix A we report whether the mother undertakes any of these activities more than 6 times per week, both at age 3, and at age 5. The table entries show large differences across ethnic groups. In Table 2 we report differences in an overall measure of LOAs at age 3 and at age 5 between whites and each of the groups we consider, unconditional (columns 1 and 3) and conditional (columns 2 and 4) on family background. This measure of LOAs is the first principal component of the indicator variables reported in Table A1, normalized to have mean 0 and standard deviation 1.¹⁷ The entries show that differences in learning oriented activities at age 3 reduce when we condition on a set of key background variables, but remain large and significant for some ethnic groups, like Pakistanis, Bangladeshis and Black Africans.¹⁸ For instance, even conditional on background characteristics, the overall score of learning oriented activities is 40% of a standard deviation lower for Bangladeshi mothers, as compared to white mothers. Consistent with current literature (see e.g. Duncan and Brooks-Gunn (1997), Carneiro and Heckman (2003), Todd and Wolpin (2006), Mayer (1997), Elder and Lubotsky (2008)) on early parents' investments, the LOAs measure is highly correlated with the income status of the household, mother's education, family composition and gender. English as a language used at home and immigration

<http://www.statistics.gov.uk/geography/glossary/s.asp>.

¹⁵Again we define neighbourhood as Lower Super Output Area. This area is less than half the neighbourhoods as defined in American Census data (about 4000 residents) (Cutler, Glaeser and Vigdor (2008)).

¹⁶This is consistent with US evidence that ethnic group's share of the population is positively associated with higher indexes of segregation (Cutler et al. (2008)).

¹⁷Using a simple average of the different learning oriented activities indicators leads to very similar results.

¹⁸The controls included are: English use at home, mother education level, poverty index, an indicator for arrival time to England less than 10 years ago, number of siblings, marital status of the mother, child's gender.

status are strongly negatively associated with learning oriented activities.

The LOA gaps are smaller in size and less associated with covariates at age 5. One explanation - which we will explore below - is that children spend some of their time in school at age 5: 99.16% of the children enrolled attend reception class full time.¹⁹

The numbers we report show clear pattern across ethnic groups. While Indian mothers seem to be most similar to white mothers if it comes to learning oriented activities, most other minority groups seem to invest less into learning activities of their children at age 3, even conditional on a large set of variables. Pakistani and Bangladeshi mothers seem to have the lowest rates of learning related activities. This is despite their low labour force participation rate. On the other hand, these groups have also the highest fertility rates and the largest households.

4.3.3 Raw test scores

We now turn to test score differences between groups at ages 3 and 5, based on the MCS test measures we describe above. Tables 3 and 4 report the mean raw test gaps between our six different ethnic groups, and whites for the MCS and the FSP assessments respectively. The tests have been normalized to have mean 0 and standard deviation 1. At age three, there is a clear difference between whites, and minority groups. In the naming vocabulary test (which assesses the spoken vocabulary of young children), ethnic minority children, in particular of Pakistani and Bangladeshi background, score clearly lower than white children: for these two groups, the gap is 1.3 and 1.5 standard deviations. This is well above the reading test gaps of Blacks and Hispanics at Kindergarten entry in the US (both around 40% of a standard deviation - see Fryer and Levitt (2004)).²⁰ The gap is also large for the other groups. One reason could be that English is not the first language spoken at home in most of these households - see Table 1. However, the gap is also large (0.5 of a standard deviation) for the Black Caribbean, where English is spoken at home. There is also a stark disadvantage in the Bracken test, which measures cognitive abilities at age three. Again, Pakistani and Bangladeshi children have the most pronounced disadvantages.

The differences in the vocabulary test carry through to age 5, and are particularly pronounced for the Pakistani and Bangladeshi populations. Although not comparable, the gap in the cognitive tests seems to be smaller at age 5 for all groups we consider. For non-verbal

¹⁹In wave 3 of MCS 98.5% of the children are enrolled in reception class. Those not enrolled are either attending private schools or do have medical conditions hampering school attendance. The BAS Naming Vocabulary assessment is similar, in terms of assessment design and

²⁰The BAS Naming Vocabulary assessment is similar, in terms of assessment design and abilities tested to the reading tests used in the American Early Childhood Longitudinal Program and reported e.g. by Fryer and Levitt (2004) for children at kindergarten entry (average age 67 months, 5 years and a half).

abilities tests (Picture similarities and Pattern Construction) Pakistani and Bangladeshi show a gap of roughly 50% of a standard deviation.²¹

Another set of test outcomes are the FSP tests, obtained at the end of reception class. As we describe above, these tests distinguish between both cognitive and non-cognitive abilities. The first set of questions refers to personal, social and emotional development; the second set to communication skills, language and literacy; the third set to mathematical development. The last set is about knowledge and understanding of the world, physical development and creative development. In Table 4 we show the raw gaps in the FSP attainments only for the children which start school in September and who all have been exposed to one year of reception class.

The gaps in the FSP assessments show surprisingly little variation across all the different scales. Pakistani and Bangladeshi children show the largest gaps not only in cognitive, but also in socio-emotional, and in physical assessments. The total FSP scale comprises the sum of the FSP single 13 components and is reported in the last column of Table 4. On the FSP total measure Pakistani and Bangladeshi children perform roughly 0.7 of standard deviation worse than whites.

4.3.4 Test Score Gaps and Family Background

Some of the large test score gaps between whites and minority individuals that we illustrate above may be explained by the differences in family background - for instance a very large fraction of Caribbean mothers are lone mothers, and high fractions of Pakistani and Bangladeshi mothers are receiving welfare benefits. Recent work by Fryer and Levitt (2004) suggests that tests score gaps between whites and blacks in the US, measured at age 5, are essentially eliminated after controlling for a small number of background characteristics.

Table 5 reports results for the "Vocabulary" and "School Readiness (Bracken)" tests at age 3, for three different specifications, conditional on an increasing set of family background characteristics.²² Estimation is done using weighted least squares, and clustering over sampling units, to take account of stratified sampling.

Specifications (1) display the raw differentials and are identical to results in Table 3. Specifications (2) control for English use in the household, where "English always used" is

²¹Although the tests are not directly comparable, we would like to note that the gap in math tests - thus a non verbal ability test - for Blacks and Hispanics in the US is about 64% and 70% of a standard deviation respectively (see Fryer and Levitt 2004).

²²We run simple regressions of the following type: $test_score_i = \sum_g \alpha_g G + \gamma X_i + \epsilon_i$, where i indexes individuals and g corresponds to the ethnic group to which an individual belongs (where whites are the reference group). The variable $test_score$ measures standardised results of the different tests (at age 3 "Vocabulary" and "Bracken", and at age 5 "Vocabulary", "Picture Similarities", "Pattern Construction", and the different scales in "FSP"). The vector X captures a wide range of possible control variables, and ϵ_i is an error term.

the omitted category. Controlling for the exposure to English reduces the gaps in the Naming Vocabulary test quite dramatically - by roughly a third, and by one-half for the Indian group. An exception is the Caribbean group, where English is spoken in most households. Thus, exposure to the English language at home appears to be a main determinant in the weak performance of ethnic minority kids in vocabulary tests.

Is language also important for the school readiness test, which tests the children's basic concept development? The results in column 2 in the second panel indicate that language spoken at home does affect also these test score gaps, but to a much lesser extent.

Specifications (3) add a wide number of background variables.²³ Controlling for these variables reduces the test gaps by about 20-30% of a standard deviation while the R^2 increases substantially. However, for all groups (except for the Indians) test score gaps remain significant, and are large in magnitude. For instance, conditional on the full set of covariates, test score gaps between Whites, and Pakistanis and Bangladeshis, are still 40 and 60 percent of a standard deviation for the school readiness test; they are about 30 percent for Africans and Black Caribbean. The covariates (we report the full set of estimates in Table A-2 in Appendix A) generally enter with the expected sign. Firstborn children, those with higher birth weights, those who breastfed longer, those with older mothers at the time of birth and girls score better. Learning Oriented Activities are all statistically significant; in particular mother's reading seems to have a large impact on both the Naming Vocabulary and the Bracken test scores.

Table 6 shows the (conditional) test gaps at age 5; the full regression results for all subscales are reported in Table A-3 in Appendix A. The first three panels refer to the MCS tests, and the last panel to the FSP tests. For the FSP we report only the total FSP score. Again, the first column of each panel reports the raw differences as reported in Table 3. The set of covariates included in the regressions at this age changes slightly from the one used in the previous section (e.g. the labour market participation of the parents is updated).

Results for the Vocabulary test gap at age 5 are similar to the ones at age 3. However, for most groups (except Africans and Caribbean) the gap has slightly decreased. Again, language spoken at home has a strong impact on the Vocabulary test score gap.

The Picture similarities and Pattern Construction tests are not measuring any language related ability. For both tests, conditioning on language used at home hardly seems to affect the test score gap. Parental human capital and human capital investments are the only set of covariates able to raise the R^2 significantly, while reducing the gap. Comparing

²³These are: poverty status, receipt of job seeking allowances, parental years of schooling, learning oriented activities, childcare arrangements, child-, family- and neighbourhood characteristics (including child gender, birth weight, birth order, age of mother at birth, mother's time of arrival in the UK, breast feeding behaviour, family composition, neighbourhood- OECD poverty indicator and ethnic concentration).

columns 1 and 3 for both the Picture Similarity and the Pattern Construction test show small differences in point estimates.

Compared to test results for the Bracken test at age three (although not directly comparable), test result gaps for the non-vocabulary tests are smaller, and they disappear entirely for the Indian subgroup. In Table A-3 in Appendix A we report results for the additional variables included. The results are similar to the ones at age three. However, parental oriented activities are hardly correlated to test scores.

Overall, these results are different than those found in some recent US literature (Fryer and Levitt 2004). Even in the most comprehensive specification we are not able to eliminate early test gaps at age 3 - except for the Indian subgroup. For all other ethnic groups, the conditional gaps in specification (3) are between one third and one half of the raw gaps shown in column (1). There is some evidence that the gap is slightly decreasing between ages 3 and 5. One reason for this may be reception class, to which all children in our sample have had some exposure by age 5. In the next section we investigate this in more detail.

4.4 Ethnic Test Score Gaps, Age at School Entry and School Exposure

4.4.1 Estimation

Our cognitive test data captures two important moments in the life of children: when they turn 3 (at a stage where they have been influenced by little more than the family), and when they turn 5 (at a stage where they have been exposed to some months of reception class). In addition, the FSP test provides information for children after 9 months of exposure to reception class. These tests allow us - in combination with random birth dates and the cut-off policies of earliest entry - to investigate the effect of school entry age on test scores. Our particular focus is to investigate whether children from minority background gain more from early exposure to school, and by entering reception class early, as compared to children from majority background.

As we discuss above, the different LEA's in Britain have different cut-off regarding the possible entry to pre-school. However, more than 70% of the children in our sample went to pre-school in local education authorities where the cut-off date was 1st September. If a child turns 4 before the 1st of September in a particular year, it is allowed to enter pre-school in that year. If - on the other hand - a child turns 4 after September 1st, the earliest possible time to enter pre-school is September in the next year. As we describe above, our sample consists of children born between September 2000 and August 2001. Thus, if all children entered pre-school at the earliest possible date, children born in September 2000 are 5 years

old when entering pre-school, while children born in August are 4 years old.

In the left panel of figure 1 we display the expected age at entry based on this cut-off rule (solid line) and the observed age at entry (black dotted line) for all children born in LEA's with a September cut-off date. The figure shows strong compliance, suggesting that most parents sent their children to school at the earliest possible date; the difference between the two lines is larger for those children who would have been younger at school entry, pointing at parents delaying children's school entry when children are allowed to enter very young.

A second test that is taken after exposure to reception class, and before entering primary school, is the MCS age 5 test which we describe above. The test is taken at different exposures of children to reception class. While designed to be taken right after children turned 5 years old (thus generating an exposure to reception class between 1 and 9 months), this did not always happen in practise. Children born between September 2000 and February 2001 were interviewed between February and May of 2006; thus, these children had an exposure to reception class of between 6 and 7 months. Children born between March 2001 and August 2001 were interviewed between April and August 2006, with the aim of having the interview as closely as possible to their fifth birthday. These children had an exposure to pre-school of between 7 and 9 months. Below, we will use this variation to compare test results across children with a different exposure to reception class.

In the right panel of figure 1, we display the exposure to pre-school for children born in different months and when they took the MCS age 5 test. Again the solid line is the maximum possible exposure at the test date (computed as date of interview - earliest possible enrolment date), and the dotted line is the observed exposure. For illustrative purposes, we have restricted the sample to children born in those LEA's where the cut-off date is September; in our empirical analysis, we will use the full sample. The figure shows that - as before - entry is delayed for those children that would have been the youngest in the class (those born in August or shortly before).

To estimate the effect of age at school entry ($AGEE$) and exposure to reception class (EXP) on age adjusted test outcomes from the MCS (T_i^{MCS}) and FSP results after reception class (T_i^{FSP}), consider the following models:

$$T_i^{MCS} = \alpha_0 + \alpha_1 EXP + X_i' \gamma + \varepsilon_i \quad (1)$$

$$T_i^{FSP} = \beta_0 + \beta_1 AGEE + X_i' \delta + \nu_i \quad (2)$$

where i is an index for individuals, and ε_i, ν_i are error terms. As age at test $AGET$ is the sum of $AGEE$ and EXP ($AGET = AGEE + EXP$), the first estimation equation identifies the combined effect of age at school entry and exposure to reception class on exam results (given that the MCS test results are age at test adjusted); the second equation gives the

combined effect of *AGEE* and *AGET*.²⁴

OLS estimates of equations (1) and (2) will result in biased estimates if parents' decisions to enrol children later than the cut-off date is correlated with test outcomes. We will therefore estimate equations (1) and (2) by 2SLS using the *earliest possible school entry age* as instrument for *EXP* and *AGEE*.

This instrument is similar to the one used in similar work by Dearden et al.(2008), Puhani and Weber (2008) and Elder and Lubotsky (2008). It relies on exogenous variation in month of birth and across policy admission areas (defined by all the LEAs applying a certain policy).²⁵ As *EXP* is equal to the difference in the interview date and the age at school entry, we need to rely on the assumption that the interview date is uncorrelated with unobserved factors that may affect test results, conditional on observed characteristics in the vector X . There is no reason to believe that the interview date is correlated with unobservables which affect test results. As discussed above, the interview date was set to be as close as possible to the child's 5th birthday while considering the requirement to interview the family during reception class. As a consequence children born in September 2000-February 2001, were all interviewed in January - May 2006, while those born March - August 2001 were interviewed in April - July 2006.²⁶ To investigate this further, we verify associations between a number of family background characteristics - household poverty index, mother's education level, mother marital status - and month of interview. There is no correlation between this set of observable characteristics and month of interview.²⁷

For the expected school starting age to be a valid instrument, two conditions need to be satisfied. First, it must be random which children are born in different months of the year. This could be violated if, for example, wealthier parents deliberately decide to have children in the autumn rather than in the summer. In this case the date of birth will be correlated with background characteristics. Bound and Jaeger (2000) review a large body of evidence of correlations between season of birth and parental wealth in the US. We verify associations of the above mentioned family background variables and season of birth without finding any significant correlation. We nevertheless report results for all specifications including quarter of birth dummies.

Second, parents must not sort into LEAs based on school entrance cut-offs, and LEAs

²⁴Suppose the full model is $T_i^{MCS} = a_0 + a_1EXP + a_2AGEE + X_i'g + e_i$, then $\alpha_1 = a_1 - a_2$. If, as found in some of the earlier literature, children who enter school at an older age perform better, then α_1 is an underestimate of the effect of exposure to reception class on test results.

²⁵LEAs which leave schools freedom to decide their own admission policies are excluded by the present analysis. The number of children involved are 273, see appendix B.

²⁶For further details on the MCS 3 fieldwork timetable see the *Millennium Cohort Study First Three Studies: a Guide to the Dataset* Ed by Kirstine Hansen Institute of Education, University of London.

²⁷We regress the relevant family's characteristic on month of interview dummies.

must not choose their cut-offs based on factors correlated with average characteristics of children in the state. This is less of a concern, as most LEAs are progressively converging toward one single admission policy. We also report results excluding children who moved in the last 5 years: results do not change substantially.²⁸ In addition, we condition on LEA indicators variables, which control for both regional variation in child ability and in schools quality. Our findings are robust to the inclusion of LEAs fixed effects which forces the identification to come from within-LEA variation in birthdates.

Finally, in some specifications we condition on the vector X , which includes a set of background variables (like poverty indices, parental education and marital status, number of siblings, child's gender, and birth weight). Notice that inclusion of these variables should not affect our IV estimates if the instruments are valid. We include these variables to improve estimation precision and to adjust for random differences between individuals in the distribution of pre-school characteristics.

As in all 2SLS models, estimates of β_1 identify local average treatment effects (LATE) among children whose actual number of months spent at school is affected by their predicted entrance age.

4.4.2 Results

Exposure to Reception Class

We first investigate the effect of the length of exposure to reception class on the MCS test score results. In Table 7 we report results for the Vocabulary and Pattern Construction tests taken at age 5, where the first two set of columns present OLS estimates, and the last two set of columns present IV estimates. We estimate equation (1), where we allow the coefficient on exposure to reception class to vary between the different ethnic groups. Specifications 1 condition on gender, birth weight, and LEA dummies, while specifications 2 condition on a large set of family background characteristics.

For the Naming Vocabulary test, the OLS estimates imply that for white children one month more of schooling is associated with an improvement in the test score of about 0.6% of a standard deviation, while the coefficient is 3.6%, and 4%, for Pakistani, and Bangladeshi children. The effect on Indians, Caribbean and African is not statistically significant. OLS results for the Pattern Construction test are similar.

The 2SLS estimates for all groups are larger than the corresponding OLS estimates, implying either that delayed entry (and shorter exposure) is more common among students who would otherwise have high test scores, or that early entry (and longer exposure) is more common among students who would otherwise have low test scores. Overall, the coefficient

²⁸This amounts to 1.589 children or 16.15% of the age 3 sample.

estimates increase substantially, and particularly so for the Pattern Construction tests. For whites, one month more school exposure increases MCS5 test results by 4.2% and 15.3% of a standard deviation, respectively. The effect is larger for nearly all minority groups, and in particular for the Pattern Construction test. Pakistani and Bangladeshi children seem to benefit most from a longer exposure to reception class, with an increase in test scores of 9.4 and 14.2% for the Vocabulary test, and 15.9% and 30.4% for the Pattern construction test. For Black Africans and Caribbean, insignificant and even negative estimate on the exposure variable in the OLS results turn now positive and significant, with large point estimates: Estimates suggest that one additional month of reception class leads to a 60.6% and 44.2% improvement in the Pattern Construction test score for Caribbean and African, respectively.

The 2SLS coefficients for the Naming Vocabulary test increase in particular for Asian children, while they are lowest for whites; this is consistent with those children gaining most in terms of the English language through reception class exposure.

One way to interpret these results is that children from ethnic minority background gain more from exposure to reception class than children with a white background. This is in contrast to some of the US literature, where exposure to school leads to an increase in test gaps between whites, and Blacks and Hispanics (see for instance Fryer and Levitt 2004, Todd and Wolpin 2006, Hanushek and Rivkin (2006)). It is however in line with recent work by Dustmann, Machin and Schoenberg (2008), which shows that children with an ethnic minority background gain relative to whites at every stage of their formal school curriculum.²⁹ But, as we point out above, the parameter we estimate is the combined effect of a longer exposure to reception class, and an earlier school entry age. Earlier research has found that an early school entry age leads to lower test scores. If this age at entry effect is lower for ethnic minority groups (in the sense that an early age at school entry is less detrimental for test score results than for whites), then this may partly explain the coefficient estimates we find above. In the next section we investigate this.

School Entry Age and Exposure to Reception Class

To investigate the effect of school at age entry on test score results, we now turn to the FSP tests. As we discuss above, these are taken at the end of reception class. Other than for the MCS5 tests, all children for the FSP tests have had the same exposure to reception class. However, there are exceptions: in LEA's that allow children to enter at various times during the year, exposure to reception class may be lower than 9 months. The idea of allowing different points of entry to school is based on the observation that 4 years olds can be too

²⁹Leuven, Lindahl, Oosterbeek and Webbink (2006) find that expanding the early enrolment possibilities for 4 years olds in the Netherlands does have a positive effect on early achievement tests only for disadvantaged children. In particular they find that one month more of schooling would improve language (math) scores of minority children of a 6.6% (3.1%) of a standard deviation. They do not find any effect of schooling for non disadvantaged Dutch children.

young to sit in reception class. Moreover, allowing children born in the summer to enter school some months later (usually in the January of the following year), allows schools to have age wise more homogeneous classes. We therefore restrict our analysis to those LEA's where the entry age is September (which is more than 70% of all LEA's).

The literature on age at school entry effects finds that the causal effect of entering school later is positive (see e.g. Bedard and Dhuey (2006), Datar (2006), Puhani and Weber (2008), Fredriksson and Oeckert (2005)). Elder and Lubotsky (2008) interpret this finding as being suggestive for the effect of exposure to pre-school environment: if children enter school later, they have accumulated more skills, and are therefore performing better. This interpretation suggests that children from weaker backgrounds should have lower age at entry effects than children from stronger backgrounds - a result that is found in Elder and Lubotsky's analysis. Our results have shown that pre-school environment may be particularly weak for children from ethnic minority backgrounds. Therefore, if age-related differences in early school performance are indeed mainly due to pre-school learning, then going to school at an earlier age may have a less detrimental (and possibly even positive) effect on test results of ethnic minority children.

We test this hypothesis in this section. In Table 8 we present estimates of the age at entry effects on the total FSP score for whites (first row), and the different ethnic minority groups in our sample. The first column presents OLS results. Column 2 presents IV results, conditioning on gender, birth weight and LEA dummies only. Column 3 adds a large set of family background characteristics.

The results show that a later age at school entry has a positive effect on outcome measures for whites: to enter school one month later increases test scores by 7.3% of a standard deviation. These results are similar to those by Dearden et al (2007) for tests results taken at age 7 (key stage 1) of children born in 1990-1992. They report an age at entry effect for children subject to September entry of 7.2% at age 7. Consistent with Elder and Lubotsky's (2008) hypothesis that the age at entry effect is related to preschool learning, the reported effect reduces over time.³⁰ This is much in line with the previous literature on age at school entry effects (Bedard and Dhuey (2006), Datar (2006), Puhani and Weber (2008), Fredriksson and Oeckert (2005)).

However, the effects are smaller for all ethnic groups, with the exception of black Africans. The effects are particularly small for minority groups from the Pakistani, Bangladeshi, and Caribbean communities - those groups that performed poorly in the MCS age 3 and age 5 tests. For both the Bangladeshi and the Caribbean groups, the point estimate of being one month older at school entry is not significantly different from zero.

³⁰Dearden et al. (2007) report an age at entry effect at the Key stage 2 examinations (age 11) of 1.7% and not statistically significant in the Key Stage 3 (age 14) examination.

In Table 10, we report IV results for specification 2, for the different FSP test scores. Again, entering school one month later has a positive impact on nearly all test measures for white children; however, the effect is close to zero (with a negative point estimate in some cases) for Pakistani, Bangladeshi and Caribbean children, suggesting that early school entry is not detrimental for these children. The crosses indicate that the estimated coefficients are significantly smaller from those for white children. The size of the effects is particularly pronounced for test results on personal, social and emotional development, and communication, language and literacy. This is consistent with the widely accredited hypothesis that the ability to become fully proficient in a second language is influenced by the developmental period in which exposure to the language begins. Much of this research finds a negative correlation between the age at which learning begins and the ability to become a native-like speaker (for reviews of this research, see Birdsong (1999) and Singleton and Ryan (2004)).³¹ Arguably the ability to communicate and express themselves helps children to better relate to others and integrate in the class.³² Thus, these results point at a higher age at school entry - although advantageous for majority children - being of no advantage for children from some of the minority groups.

Our estimates also suggest that the larger effect of exposure to reception class on MCS5 test results, as we reported in the last section, is partly explained by a non-positive effect of age at school entry for Bangladeshi, Caribbean and Pakistani children.

Variation by early family background

The results we report above are in line with the view that age at school entry effects capture (partly) the accumulation of skills prior to reception class, as suggested by Elder and Lubotsky (2008). Those ethnic groups who have been most disadvantaged in early test results - and received the lowest exposure to parental learning activities are at the same time those groups that seem to be harmed less (or possibly even gain) from being younger at school entry. To test this hypothesis we classify children on the basis of their family socioeconomic conditions at age 3. We regress the school readiness test on language used at home, income (4 income brackets), and parental education. The predicted Bracken test score is then used as an index of children's family background at age 3. The children are classified into one of the four quartiles of this early family background index (with quartile 4 representing the highest). In table 11, we report IV results, again for specification 1. The point estimates of the age at entry effect are increasing in the quartile. In many cases, especially for the social and language related tests, estimates for the higher quartiles are statistically larger

³¹Conger (2009) finds that age at entry has a negative effect not only on language proficiency but also on the speed of language acquisition, confirming the hypothesis that for children having English as a second language the effect of early school enrolment can be very important for a full integration.

³²For a review of the evidence on the relation between childhood development and literacy see Lonigan and Whitehurst (1998).

than for the lowest quartile. This corroborates the hypothesis that early family background is driving the late entry effect. Disadvantaged families in terms of language, income, human capital, do provide a poor substitute for kindergarten classes.

Robustness Checks

If month of birth is manipulated by parents in order to influence children's entry age, our instrument could lose validity. In tables A-5 and A-6 we report results for the schooling exposure and the age at entry effect including quarter of birth as an additional control variable. In addition to specification 2 which includes already a wide set of variables capturing the family background, we also report results for a specification including use of English at home and months of early education (specification 3). Results are not significantly influenced by the inclusion of quarter of birth, nor from additional family background variables. In tables A-7 and A-8 we examine results excluding children who moved in the 5 years prior to reception class start. This is to exclude any possible family's sorting into LEAs based on school entrance cut-offs. Again results are not significantly influenced by this exclusion.³³

4.5 Discussion and Conclusions

In this paper we investigate the test score gap between ethnic minority and majority children. We find large gaps in test scores at age 3. The raw test scores are lower for all ethnic minority children, as compared to white children. This gap narrows when we condition on background characteristics, but it is still sizeable conditional on a large set of variables. At age 3, the test score gap is importantly related to the language spoken in the home. This points at parental language abilities being important not only for parents' labour market outcomes, but being critically associated with early achievements of their children. At age 5, the test score gap is still substantial and - again - cannot be eliminated through conditioning on a large set of parental background characteristics. However, although tests are not directly comparable, the gap seems to be slightly reduced, as compared to age 3.

One reason for this may be exposure to reception class, which all children in our sample had at age 5. Using age adjusted tests that have been conducted at different stages of exposure to reception class, and instrumenting exposure using cut-off school policies, we find that exposure to reception class has indeed a larger effect on children from those groups who were most disadvantaged at age 3.

We then investigate whether this exposure effect may be due to lower test deficiencies for children from minority groups who enter school early. Using another set of tests that were conducted after the first year of reception class, we find that this is the case: while - as found

³³MCS data show that more than half of the parents who changed address in the 5 years prior to the reception class start, moved to a bigger better house closer to relatives when the cohort child was born.

in other studies - white majority children lose out on test scores when they enter school at a younger age, children from those ethnic minority groups that were most disadvantaged in early achievement tests at age 3 do not - or may even gain. These results are compatible with the interpretation of early school entry effect given by Elder and Lubotsky (2008), who argue that age-related differences in early school performance are driven by pre-school learning, and are smaller for children who are exposed to a family background that is less favourable to the accumulation of human capital important for learning success. This may be the case for some ethnic minority groups who -as we point out - receive less parental learning input at an earlier age, and are less exposed to the English language. In fact, we find that the gain from entering school at a slightly later age is smaller for children where English is not spoken at home.

Our results are important and novel in a number of dimensions. First, we believe the study of early achievement of ethnic minority children is extremely important for a long term and intergenerational integration of minorities. While in the U.S., the early stage development of children has been understood as perhaps the most critical factor in explaining the social and economic integration of minorities (see e.g. the discussion in Carneiro, Heckman and Masterov 2005), very little attention has been paid to this in other countries. We provide analysis for a European country - Britain - where by now one in four children in the school system are of ethnic minority background (DfES (2007)). Our findings for Britain differ slightly from those for Hispanic and Black minorities in the US, in two dimensions: First, as in US studies (Fryer and Levitt (2004), Todd and Wolpin (2006), Hanushek and Rivkin (2006), Krueger and Whitmore, (2002)), we find a large achievement gap between whites and minority children at an early age (age 3). However, while for instance Fryer and Levitt (2004) find that this gap diminishes conditional on a large set of background characteristics, this is not the case for Britain. Secondly, and more importantly, we find that exposure to early schooling does not lead to an increase in this gap. We rather find that the gap tends to decrease, and that the combined effect of entry age and school exposure leads to higher gains for those ethnic minority groups that were most disadvantaged at an earlier age.

Our study also adds to the recent literature on school entrance age effects. We find that - while white children gain in early test scores when entering school slightly older - this seems not to be the case for ethnic minority children from groups that were most disadvantaged at a young age. Our findings support the view put forward by Elder and Lubotsky (2008), that early school entry effects are related to pre-school learning. Our findings therefore emphasise that early, rather than late, school entry may be beneficial for children from minority family backgrounds, with less exposure to skill-enhancing activities. We identify language as a main determinant of early test score deficiencies.

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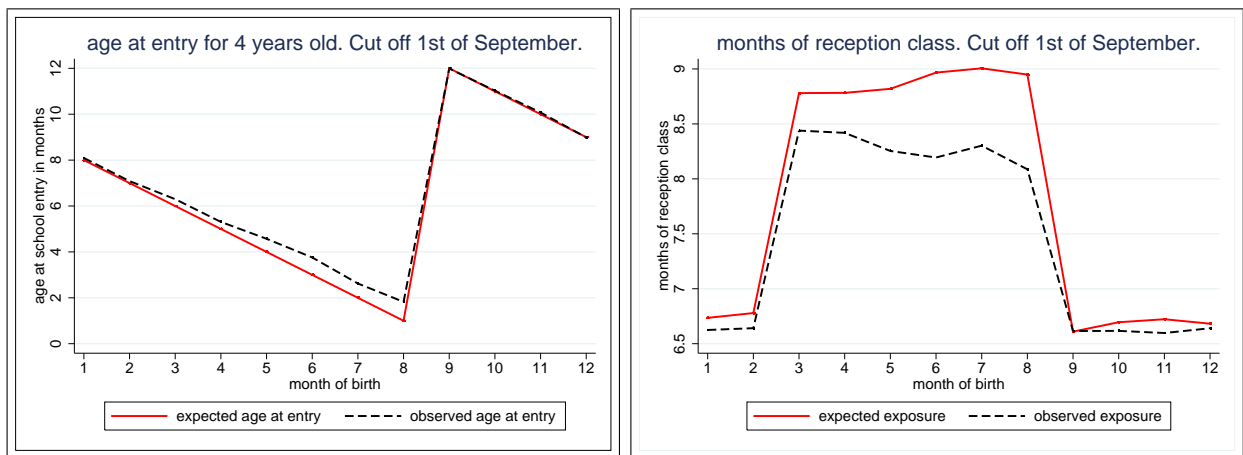


Figure 1: Expected and observed age at entry. expected and observed months of schooling. Policy A

Table 1: Summary statistics by ethnic group.

	white	Indian	Pakistani	Bangla	b Car.	b Afr.	others
Observations	7303	391	718	278	179	283	1000
Percentage	71.94	3.85	7.07	2.74	1.76	2.79	9.85
<i>Age 3</i>							
English used only partly	0.012 (0.109)	0.711 (0.454)	0.777 (0.416)	0.705 (0.457)	0.039 (0.194)	0.519 (0.501)	0.347 (0.476)
English never used	0.002 (0.050)	0.212 (0.409)	0.181 (0.385)	0.270 (0.445)	0.017 (0.129)	0.233 (0.424)	0.128 (0.334)
single parent	0.165 (0.371)	0.064 (0.245)	0.095 (0.293)	0.083 (0.276)	0.553 (0.499)	0.389 (0.488)	0.289 (0.454)
mother working before birth	0.709 (0.454)	0.563 (0.497)	0.164 (0.370)	0.130 (0.337)	0.652 (0.478)	0.439 (0.497)	0.536 (0.499)
mother working	0.534 (0.499)	0.528 (0.500)	0.119 (0.324)	0.125 (0.331)	0.528 (0.501)	0.389 (0.488)	0.364 (0.482)
number of children	2.154 (1.008)	2.182 (0.970)	2.845 (1.281)	2.949 (1.390)	2.343 (1.226)	2.875 (1.546)	2.280 (1.183)
childcare: only parental care	0.437 (0.496)	0.464 (0.499)	0.710 (0.454)	0.754 (0.432)	0.302 (0.460)	0.476 (0.500)	0.476 (0.500)
childcare: informal relatives	0.249 (0.432)	0.247 (0.432)	0.184 (0.387)	0.153 (0.361)	0.225 (0.419)	0.154 (0.361)	0.162 (0.369)
childcare: informal non relatives	0.107 (0.310)	0.043 (0.203)	0.009 (0.094)	0.004 (0.064)	0.118 (0.324)	0.114 (0.319)	0.114 (0.318)
child care: formal	0.207 (0.405)	0.247 (0.432)	0.097 (0.296)	0.089 (0.285)	0.355 (0.480)	0.256 (0.437)	0.248 (0.432)
partner working	0.917 (0.276)	0.904 (0.294)	0.787 (0.410)	0.729 (0.445)	0.797 (0.404)	0.738 (0.441)	0.805 (0.397)
age mother left f-t edu	17.43 (2.47)	18.45 (2.79)	16.43 (3.87)	16.02 (3.35)	17.34 (2.41)	18.10 (4.07)	17.68 (4.02)
age partner left f-t edu	17.37 (2.75)	18.85 (3.74)	17.85 (3.66)	17.22 (3.73)	17.41 (3.13)	19.87 (4.99)	18.65 (4.07)
income supp/ job seeker	0.167 (0.373)	0.095 (0.293)	0.230 (0.421)	0.259 (0.439)	0.380 (0.487)	0.424 (0.495)	0.335 (0.472)
oecd poverty indicator	0.262 (0.440)	0.280 (0.450)	0.722 (0.448)	0.760 (0.428)	0.503 (0.502)	0.582 (0.494)	0.464 (0.499)
ethnic concentration	93.74 (11.23)	27.76 (23.04)	34.92 (22.64)	22.14 (19.26)	11.53 (7.88)	11.79 (9.99)	7.98 (6.17)
percentage in the pop arrival < 10yrs	92.1 0.019 (0.136)	1.8 0.294 (0.456)	1.3 0.274 (0.447)	0.5 0.281 (0.450)	1 0.073 (0.260)	0.8 0.435 (0.497)	2.6 0.283 (0.451)
age mother at birth	28.91 (5.895)	28.68 (5.304)	26.33 (5.300)	26.08 (4.885)	30.03 (6.589)	30.71 (5.889)	28.70 (5.890)
NO internet access	0.302 (0.459)	0.412 (0.493)	0.731 (0.444)	0.809 (0.394)	0.393 (0.490)	0.440 (0.497)	0.432 (0.496)
Female	0.492 (0.500)	0.481 (0.500)	0.514 (0.500)	0.504 (0.501)	0.469 (0.500)	0.470 (0.500)	0.496 (0.500)
Birth weight	3.353 (0.651)	3.066 (1.393)	3.050 (0.677)	3.014 (0.747)	3.087 (0.682)	3.463 (3.760)	3.395 (3.934)
<i>Age5</i>							
mother working	0.617 (0.485)	0.565 (0.496)	0.212 (0.409)	0.240 (0.428)	0.557 (0.498)	0.411 (0.493)	0.467 (0.499)
income supp/ job seeker	0.128 (0.334)	0.080 (0.272)	0.209 (0.407)	0.215 (0.411)	0.335 (0.474)	0.359 (0.480)	0.258 (0.437)
months of early educ	16.30 (9.346)	15.69 (9.403)	12.79 (6.375)	12.59 (5.695)	17.84 (10.306)	16.28 (10.330)	15.40 (9.100)

Source: MCS wave 2 and wave 3.

Table 2: Learning Oriented Activities gap at age 3 and age 5

	<i>Learning Oriented Activities</i>			
	age 3		age 5	
Indian	-0.041 (0.082)	0.091 (0.084)	0.098 (0.057)*	0.129 (0.079)
Pakistani	-0.437 (0.060)***	-0.178 (0.077)**	-0.166 (0.062)***	-0.070 (0.073)
Bangladeshi	-0.761 (0.235)***	-0.434 (0.229)*	-0.313 (0.076)***	-0.202 (0.101)**
Black Caribb.	-0.323 (0.112)***	-0.187 (0.092)**	-0.017 (0.070)	-0.016 (0.073)
Black African	-0.456 (0.092)***	-0.186 (0.104)*	-0.120 (0.054)**	-0.063 (0.065)
others	-0.133 (0.044)***	-0.017 (0.046)	-0.000 (0.034)	-0.012 (0.043)
Engl. partly used		-0.137 (0.054)**		-0.102 (0.065)
Engl never used		-0.209 (0.101)**		-0.209 (0.150)
income supp.		-0.142 (0.037)***		0.024 (0.047)
m medium edu		0.061 (0.021)***		0.045 (0.026)*
m high edu		0.191 (0.030)***		0.002 (0.033)
arrived < 10 years		-0.216 (0.059)***		0.169 (0.060)***
single parent		-0.176 (0.033)***		0.106 (0.115)
nr children		-0.088 (0.011)***		-0.072 (0.011)***
female		0.172 (0.019)***		0.106 (0.019)***
Obs	9305	9305	9585	9585
R²	0.02	0.11	0.00	0.01

*Notes: Significance levels: * 10%, ** 5%, *** 1%. The omitted category is white British, thus the table is showing home input measures gaps at age 3 and age 5. The home input measure is the first principal component of indicators for the following activities performed everyday: - age 3: reading to the child, teach a song, abc, counting, paint; - age 5: reading to the child, teaching of the following activities: play an instrument, math, read, write. The controls included are: English use at home, mother education level, poverty index, an indicator for arrival time to England less than 10 years ago, number of siblings, marital status of the mother, child's gender.*

Table 3: Raw test gaps at age 3 and age 5

	Test gaps (age 3)		Test gaps (age 5)			
	<i>Vocabulary</i>	<i>Bracken</i>	<i>Vocabulary</i>	<i>Pictures</i>	<i>Pattern</i>	<i>fsptotal</i>
Indian	-0.761 (0.100)***	-0.289 (0.113)**	-0.529 (0.074)***	0.032 (0.067)	-0.106 (0.059)*	-0.090 (0.078)
Pakistani	-1.363 (0.068)***	-0.962 (0.070)***	-1.303 (0.056)***	-0.363 (0.059)***	-0.528 (0.051)***	-0.650 (0.085)***
Bangladeshi	-1.594 (0.109)***	-1.242 (0.077)***	-1.334 (0.066)***	-0.297 (0.103)***	-0.495 (0.078)***	-0.838 (0.149)***
Black Caribbean	-0.575 (0.088)***	-0.58 (0.122)***	-0.575 (0.076)***	0.140 (0.118)	-0.272 (0.077)***	-0.136 (0.152)
Black African	-0.916 (0.095)***	-0.666 (0.095)***	-0.927 (0.069)***	-0.123 (0.053)**	-0.518 (0.102)***	-0.296 (0.129)**
others	-0.356 (0.048)***	-0.126 (0.047)***	-0.271 (0.037)***	0.040 (0.038)	-0.103 (0.039)***	-0.155 (0.044)***
All minorities†	-1.035 (0.069)***	-0.713 (0.068)***	-0.950 (0.061)***	-0.170 (0.045)***	-0.384 (0.042)***	-0.440 (0.061)***
Obs.	9305	8781	9585	9576	9556	6592

Notes: Standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%. † does not include the group "Others". All tests have been normalized to have mean 0 and standard deviation 1. The omitted category is White British. The table is thus showing score gaps at age 3: Naming Vocabulary and Bracken school readiness, and at age 5: Naming Vocabulary, Picture Similarities, Pattern Construction, and Foundation Stage Profile total score.

Table 4: Raw Foundation Stage Profile gap. Only September entry

	Personal, social, emotional dev.				Communication, language, literacy				Mathematical dev.				total <i>fsptotal</i>		
	<i>da</i>	<i>sd</i>	<i>ed</i>		<i>lct</i>	<i>lsl</i>	<i>r</i>	<i>w</i>	<i>n/c</i>	<i>c</i>	<i>ssm</i>	<i>kuw</i>		<i>pd</i>	<i>cd</i>
Indian.	0.057 [0.074]	0.031 [0.080]	-0.036 [0.069]		-0.182 [0.071]**	-0.054 [0.092]	-0.132 [0.089]	-0.016 [0.112]	-0.005 [0.070]	-0.129 [0.081]	-0.195 [0.071]**	-0.177 [0.066]**	0.012 [0.074]	-0.127 [0.076]*	-0.09 [0.078]
Pak.	-0.475 [0.091]**	-0.437 [0.095]**	-0.503 [0.106]**		-0.575 [0.093]**	-0.497 [0.100]**	-0.628 [0.081]**	-0.457 [0.088]**	-0.47 [0.074]**	-0.612 [0.064]**	-0.707 [0.079]**	-0.646 [0.090]**	-0.437 [0.104]**	-0.598 [0.091]**	-0.65 [0.085]**
Bangl.	-0.569 [0.192]**	-0.628 [0.171]**	-0.695 [0.144]**		-0.808 [0.150]**	-0.72 [0.098]**	-0.796 [0.122]**	-0.65 [0.103]**	-0.617 [0.127]**	-0.773 [0.126]**	-0.942 [0.146]**	-0.686 [0.131]**	-0.536 [0.161]**	-0.67 [0.166]**	-0.838 [0.149]**
b.Car.	0.056 [0.135]	-0.268 [0.179]	-0.146 [0.150]		-0.148 [0.127]	-0.124 [0.128]	-0.072 [0.163]	-0.14 [0.115]	0.028 [0.166]	-0.116 [0.169]	-0.116 [0.153]	-0.282 [0.158]*	0.032 [0.146]	-0.135 [0.163]	-0.136 [0.152]
b.Afr.	-0.271 [0.141]*	-0.181 [0.126]	-0.263 [0.161]		-0.437 [0.155]**	-0.264 [0.105]**	-0.161 [0.102]	-0.216 [0.115]*	-0.114 [0.089]	-0.106 [0.123]	-0.308 [0.151]**	-0.419 [0.137]**	-0.188 [0.126]	-0.329 [0.124]**	-0.296 [0.129]**
others	-0.122 [0.047]**	-0.115 [0.050]**	-0.132 [0.044]**		-0.157 [0.042]**	-0.099 [0.044]**	-0.158 [0.046]**	-0.085 [0.046]*	-0.105 [0.044]**	-0.133 [0.041]**	-0.161 [0.045]**	-0.186 [0.043]**	-0.07 [0.042]*	-0.147 [0.042]**	-0.155 [0.044]**
Obs.	6592	6592	6592		6591	6591	6591	6591	6592	6590	6589	6592	6592	6590	6592
R^2	0.01	0.01	0.02		0.02	0.02	0.02	0.01	0.01	0.02	0.03	0.03	0.01	0.02	0.02

Notes: Standard errors in brackets. * significant at 10%, ** significant at 5%, *** significant at 1%. All tests have been normalized to have mean 0 and standard deviation 1. The omitted category is White British. DA: disposition and attitudes, SD social development, ED emotional development, LCT: language for communicating and thinking, LSL: linking sounds and letters, R: reading, W: writing, NLC: numbers as labels and for counting, C: calculating, SSM: shape, space, measures, KUW: knowledge and understanding of the world, PD: physical development, CD: creative development.

Table 5: Analysis of Test gaps (age 3)

	<i>NAMING VOCABULARY TEST</i>			<i>School readiness test (BRACKEN)</i>		
	(1)	(2)	(3)	(1)	(2)	(3)
Indian	-0.763 [0.106]***	-0.273 [0.106]**	-0.280 [0.092]***	-0.289 [0.113]**	-0.218 [0.124]*	-0.234 [0.094]**
Pakistani	-1.359 [0.067]***	-0.859 [0.078]***	-0.590 [0.066]***	-0.962 [0.070]***	-0.901 [0.100]***	-0.507 [0.073]***
Bangladeshi	-1.574 [0.116]***	-1.056 [0.123]***	-0.738 [0.090]***	-1.242 [0.077]***	-1.156 [0.107]***	-0.659 [0.083]***
Black Caribb.	-0.541 [0.096]***	-0.549 [0.088]***	-0.342 [0.059]***	-0.58 [0.122]***	-0.575 [0.121]***	-0.352 [0.092]***
Black African	-0.836 [0.102]***	-0.528 [0.077]***	-0.360 [0.080]***	-0.666 [0.095]***	-0.591 [0.096]***	-0.412 [0.081]***
others	-0.327 [0.050]***	-0.173 [0.044]***	-0.140 [0.042]***	-0.126 [0.047]***	-0.105 [0.052]**	-0.086 [0.045]*
Engl. partly used		-0.481 [0.055]***	-0.412 [0.053]***		-0.003 [0.070]	-0.051 [0.056]
Engl. never used		-0.852 [0.119]***	-0.623 [0.092]***		-0.399 [0.143]***	-0.208 [0.098]**
income supp/job seeker			-0.148 [0.031]***			-0.151 [0.033]***
LOA: teach ABC			0.047 [0.026]*			0.144 [0.026]***
LOA: teach song			0.051 [0.021]**			0.041 [0.022]*
LOA: read to the child			0.183 [0.022]***			0.195 [0.022]***
LOA: paint			0.029 [0.019]			0.025 [0.020]
Obs	9305	9305	9305	8781	8781	8781
R²	0.11	0.12	0.26	0.05	0.05	0.29

Note: Significance levels: * 10%, ** 5%, *** 1%. Both tests have been normalized to have mean 0 and standard deviation 1. Sampling weights are used to take account of sample stratification. LOA: learning oriented activities, coefficient reported only for activities performed everyday. Specification 3 includes controls for the use of English at home, mother and father education, income support and/or job seeking benefits indicator, learning oriented activities (LOA), child care arrangements, child characteristics (gender, birth weight, birth order), breast feeding behaviour, mother age at birth, family structure (single parent indicator, nr of siblings), neighbourhood indicators for income poverty and littering behaviour.

Table 6: Analysis of Test gaps (age 5)

	NAMING VOCABULARY TEST			PICTURE SIMILARITIES			PATTERN CONSTRUCTION			jsptotal		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Indian	-0.529 (0.074)***	-0.077 (0.065)	-0.109 (0.066)	0.032 (0.067)	0.007 (0.084)	-0.129 (0.086)	-0.106 (0.059)*	-0.059 (0.067)	-0.070 (0.073)	-0.090 (0.078)	-0.040 (0.092)	-0.043 (0.083)
Pakist	-1.303 (0.056)***	-0.777 (0.072)***	-0.470 (0.074)***	-0.363 (0.059)***	-0.388 (0.086)***	-0.272 (0.103)***	-0.528 (0.051)***	-0.473 (0.061)***	-0.282 (0.072)***	-0.650 (0.085)***	-0.592 (0.099)***	-0.310 (0.098)***
Bangla	-1.334 (0.066)***	-0.751 (0.090)***	-0.451 (0.089)***	-0.297 (0.103)***	-0.322 (0.129)**	-0.102 (0.134)	-0.495 (0.078)***	-0.434 (0.090)***	-0.257 (0.100)**	-0.838 (0.149)***	-0.774 (0.169)***	-0.510 (0.109)***
B Car	-0.575 (0.076)***	-0.544 (0.079)***	-0.295 (0.087)***	0.140 (0.118)	0.138 (0.117)	0.026 (0.093)	-0.272 (0.077)***	-0.269 (0.076)***	-0.189 (0.080)**	-0.136 (0.152)	-0.135 (0.152)	-0.056 (0.148)
B Afr	-0.927 (0.069)***	-0.552 (0.070)***	-0.406 (0.078)***	-0.123 (0.053)**	-0.141 (0.057)**	-0.257 (0.075)***	-0.518 (0.102)***	-0.479 (0.103)***	-0.413 (0.105)***	-0.296 (0.129)**	-0.259 (0.135)*	-0.203 (0.124)
others	-0.271 (0.037)***	-0.140 (0.031)***	-0.140 (0.037)***	0.040 (0.038)	0.036 (0.039)	0.009 (0.041)	-0.103 (0.039)***	-0.089 (0.041)**	-0.021 (0.043)	-0.155 (0.044)***	-0.142 (0.046)***	-0.072 (0.050)
Eng partly		-0.596 (0.067)***	-0.457 (0.049)***		0.036 (0.068)	-0.061 (0.059)		-0.061 (0.045)	-0.071 (0.050)		-0.061 (0.064)	-0.025 (0.060)
Eng never		-1.231 (0.132)***	-0.920 (0.136)***		-0.253 (0.116)**	-0.278 (0.140)**		-0.164 (0.106)	-0.156 (0.102)		-0.251 (0.209)	-0.098 (0.180)
income supp.			-0.180 (0.041)***			-0.162 (0.042)***			-0.174 (0.059)***			-0.412 (0.067)***
LOA: help write			0.009 (0.025)			-0.006 (0.028)			-0.015 (0.031)			0.081 (0.032)**
LOA: help math			-0.037 (0.023)			-0.028 (0.027)			-0.020 (0.026)			-0.123 (0.030)***
LOA: help read			0.020 (0.022)			0.003 (0.023)			0.039 (0.025)			0.098 (0.024)***
LOA: read to child			0.047 (0.022)**			0.007 (0.023)			0.013 (0.020)			0.024 (0.024)
Obs	9585	9585	9585	9576	9576	9576	9556	9556	9556	6592	6592	6592
R-sq.	0.11	0.13	0.29	0.01	0.01	0.10	0.02	0.02	0.14	0.02	0.03	0.26

Notes: Standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%. All tests have been normalized to have mean 0 and standard deviation 1. Sampling weights are used to take account of sample stratification. LOA: learning oriented activities, coefficient reported only for activities performed everyday. Specification 3 includes controls for the use of English at home, mother and father education, income support and/or job seeking benefits indicator, mother and father education, learning oriented activities, months of early education, child characteristics (gender, birth weight, first born), breast feeding behaviour, mother age at birth, family structure (single parent indicator, nr of siblings), neighbourhood indicators for income poverty and littering behaviour, Local Education Authority dummies, and age in months for the jsptotal

Table 7: Effect of exposure to reception class on MCS tests. Interaction by group.

	OLS				2SLS			
	specification 1		specification 2		specification 1		specification 2	
	<i>vocabulary</i>	<i>P Constr</i>	<i>vocabulary</i>	<i>P Constr</i>	<i>vocabulary</i>	<i>P Constr</i>	<i>vocabulary</i>	<i>P Constr</i>
(white)* <i>EXP</i>	0.006 [0.005]	0.007 [0.007]	0.009 [0.005]*	0.009 [0.007]	0.042 [0.017]**	0.153 [0.023]***	0.039 [0.017]**	0.151 [0.023]***
(indian)* <i>EXP</i>	0.004 [0.026]	0.035 [0.023]	0.001 [0.024]	0.032 [0.022]	0.055 [0.084]	0.238 [0.097]**	0.056 [0.080]	0.236 [0.095]**
(paki)* <i>EXP</i>	0.036 [0.020]*	0.031 [0.017]*	0.043 [0.019]**	0.034 [0.016]**	0.094 [0.041]**	0.159 [0.062]**	0.101 [0.040]**	0.164 [0.057]***
(bangla)* <i>EXP</i>	0.04 [0.022]*	0.047 [0.026]*	0.035 [0.021]	0.041 [0.027]	0.142 [0.096]	0.304 [0.114]***	0.104 [0.088]	0.288 [0.106]***
(bcaribb)* <i>EXP</i>	-0.026 [0.045]	-0.017 [0.048]	-0.019 [0.038]	-0.011 [0.045]	0.23 [0.192]	0.606 [0.259]**	0.217 [0.176]	0.596 [0.244]**
(bafrican)* <i>EXP</i>	-0.003 [0.017]	0.034 [0.022]	-0.003 [0.015]	0.032 [0.021]	0.114 [0.118]	0.442 [0.211]**	0.212 [0.141]	0.513 [0.220]**
(others)* <i>EXP</i>	-0.009 [0.012]	0.002 [0.013]	-0.004 [0.011]	0.006 [0.013]	-0.04 [0.041]	0.104 [0.040]**	-0.028 [0.038]	0.113 [0.040]***
Obs.	9317	9289	9317	9289	9317	9289	9317	9289
R ²	0.18	0.08	0.25	0.13				

Note: Significance levels: * 10%, ** 5%, *** 1%. *EXP*: months of reception class Specification 1: gender, birth weight and LEAs dummies; Specification 2: gender, birthweight, mother education, poverty indicator, single parent family, nr of children, and LEAs dummies

Table 8: Effect of age at entry on FSP Total score.

	OLS	2SLS	2SLS
		(1)	(2)
(whites)* <i>AGEE</i>	0.061 [0.004]***	0.073 [0.004]***	0.074 [0.004]***
(indian)* <i>AGEE</i>	0.061 [0.022]***	0.061 [0.024]**	0.058 [0.024]**
(pakistani)* <i>AGEE</i>	0.047 [0.012]***	0.06 [0.010]***	0.059 [0.011]***
(banglad)* <i>AGEE</i>	0.042 [0.026]	0.013†† [0.028]	0.023† [0.030]
(bcaribb)* <i>AGEE</i>	0.003 [0.045]	0.013 [0.055]	-0.004 [0.056]
(bafrican)* <i>AGEE</i>	0.035 [0.035]	0.087 [0.047]*	0.077 [0.047]
(other)* <i>AGEE</i>	0.068 [0.011]***	0.091 [0.011]***	0.086 [0.011]***
Obs.	6590	6590	6590

Notes: Significance levels: * 10%, ** 5%, *** 1%. Only children with entry in September. *AGEE*: age at entry. Specification 1: gender, birth weight and LEAs dummies, Specification 2: gender, birth weight, mother education, poverty indicator, single parent family, nr of children, and LEAs dummies.

Table 9: First stage fsptotal specification 2

	(W)* <i>eAGEE</i>	(I)* <i>eAGEE</i>	(P)* <i>eAGEE</i>	(B)* <i>eAGEE</i>	(bC)* <i>eAGEE</i>	(bA)* <i>epAGEE</i>	(O)* <i>eAGEE</i>
coeff.	0.9687 [0.014]***	0.9231 [0.033]***	1.014 [0.022]***	0.9419 [0.031]***	0.8765 [0.061]***	0.8675 [0.044]***	0.9396 [0.019]***
F-stat	1115.33	160.46	600.5	321.16	111.5	86.76	471.74
part-R	0.9394	0.8501	0.8949	0.793	0.8151	0.779	0.8387

Note: *eAGEE*: expected age at entry.

Table 10: 2SLS FSP specification 2

	Personal, social, emotional			Communication, language, literacy					Mathematical dev.			total		
	<i>da</i>	<i>sd</i>	<i>cd</i>	<i>lcl</i>	<i>lsl</i>	<i>r</i>	<i>w</i>	<i>mlc</i>	<i>c</i>	<i>ssm</i>	<i>kuw</i>		<i>pld</i>	<i>cd</i>
(W)* <i>AGEE</i>	0.064	0.049	0.051	0.058	0.072	0.069	0.078	0.064	0.068	0.061	0.058	0.058	0.053	0.074
	[0.004]***	[0.004]***	[0.004]***	[0.004]***	[0.005]***	[0.005]***	[0.005]***	[0.004]***	[0.004]***	[0.004]***	[0.004]***	[0.005]***	[0.004]***	[0.004]***
(1)* <i>AGEE</i>	0.077	0.051	0.039	0.057	0.062	0.046	0.06	0.058	0.03	0.05	0.04	0.062	0.007†	0.058
	[0.020]***	[0.027]*	[0.025]	[0.023]**	[0.025]**	[0.021]**	[0.023]**	[0.020]***	[0.027]	[0.024]**	[0.030]	[0.020]***	[0.024]	[0.024]**
(P)* <i>AGEE</i>	0.032†††	0.022††	0.038	0.049	0.075	0.055	0.055†	0.058	0.058	0.054	0.06	0.035††	0.028††	0.059
	[0.008]***	[0.011]**	[0.011]**	[0.012]***	[0.016]***	[0.013]***	[0.012]***	[0.013]***	[0.012]***	[0.013]***	[0.010]***	[0.010]***	[0.010]***	[0.011]**
(B)* <i>AGEE</i>	-0.003†	-0.002	-0.007†	0.022	0.03†	0.049	0.041†	0.048	0.044	0.007†	0.012	-0.004†	-0.003†	0.023†
	[0.036]	[0.031]	[0.028]	[0.024]	[0.022]	[0.025]*	[0.020]**	[0.036]	[0.028]	[0.028]	[0.032]	[0.037]	[0.031]	[0.030]
(bc)* <i>AGEE</i>	-0.007†	-0.054†	-0.015	0.003	-0.019	-0.002	-0.022†	0.014	0.033	0.013	0.048	-0.031†††	-0.001	-0.004
	[0.042]	[0.057]	[0.054]	[0.056]	[0.054]	[0.057]	[0.053]	[0.063]	[0.070]	[0.047]	[0.040]	[0.033]	[0.040]	[0.056]
(ba)* <i>AGEE</i>	0.044	0.085	0.133	0.076	0.066	0.067	0.117	0.049	0.018	0.08	0.068	-0.03†	0.047	0.077
	[0.054]	[0.040]**	[0.045]***	[0.052]	[0.045]	[0.043]	[0.049]**	[0.052]	[0.045]	[0.046]*	[0.044]	[0.051]	[0.045]	[0.047]
(O)* <i>AGEE</i>	0.064	0.056	0.057	0.067	0.085	0.086	0.09	0.08	0.087	0.072	0.06	0.057	0.053	0.086
	[0.011]**	[0.011]**	[0.011]**	[0.011]**	[0.010]**	[0.011]**	[0.010]**	[0.013]**	[0.011]**	[0.012]**	[0.011]**	[0.010]**	[0.011]**	[0.011]**
Obs.	6590	6590	6590	6589	6589	6589	6589	6590	6588	6587	6590	6590	6588	6590

Notes: Standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%. † significantly different from white's estimates at 10%, †† 5%, ††† 1%. *AGEE*: age at entry. Controls are: gender, birth weight, mother education, poverty indicator, single parent family, nr of children, ethnic- and LEAs dummies

Table 11: 2SLS FSP specification 1. Bracken index.

	Personal, social, emotional			Communication, language, literacy			Mathematical dev.			total				
	<i>da</i>	<i>sd</i>	<i>ed</i>	<i>lct</i>	<i>lsl</i>	<i>r</i>	<i>w</i>	<i>nlc</i>	<i>c</i>	<i>ssm</i>	<i>kw</i>	<i>pd</i>	<i>cd</i>	<i>fsp/total</i>
(q1)*AGEE	0.044 [0.009]***	0.023 [0.009]**	0.036 [0.008]***	0.045 [0.009]***	0.056 [0.010]***	0.05 [0.009]***	0.057 [0.008]***	0.054 [0.010]***	0.058 [0.009]***	0.048 [0.009]***	0.052 [0.010]***	0.045 [0.011]***	0.031 [0.009]***	0.056 [0.009]***
(q2)*AGEE	0.069†† [0.008]***	0.055††† [0.007]***	0.06†† [0.008]***	0.067† [0.008]***	0.079† [0.007]***	0.071 [0.007]***	0.08†† [0.007]***	0.066 [0.007]***	0.073 [0.008]***	0.066 [0.008]***	0.057 [0.008]***	0.063 [0.008]***	0.055†† [0.008]***	0.079†† [0.007]***
(q3)*AGEE	0.059 [0.007]***	0.048†† [0.008]***	0.047 [0.008]***	0.054 [0.007]***	0.072 [0.008]***	0.079†† [0.008]***	0.082††† [0.008]***	0.067 [0.007]***	0.066 [0.007]***	0.064 [0.007]***	0.056 [0.007]***	0.053 [0.008]***	0.051† [0.007]***	0.074† [0.007]***
(q4)*AGEE	0.06 [0.007]***	0.053††† [0.006]***	0.046 [0.006]***	0.055 [0.007]***	0.073 [0.009]***	0.066 [0.008]***	0.082††† [0.008]***	0.057 [0.008]***	0.061 [0.008]***	0.048 [0.006]***	0.052 [0.007]***	0.053 [0.007]***	0.048 [0.007]***	0.07 [0.007]***
Obs.	5322	5322	5322	5322	5322	5321	5321	5322	5321	5321	5322	5322	5321	5322

Notes: Standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%. † significant at 10%, †† 5%, ††† 1%. AGE: age at entry. Index created regressing age 3 Bracken scores on income and language at age 3 and parents education. Controls are: gender, birth weight, and LEAs dummies.

4.6 APPENDIX A - Children assessment measures

(1) BAS Naming Vocabulary (age 3 and age 5)

The Naming Vocabulary is a verbal scale for children aged 2 years 6 months to 7 years 11 months. It assesses the spoken vocabulary of young children. The test items consist of a booklet of coloured pictures of objects which the child is shown one at a time and asked to name. The scale measures expressive language ability, and successful performance depends on the child's previous development of a vocabulary of nouns. The items require the child to recall words from long-term memory rather than to recognise or understand the meaning of words or sentences.

(2) Bracken School Readiness Assessment (age 3)

The Bracken Basic Concept Scale - Revised (BBCS-R) is used to assess the basic concept development in children in the age range of 2 years 6 months to 7 years 11 months. The six subtests administered evaluate 88 concepts related to colours, letters (upper and lower cases), numbers/counting, sizes, comparisons and shapes. The readiness concepts assessed in these sub-tests are argued to be directly related to early childhood education and to predict readiness for more formal education.

(3) BAS Picture similarities (age 5)

In the picture similarities assessments children are shown a row of four pictures on a page. They are asked to place a free-standing card with a fifth picture underneath the picture with which the card shares a similar element or concept. The picture similarities assessment measures a child's problem solving ability.

(4) BAS Pattern Construction (age 5)

The BAS Pattern Construction test is meant to measure spatial ability and is considered highly related to overall cognitive ability. Generally, for each item a child must copy a two-dimensional pattern, usually of two colours, by arranging three-dimensional blocks whose sides are of different colours and patterns.

(5) The Foundation Stage Profile (age5)

The Foundation Stage Profile (FSP) assessment records the child's achievement as reported by their teacher at the end of the first year of reception class for children in state schools in England. The FSP captures the six areas of learning - personal, social and emotional development; communication, language and literacy; mathematical development; knowledge and understanding of the world; physical development; creative development - as a set of 13 assessment scales listed in the table below.

Area of Learning/ Abilities assessed	Assessment Scale
MCS assessments	
<i>expressive language ability</i>	Naming Vocabulary:
<i>comprehension of relevant educational concepts</i>	Bracken school readiness
<i>nonverbal reasoning skills: problem solving</i>	Picture Similarities
<i>nonverbal reasoning skills: spatial abilities</i>	Pattern Construction
Foundation Stage Profile	
<i>Personal, social and emotional development (PSE)</i>	Disposition and attitudes (DA) Social development (SD) Emotional development (ED)
<i>Communication, language and literacy (CLL)</i>	Language for communicating and thinking (LCT) Linking sounds and letters (LSL) Reading (R) Writing (W)
<i>Mathematical development (MD)</i>	Numbers as labels and for counting (NLC) Calculating (C) Shape, space and measures (SSM)
<i>Knowledge and understanding of the world (KUW)</i>	Knowledge and understanding of the world (KUW)
<i>Creative development (CD)</i>	Creative development (CD)
<i>Physical development (PD)</i>	Physical development (PD)

Table A-1: Parental learning oriented activities.

	white	Indian	Pakistani	Bangla	b Caribb.	b African	others
<i>Age 3</i>							
teach abc > 6 x week	0.270 (0.444)	0.425 (0.495)	0.294 (0.456)	0.245 (0.431)	0.294 (0.457)	0.240 (0.428)	0.337 (0.473)
teach count > 6 x week	0.566 (0.496)	0.559 (0.497)	0.456 (0.498)	0.344 (0.476)	0.471 (0.501)	0.374 (0.485)	0.494 (0.500)
teach song > 6 x week	0.612 (0.487)	0.594 (0.492)	0.501 (0.500)	0.322 (0.468)	0.497 (0.502)	0.415 (0.494)	0.537 (0.499)
paint at home > 6 x week	0.497 (0.500)	0.535 (0.499)	0.504 (0.500)	0.341 (0.475)	0.418 (0.495)	0.378 (0.486)	0.500 (0.500)
mother reads > 6 x week	0.619 (0.486)	0.403 (0.491)	0.342 (0.475)	0.253 (0.435)	0.354 (0.480)	0.293 (0.456)	0.482 (0.500)
average LOAS age 3	0.437 (0.259)	0.409 (0.264)	0.327 (0.261)	0.218 (0.249)	0.328 (0.252)	0.257 (0.268)	0.400 (0.272)
<i>Age 5</i>							
help math > 6 x week	0.308 (0.462)	0.352 (0.478)	0.321 (0.467)	0.257 (0.438)	0.371 (0.485)	0.326 (0.470)	0.330 (0.471)
help writing > 6 x week	0.248 (0.432)	0.368 (0.483)	0.329 (0.470)	0.287 (0.453)	0.360 (0.482)	0.346 (0.477)	0.304 (0.460)
help reading > 6 x week	0.574 (0.495)	0.545 (0.499)	0.514 (0.500)	0.411 (0.493)	0.500 (0.502)	0.495 (0.501)	0.571 (0.495)
mother reads > 6 x week	0.519 (0.500)	0.440 (0.497)	0.376 (0.485)	0.324 (0.469)	0.420 (0.495)	0.428 (0.496)	0.481 (0.500)
average LOAS age 5	0.223 (0.169)	0.232 (0.188)	0.199 (0.180)	0.168 (0.180)	0.224 (0.184)	0.198 (0.182)	0.226 (0.174)

Notes: MCS wave 2 and wave 3.

Table A-2: Full regressions results MCS tests age 3.

	<i>Vocabulary</i>	<i>Bracken</i>
Indian	-0.170 (0.094)*	-0.171 (0.098)*
Pakistani	-0.409 (0.068)***	-0.403 (0.076)***
Bangladeshi	-0.640 (0.079)***	-0.597 (0.085)***
Black Caribb.	-0.277 (0.059)***	-0.313 (0.089)***
Black African	-0.307 (0.084)***	-0.378 (0.082)***
others	-0.120 (0.041)***	-0.073 (0.046)
Engl. partly used	-0.400 (0.053)***	-0.042 (0.055)
Engl. never used	-0.598 (0.088)***	-0.179 (0.098)*
income supp/job seeker	-0.149 (0.031)***	-0.139 (0.033)***
LOA: teach ABC everyday	0.047 (0.026)*	0.144 (0.026)***
LOA: teach count everyday	-0.004 (0.023)	0.017 (0.023)
LOA: teach song everyday	0.051 (0.021)**	0.040 (0.022)*
LOA: read to the child mother	0.183 (0.022)***	0.195 (0.022)***
LOA: paint everyday	0.029 (0.019)	0.025 (0.020)
LOA: read to the child father	0.111 (0.028)***	0.140 (0.025)***
breastfed up to 6 months	0.030 (0.028)	0.039 (0.026)
breastfed more then 6 months	0.070 (0.028)**	0.125 (0.023)***
arrived less than 10 yrs ago	-0.420 (0.051)***	-0.231 (0.059)***
medium education mother	0.058 (0.022)**	0.101 (0.020)***
high education mother	0.176 (0.037)***	0.251 (0.031)***
medium education father	0.099 (0.024)***	0.108 (0.030)***
high education father	0.121 (0.036)***	0.241 (0.034)***
age mother at birth 20-29	0.141 (0.038)***	0.224 (0.043)***
age mother at birth 30-39	0.217 (0.040)***	0.338 (0.042)***
age mother at birth more than 40	0.337 (0.080)***	0.409 (0.087)***
single parent	-0.057 (0.042)	0.029 (0.042)
nr of children	-0.068 (0.011)***	-0.092 (0.012)***
child care: relatives care	0.032 (0.026)	0.073 (0.026)***
child care: informal non relatives	0.003 (0.032)	0.068 (0.036)*
child care: formal	-0.060 (0.027)**	0.119 (0.027)***
female	0.208 (0.019)***	0.192 (0.020)***
first born	0.149 (0.028)***	0.137 (0.028)***
birth weight	0.039 (0.018)**	0.034 (0.012)***
no internet	-0.124 (0.024)***	-0.147 (0.024)***
house clean	0.180 (0.042)***	0.265 (0.051)***
oecd neighborh. poor indicator	-0.104 (0.026)***	-0.148 (0.029)***
neighborh litter indicator	-0.194 (0.061)***	-0.158 (0.058)***
neighborh. ethnic concentration	-0.007 (0.001)***	-0.003 (0.001)***
Obs.	9305	8781
R ²	0.27	0.29

Table A-3: Full regressions results MCS tests age 5.

	<i>Vocabulary</i>	<i>P. Similarities</i>	<i>P. Construction</i>
Indian	-0.109 (0.066)	-0.129 (0.086)	-0.070 (0.073)
Pakistani	-0.470 (0.074)***	-0.272 (0.103)***	-0.282 (0.072)***
Bangladeshi	-0.451 (0.089)***	-0.102 (0.134)	-0.257 (0.100)**
Black Caribb.	-0.295 (0.087)***	0.026 (0.093)	-0.189 (0.080)**
Black African	-0.406 (0.078)***	-0.257 (0.075)***	-0.413 (0.105)***
others	-0.140 (0.037)***	0.009 (0.041)	-0.021 (0.043)
Engl. partly used	-0.457 (0.049)***	-0.061 (0.059)	-0.071 (0.050)
Engl. never used	-0.920 (0.136)***	-0.278 (0.140)**	-0.156 (0.102)
income supp/job seeker	-0.180 (0.041)***	-0.162 (0.042)***	-0.174 (0.059)***
LOA: help w/ writing	0.009 (0.025)	-0.006 (0.028)	-0.015 (0.031)
LOA: help w/ math	-0.037 (0.023)	-0.028 (0.027)	-0.020 (0.026)
LOA: help w/ reading	0.020 (0.022)	0.003 (0.023)	0.039 (0.025)
LOA: read to child mother	0.047 (0.022)**	0.007 (0.023)	0.013 (0.020)
LOA: paint everyday	-0.019 (0.031)	-0.027 (0.038)	0.029 (0.035)
LOA: read to the child father	0.061 (0.032)*	-0.003 (0.032)	0.025 (0.029)
breastfed up to 6 months	0.043 (0.025)*	0.098 (0.030)***	0.070 (0.029)**
breastfed more then 6 months	0.099 (0.025)***	0.144 (0.028)***	0.109 (0.028)***
arrived less than 10 yrs ago	-0.347 (0.049)***	-0.009 (0.047)	-0.026 (0.048)
medium education mother	0.111 (0.022)***	0.068 (0.026)***	0.086 (0.024)***
high education mother	0.326 (0.032)***	0.187 (0.036)***	0.217 (0.037)***
medium education father	0.084 (0.024)***	0.107 (0.029)***	0.074 (0.027)***
high education father	0.188 (0.029)***	0.118 (0.032)***	0.141 (0.037)***
age mother at birth 20-29	0.168 (0.037)***	0.100 (0.043)**	0.082 (0.046)*
age mother at birth 30-39	0.256 (0.037)***	0.156 (0.048)***	0.098 (0.047)**
age mother at birth more than 40	0.270 (0.074)***	0.052 (0.081)	0.102 (0.086)
single parent	-0.022 (0.088)	-0.123 (0.103)	-0.055 (0.127)
nr of children	-0.071 (0.010)***	-0.041 (0.011)***	-0.054 (0.012)***
female	0.055 (0.020)***	0.109 (0.023)***	0.182 (0.022)***
first born	0.158 (0.022)***	-0.005 (0.026)	-0.041 (0.026)
birth weight	0.061 (0.016)***	0.056 (0.017)***	0.159 (0.018)***
no internet	-0.194 (0.022)***	-0.137 (0.026)***	-0.131 (0.030)***
months early education	0.001 (0.001)	-0.003 (0.002)*	-0.003 (0.002)**
oecd neighbor poor indicator	-0.074 (0.024)***	-0.056 (0.027)**	-0.093 (0.028)***
neighborh litter indicator	-0.116 (0.066)*	0.002 (0.085)	-0.071 (0.100)
neighborh. ethnic concentration	-0.002 (0.001)*	0.002 (0.001)*	0.001 (0.002)
LEA dummies	Y	Y	Y
Obs.	9585	9576	9556
R²	0.29	0.10	0.14

Table A-4: OLS FSP specification 2.

	Personal, social, emotional			Communication, language, literacy					Mathematical dev.			total		
	<i>da</i>	<i>sd</i>	<i>ed</i>	<i>lcl</i>	<i>lsl</i>	<i>r</i>	<i>w</i>	<i>nlc</i>	<i>c</i>	<i>ssm</i>	<i>kuw</i>		<i>pld</i>	<i>cd</i>
(W)* <i>AGEE</i>	0.053 [0.004]***	0.043 [0.003]***	0.044 [0.003]***	0.048 [0.004]***	0.057 [0.004]***	0.056 [0.004]***	0.064 [0.004]***	0.055 [0.004]***	0.055 [0.004]***	0.05 [0.004]***	0.047 [0.004]***	0.049 [0.004]***	0.044 [0.004]***	0.061 [0.004]***
(I)* <i>AGEE</i>	0.068 [0.020]***	0.046 [0.025]*	0.036 [0.023]	0.059 [0.022]***	0.068 [0.022]***	0.044 [0.020]**	0.057 [0.022]***	0.055 [0.019]***	0.045 [0.024]*	0.059 [0.022]***	0.047 [0.027]*	0.061 [0.019]***	0.016 [0.023]	0.061 [0.022]***
(P)* <i>AGEE</i>	0.03 [0.009]***	0.019 [0.010]*	0.03 [0.011]***	0.039 [0.011]***	0.06 [0.016]***	0.044 [0.013]***	0.045 [0.013]***	0.047 [0.015]***	0.046 [0.013]***	0.046 [0.012]***	0.046 [0.012]***	0.03 [0.010]***	0.017 [0.010]*	0.047 [0.012]***
(B)* <i>AGEE</i>	0.011 [0.029]	0.024 [0.026]	0.013 [0.023]	0.042 [0.023]*	0.042 [0.020]**	0.063 [0.023]***	0.044 [0.019]**	0.071 [0.035]**	0.057 [0.025]**	0.031 [0.025]	0.042 [0.030]	-0.006 [0.030]	0.025 [0.026]	0.042 [0.026]
(BC)* <i>AGEE</i>	-0.006 [0.038]	-0.027 [0.051]	-0.002 [0.049]	0.017 [0.047]	-0.024 [0.042]	0.003 [0.044]	-0.053 [0.041]	0.029 [0.049]	0.035 [0.050]	0.033 [0.033]	0.053 [0.041]	-0.017 [0.027]	0.007 [0.037]	0.003 [0.045]
(bA)* <i>AGEE</i>	-0.003 [0.052]	0.05 [0.028]*	0.077 [0.035]**	0.022 [0.041]	0.022 [0.034]	0.024 [0.036]	0.075 [0.036]**	0.005 [0.035]	0.004 [0.037]	0.058 [0.042]	0.021 [0.035]	-0.017 [0.043]	0.026 [0.039]	0.035 [0.035]
(O)* <i>AGEE</i>	0.049 [0.010]***	0.044 [0.010]***	0.044 [0.011]***	0.054 [0.010]***	0.069 [0.010]***	0.066 [0.011]***	0.068 [0.010]***	0.065 [0.012]***	0.069 [0.011]***	0.059 [0.012]***	0.049 [0.010]***	0.045 [0.012]***	0.042 [0.011]***	0.068 [0.011]***
Obs.	6590	6590	6590	6589	6589	6589	6589	6590	6588	6587	6590	6590	6588	6590
<i>R</i> ²	0.18	0.19	0.19	0.2	0.22	0.24	0.24	0.17	0.2	0.2	0.2	0.17	0.23	0.27

Table A-5: Effect of exposure to reception class on MCS tests controlling for quarter of birth.

	OLS				2SLS			
	specification 2		specification 3		specification 2		specification 3	
	<i>vocabulary</i>	<i>P Constr</i>	<i>vocabulary</i>	<i>P Constr</i>	<i>vocabulary</i>	<i>P Constr</i>	<i>vocabulary</i>	<i>P Constr</i>
(white)* <i>EXP</i>	0.008 [0.005]	0.002 [0.006]	0.009 [0.005]*	0.009 [0.007]	0.025 [0.019]	0.122 [0.025]***	0.029 [0.019]	0.124 [0.026]***
(indian)* <i>EXP</i>	-0.001 [0.023]	0.027 [0.020]	0.001 [0.024]	0.032 [0.022]	0.008 [0.075]	0.209 [0.092]**	0.014 [0.074]	0.212 [0.092]**
(paki)* <i>EXP</i>	0.042 [0.019]**	0.03 [0.017]*	0.043 [0.019]**	0.034 [0.016]**	0.072 [0.043]*	0.133 [0.052]**	0.088 [0.045]*	0.139 [0.054]**
(bangla)* <i>EXP</i>	0.032 [0.020]	0.034 [0.027]	0.035 [0.021]	0.041 [0.027]	0.075 [0.082]	0.262 [0.101]**	0.071 [0.083]	0.261 [0.103]**
(bcaribb)* <i>EXP</i>	-0.02 [0.037]	-0.016 [0.043]	-0.019 [0.038]	-0.011 [0.045]	0.163 [0.165]	0.56 [0.237]**	0.179 [0.162]	0.567 [0.237]**
(bafrican)* <i>EXP</i>	-0.001 [0.015]	0.027 [0.021]	-0.003 [0.015]	0.032 [0.021]	0.313 [0.171]*	0.476 [0.211]**	0.316 [0.169]*	0.477 [0.209]**
(others)* <i>EXP</i>	-0.006 [0.011]	-0.001 [0.013]	-0.004 [0.011]	0.006 [0.013]	-0.037 [0.038]	0.085 [0.042]**	-0.033 [0.038]	0.087 [0.042]**
Obs	9317	9289	9317	9289	9317	9289	9317	9289
<i>R</i> ²	0.25	0.13	0.18	0.08				

notes: Standard errors in brackets. Only children with entry in September. *EXP*: months of reception class Specification 2: gender, birth weight, mother education, poverty indicator, single parent family, nr of children, quarter of birth and LEAs dummies Specification 3: gender, birth weight, mother education, poverty indicator, single parent family, nr of children, months of early education, language spoken at home, LEAs dummies and quarter of birth dummies

Table A-6: Effect of age at entry on FSP Total score, controlling for quarter of birth.

	OLS	2SLS (2)	2SLS (3)
(whites)* <i>AGEE</i>	0.049 [0.004]***	0.068 [0.005]***	0.068 [0.005]***
(indian)* <i>AGEE</i>	0.05 [0.022]**	0.053 [0.025]**	0.054 [0.025]**
(pakistani)* <i>AGEE</i>	0.036 [0.012]***	0.053 [0.012]***	0.053 [0.012]***
(banglad)* <i>AGEE</i>	0.031 [0.027]	0.017 [0.030]	0.018 [0.030]
(bcaribb)* <i>AGEE</i>	-0.014 [0.046]	-0.014 [0.057]	-0.017 [0.056]
(bafrican)* <i>AGEE</i>	0.022 [0.035]	0.071 [0.047]	0.067 [0.047]
(other)* <i>AGEE</i>	0.057 [0.011]***	0.08 [0.011]***	0.08 [0.011]***
Obs.	6590	6590	6590

notes: Standard errors in brackets. Only children with entry in September. *AGEE*: age at entry. Specification 2: gender, birth weight, mother education, poverty indicator, single parent family, nr of children, quarter of birth and LEAs dummies Specification 3: gender, birth weight, mother education, poverty indicator, single parent family, nr of children, months of early education, language spoken at home, LEAs dummies and quarter of birth dummies.

Table A-7: Effect of exposure to reception class on MCS tests discarding children who moved in last 5 years.

	OLS				2SLS			
	specification 1		specification 2		specification 1		specification 2	
	<i>vocabulary</i>	<i>P Constr</i>	<i>vocabulary</i>	<i>P Constr</i>	<i>vocabulary</i>	<i>P Constr</i>	<i>vocabulary</i>	<i>P Constr</i>
(white)* <i>EXP</i>	0.013 [0.006]**	0.012 [0.007]	0.015 [0.006]**	0.013 [0.007]*	0.059 [0.018]***	0.154 [0.024]***	0.057 [0.017]***	0.153 [0.024]***
(indian)* <i>EXP</i>	0.011 [0.029]	0.036 [0.024]	0.005 [0.026]	0.033 [0.023]	0.05 [0.096]	0.164 [0.092]*	0.051 [0.091]	0.162 [0.090]*
(paki)* <i>EXP</i>	0.031 [0.023]	0.024 [0.022]	0.04 [0.020]**	0.029 [0.020]	0.104 [0.045]**	0.166 [0.056]***	0.11 [0.044]**	0.171 [0.054]***
(bangla)* <i>EXP</i>	0.049 [0.025]*	0.06 [0.028]**	0.042 [0.026]	0.055 [0.030]*	0.156 [0.095]	0.273 [0.098]***	0.104 [0.086]	0.249 [0.090]***
(bcaribb)* <i>EXP</i>	-0.041 [0.048]	-0.04 [0.048]	-0.035 [0.040]	-0.035 [0.045]	0.265 [0.178]	0.603 [0.283]**	0.239 [0.163]	0.584 [0.269]**
(bafrican)* <i>EXP</i>	0.001 [0.018]	0.037 [0.028]	0.001 [0.018]	0.037 [0.028]	0.149 [0.128]	0.413 [0.259]	0.203 [0.137]	0.451 [0.259]*
(others)* <i>EXP</i>	-0.003 [0.014]	0.013 [0.014]	0.003 [0.013]	0.017 [0.014]	-0.03 [0.043]	0.096 [0.041]**	-0.013 [0.039]	0.108 [0.041]***
Obs.	7850	7825	7850	7825	7850	7825	7850	7825
<i>R</i> ²	0.19	0.1	0.25	0.13				

notes: Standard errors in brackets. Only children with entry in September. *EXP*: months of reception class Specification 1: gender, birth weight and LEAs dummies; Specification 2: gender, birth weight, mother education, poverty indicator, single parent family, nr of children, and LEAs dummies.

Table A-8: Effect of age at entry on FSP Total score discarding children who moved in the last 5 years

	OLS	2SLS (1)	2SLS (2)
(whites)* <i>AGEE</i>	0.06 [0.004]***	0.073 [0.005]***	0.074 [0.004]***
(indian)* <i>AGEE</i>	0.069 [0.024]***	0.068 [0.026]***	0.068 [0.026]**
(pakistani)* <i>AGEE</i>	0.052 [0.011]***	0.06 [0.010]***	0.059 [0.010]***
(banglad)* <i>AGEE</i>	0.025 [0.031]	-0.027 [0.037]	-0.005 [0.037]
(bcaribb)* <i>AGEE</i>	0.004 [0.047]	0.01 [0.059]	-0.006 [0.059]
(bafrican)* <i>AGEE</i>	0.022 [0.044]	0.117 [0.056]**	0.115 [0.053]**
(other)* <i>AGEE</i>	0.074 [0.013]***	0.099 [0.013]***	0.09 [0.013]***
Obs.	5531	5531	5531

notes: Standard errors in brackets. Only children with entry in September. AGEE: age at entry. Specification 1: gender, birth weight and LEAs dummies, Specification 2: gender, birth weight, mother education, poverty indicator, single parent family, nr of children, and LEAs dummies

4.7 APPENDIX B - Admissions policies

Most LEAs establish a single entry point: all children, regardless of age, start school in the September of the academic year in which they turn 5 (**Policy A**).

The other predominant policy foresees two possible entry points **Policy B**: Children born 1 September to 29 February start school in the September of the academic year in which they turn 5; children born 1 March to 31 August start school in the January of the academic year in which they turn 5.

Policy C: Children born 1 September to 31 December start school in the September of the academic year in which they turn 5; children born 1 January to 31 August start school in the January of the academic year in which they turn 5.

Policy D: Children born 1 September to 30 April start school in the September of the academic year in which they turn 5; children born 1 May to 31 August start school in the January of the academic year in which they turn 5.

A very tiny minority of LEAs foresees three points of entry: The rising 5 policy: Children start school at the beginning of the term in which they turn 5, so children born 1 September to 31 December start school in September, children born 1 January to 30 April start school in January and children born 1 May to 31 August start school in April (**Policy E**)

There is then a minor part of LEAs which leave school freedom to choose their own admission policy, or where the admission policy is not clear. (**Policy F**)

From table 1B , it is clear the majority of children are in LEAs which apply the single entry point in September: policy A

Table B-1: Admission policies

	Admission Policy					
	A	B	C	D	E	F
nr. children	7,144	1,470	565	65	172	273
percentage	73.70	15.16	5.83	0.67	1.77	2.82

Table B-2: Compliance rate to admission policy by ethnic group

	<i>COMPLIANCE RATE TO ADMISSION POLICY in percentage</i>						
	whites	Indian	Pakistani	Bangla	b.Caribb	b.African	other
Compliance	0.88	0.93	0.91	0.80	0.79	0.76	0.88

Table B-3: Schooling statistics age 5

	white	Indian	Pakistani	Bangla	b Caribb.	b African	others
age in months at test	62.37 (2.894)	62.76 (2.761)	62.68 (2.888)	62.94 (2.913)	62.58 (3.077)	62.78 (3.010)	62.58 (2.943)
age at school entry	55.06 (3.454)	54.95 (3.356)	54.96 (3.650)	54.83 (3.634)	55.29 (3.260)	55.25 (3.366)	54.91 (3.601)
months of recep class	7.251 (2.500)	7.721 (2.382)	7.435 (2.765)	7.870 (2.612)	7.194 (2.290)	7.442 (2.605)	7.585 (2.707)

Source: MCS wave 3.

Table B-4: Month of birth

month of birth (age 5 sample)	frequency	percentage
January	806	8.35
February	709	7.34
March	814	8.43
April	777	8.05
May	805	8.34
June	848	8.78
July	806	8.35
August	776	8.04
September	828	8.57
October	809	8.38
November	822	8.51
December	857	8.87
total	9657	100