Microeconomic Foundations of the Demographic Dividend[1]

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Abstract

The potential economic returns to the demographic transition are high. As countries move from a steady state with high mortality and high fertility to an equilibrium with low mortality and fewer children, lower dependency ratios, higher investment in human and physical capital as well as increased female labor force participation contribute to economic growth. In this paper, we analyze the demographic transition at the household level, and investigate the distributional patterns of the economic and welfare benefits associated with the demographic transition across socioeconomic groups within countries and over time. We find significant and large differences in the effects of the demographic transition across socioeconomic status (SES) groups but also substantial behavioral change across all groups in the later stage of the transition, so that the long-run effects of the demographic transition on inequality remain ambiguous.

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1. Introduction

The potential economic returns to the demographic transition are high. As countries move from a steady state with high mortality and high fertility to an equilibrium with low mortality and fewer children, several factors change in a way that is conducive to economic growth: working age adults have to support fewer children and are thus richer in terms of per capita income; fewer children mean more resources per child and higher capital investment; fewer children also imply more time for parents to work; last, longer life expectancy and less reliance on within-family support implies higher investment in physical capital. While the potential benefits of the demographic transition have been documented extensively at the country level, the distribution of the benefits within a county has not been explored very much to date. In this paper, we take a first step in this direction. We combine a large number of household level data sets from the Demographic and Health Surveys (DHS) to measure the extent to which the correlation between income and age structure is observable at the household level, and to investigate the degree to which demographic change contributes to a society's inequality over time.

In the initial stages of the demographic transition, infant mortality rates decline and fertility rates remain high. Couples make a decision over how many children to have based on a number of social determinants of fertility such as age, religion, wealth, contraceptive use, and also infant mortality (Schultz 1997). In a high infant mortality environment, families will elect to have more children than their ideal family size - partially to replace some of the lost children, and partially to anticipate future deaths in their family. With a decline in infant mortality, couples take time to adjust their expectations of infant mortality and thus the decline in fertility lags (by about 10 years) the decline in infant mortality (Angeles 2010).

The decline in fertility yields a mechanical effect on income per capita through changes in the age structure. With fewer children under working-age, total national income is divided by a smaller total population, yielding higher income *per capita* in the country. In addition to this accounting effect, the shifts in age structure trigger behavioral responses that have a positive effect on growth as described before: with fewer children to support, parents invest more in the education of their children (Becker, Murphy et al. 1990; Galor 2006), and save more for their

retirement (Bloom, Canning et al. 2003), and women increasingly participate in the formal labor market (Bloom, Canning et al. 2009. As a result, economic growth accelerates, yielding what has been coined the demographic dividend (Bloom, Canning et al. 2003).

At the micro-level, little research has been done to date. Hausmann and Szekely (2001) consider a group of Latin American countries and investigate the effects of demographic transition on inequality at the household level. While inequality has a long history in the subcontinent, the authors find that the demographic transition further accentuated pre-existing trends, with faster, and earlier demographic shifts among the wealthiest population groups further increasing the gap between the rich and poor.

In this paper, we work with Hausmann and Szekely (2001) hypothesis of widening inequality, and investigate whether the changes in dependency ratios and household structures are more pronounced among richer than among poorer households. To do this, we pool all households data available from the DHS surveys to get a sample of 1.65 Million households over the period from 1990-2008, and then divide the household population into five socio-economic status (SES) groups based on their observable characteristics. If countries experience unequal or unbalanced demographic transitions, then we should observe that changes in dependency ratios and behavior are more pronounced in richer SES groups than in poorer SES.

We divide our analysis in three parts: in the first part, we provide a detailed description of the household and age structures observed in developing countries, and show basic correlations between households' income and age structure. In the second part, we pool all available data, and directly test the Hausman hypothesis in our data by exploring time variations captured through multiple surveys in a given country. Last, we take a look at the three countries with the largest aggregate declines in dependency, and decompose these changes in the underlying changes in income distribution and behavior conditional on income. We conclude the paper with a short summary and discussion.

2. Data and Methodology

In this paper we combine all currently available data from the Demographic and Health Surveys (DHS) into a large micro-data base covering approximately 1.65 Million households in 57 countries over the period 1990-2008 to analyze changes in age structure at the household level over time. Originally designed with a focus on reproductive health similar to the World Fertility Surveys, DHS surveys have steadily grown in geographical coverage and scope over time. At present, more than 170 DHS surveys are available across 73 countries. Some of the earlier surveys collected information on female respondents only; given the household-level focus of this study we exclude these early surveys and this leaves us with a total of 146 surveys in 57 countries. Given the large and rather heterogeneous group of countries in our sample, we divide countries into four regions in a first step: Sub-Saharan Africa, Latin America, South- and South East Asia, and Other Asian countries. As Table 1 shows, Sub-Saharan African countries are by far the largest group in our sample, getting about as much coverage in the combined DHS data set as the three other regions combined.

Table 1: Sample distribution

Sub-Saharan Africa	Surveys	Households	**South-East Asia**	Surveys	Households
Benin	3	27,325	Cambodia	2	26,479
Burkina Faso	2	11,127	India	1	88,562
Cameroon	3	18,697	Indonesia	5	168,640
Central African Rep.	1	5,551	Nepal	3	25,391
Chad	2	12,209	Pakistan	1	7,193
Comoros	1	2,252	Philippines	4	50,457
Congo, Dem. Rep.	1	8,886	Vietnam	2	13,965
Congo, Rep.	1	5,879	*Total*	*18*	*380,687*
Cote	3	12,425			
Ethiopia	2	27,793	**Latin America**		
Ghana	4	29,854	Bolivia	4	59,994
Guinea	2	11,372	Brazil	2	19,235
Kenya	4	33,948	Colombia	4	65,614
Lesotho	1	8,592	Dominican Rep.	5	54.82
Liberia	2	10,986	Guatemala	2	16,884
Madagascar	4	39,392	Guyana	1	2,608
Malawi	3	33,200	Haiti	3	24,411

Mali	3	34,045	Honduras	1	18,683
Mozambique	2	21,597	Paraguay	1	5,683
Namibia	3	19,693	Peru	4	116,574
Niger	3	18,830	*Total*	*27*	*409,148*
Nigeria	4	57,941			
Rwanda	3	26,220	**North Africa and West Asia**		
Senegal	5	28,066	Egypt	6	94,313
Sierra Leone	1	7,284	Jordan	4	38,057
Swaziland	1	4,843	Kazakhstan	2	10,022
Tanzania	6	51,141	Kyrgyz Rep.	1	3,672
Togo	1	7,517	Moldova	1	11,095
Uganda	3	24,305	Morocco	1	11,513
Zambia	4	26,520	Turkey	3	27,514
Zimbabwe	3	21,612	Uzbekistan	1	3,703
			Yemen	1	12,836
Total	*81*	*649,102*	*Total*	*20*	*212,725*

The DHS are a nationally representative population surveys using stratified two-stage cluster sampling (Measure DHS 1996). In the first stage, a fixed number of clusters are randomly selected in each stratum of interest; after listing all households in the selected Enumeration Areas (EAs), a fixed fraction of households is selected for the survey. Typically, each EA contains about 250 households, out of which 20 are selected for the survey. Interviewers visit all selected households and complete a detailed household roster. After completion of the household questionnaire, all women in the household in the age range 15-49 are asked to complete a more detailed "individual questionnaire", which collects detailed information on reproductive behavior and fertility histories, but also on the educational attainment of parents and female labor force participation. In some of the more recent surveys, separate survey modules for males are also available.

Given the focus of this paper on age structure and inter-household inequalities, the primary data we use in our analysis is the data collected in the household questionnaire, which is published in a separate household roster (HR) file. Table 2 shows descriptive statistics for these data. The average household size is very close to five persons, with an average of 2.76 adults of working age (15-64), 2.05 children under the age of 15, and only approximately one person aged 65 or older for every 5 households. Table 1 also shows a few household characteristics typically

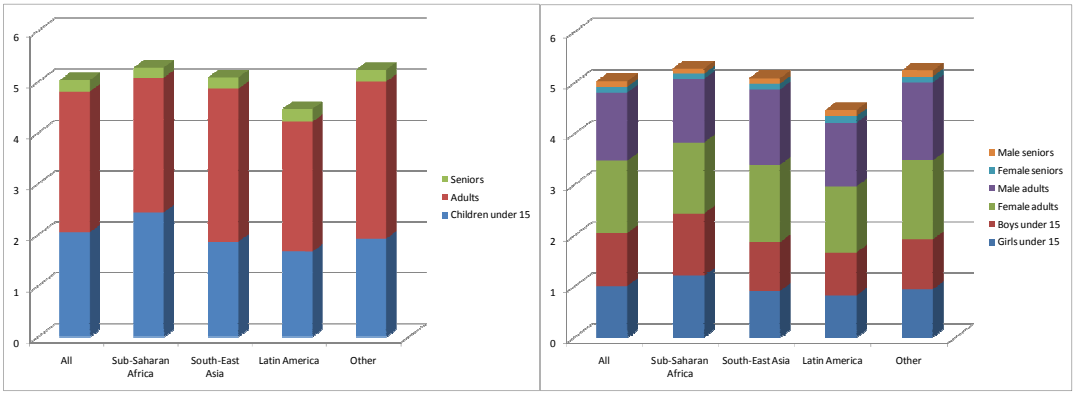
collected in the household surveys. Approximately half of the households have access to electricity, 41% of households own a TV, 27% own a fridge, 40% a mobile phone, and 55% a watch, and only 8 percent of households have a car.[2]

Table 2: Descriptive statistics

	Obs	Mean	St.dev.	Min	Max
Number of children	1651662	2.049	1.975	0	73
Number of adults	1651662	2.759	1.708	0	43
Number of seniors	1651662	0.221	0.498	0	8
HH has electricity	1554623	0.526	0.499	0	1
HH owns radio	1594719	0.615	0.487	0	1
HH owns tv	1594719	0.408	0.491	0	1
HH owns fridge	1548804	0.272	0.445	0	1
HH own car	1534886	0.075	0.263	0	1
HH owns phone	1174844	0.179	0.383	0	1
HH owns mobile phone	397751	0.396	0.489	0	1
HH owns watch	113018	0.551	0.497	0	1

As Figure 1 illustrates, the average household size is fairly similar across the four country groups in our sample. The notable exception is Latin America, with an average family size of about 4.5 persons; this difference appears to be driven by both a smaller average number of adults (2.5 on average) and a smaller average number of children under 15 (1.6) in the respective countries.

Figure 1: Age structure by country group



[2] Asset information collected varies across countries; the last two items (mobile phone and watch) were only collected in the last wave of the DHS surveys.

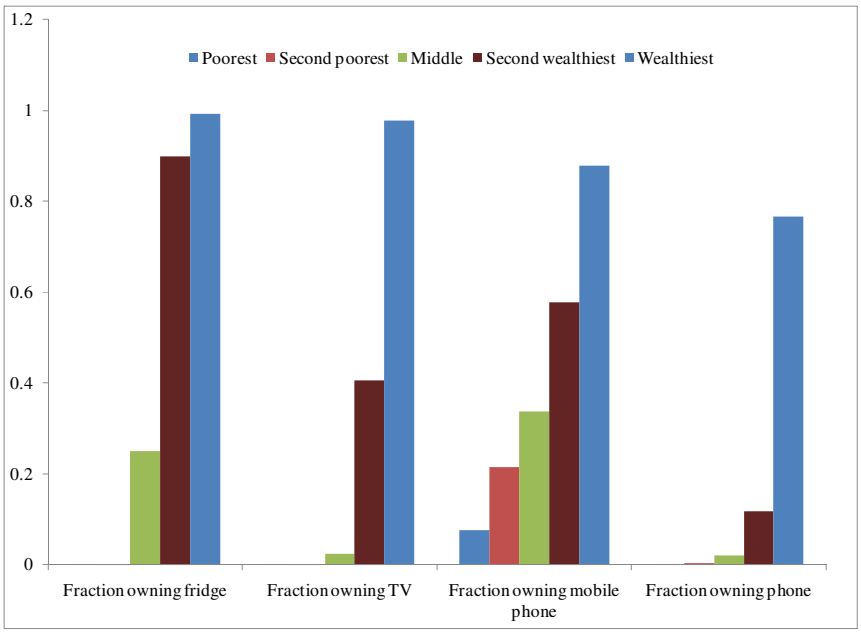
The main empirical question we try to address in this paper is whether the benefits of the demographic transitions in terms of lower dependency ratios accrue equally to all socio-economic groups. While socio-economic classes are generally defined via the income or assets of households relative to the average income or assets holding in the same country, using a relative definition is problematic in our setup, as households with unchanging characteristics would be re-classified over time as average income and asset levels change. To deal with this issue, we construct an absolute measure of socio-economic class based on a household's asset holdings. We assume that each household has an unobservable wealth level, which is a key determinant of households' ability to acquire assets. Use a multilevel logit model we can estimate the households probability to have a specific asset as:

$$\Pr(H_{aic} = 1) = \alpha + \sum_{a} \mathbf{P}_{ac}\beta_a + \mathbf{A}_{aic}\theta_a + \delta_i + \varepsilon_{aic}$$

where H_{aic} is a binary indicator for holding an asset *a* in individual household *i* within country *c*, β_t is a vector of effects for a matrix $\mathbf{P}_{ac}$ of country-specific continuous asset prices, θ_a is a vector of asset-specific fixed effects for the matrix $\mathbf{A}_{aic}$ of holdings by asset type, δ_j is a household random effect, and ε_{ijk} is an independently, identically, and normally distributed stochastic term. Since the the household random effect δ_j is the same across all assets, we can identify the underlying latent variable, permanent income.

Using the estimated permanent household income, we divide all households in our sample in income quintiles – as Figure 2 shows, the differences in asset holdings across these five quintiles are quite pronounced.

Figure 2: Asset holdings by permanent income quintiles



3. Empirical Analysis and Results

3.1. Cross-sectional relation between household wealth and age structure

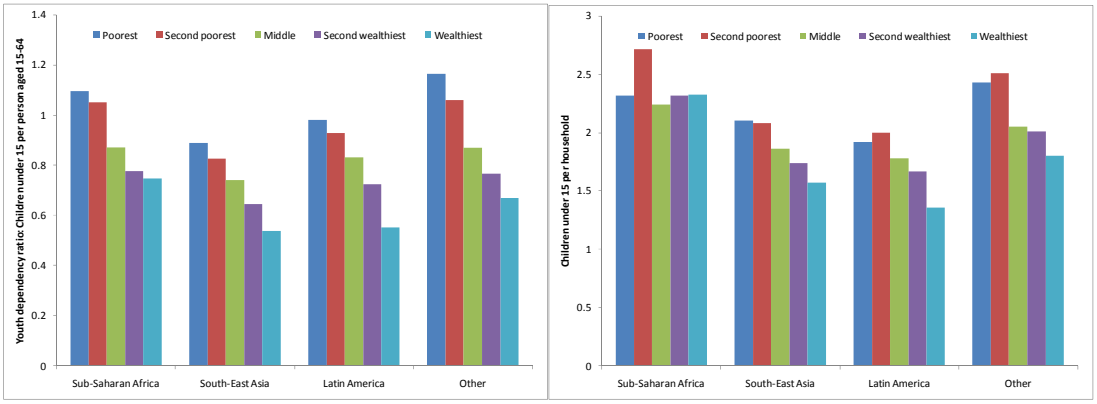
The first question we address in this section is whether the positive correlation between dependency ratio and income observed across countries also holds in the cross-section of households. To do so, we first follow the approach in the macro-economic literature and define youth dependency ratio at the household level as the number of household members under 15 divided by the number of household members of working age (15-64). In the cross-section of countries, this ratio ranged between 0.21 (Italy) to 1.07 (Uganda), with most developed countries centered around a value of 0.25, and most developing countries at values close to 1 (WDI, 2007). At the household level, dependency ratios show a lot more variation. In cases where the oldest individual living in the household is under 15 or the youngest person living in the household, the ratio is not defined – this is the case in less than 1% of our sample, which we neglect for the following exhibit.

Since our income permanent income variable is measured at the household level, correlating dependency ratios with income groups may be slightly misleading: a larger number of adults

implies – all else equal – both a higher permanent income, and smaller dependency ratios. To deal with this issue, we use the average number of children per household as a second and alternative measure of youth dependency.

Figure 3 shows the relation between permanent income and our two measures of youth dependency by country group. The similarity in the patterns across regions is remarkable. While the lowest SES groups have youth dependency ratios of one or higher in all four regions, the highest SES groups have dependency ratios that range between 0.6 (South-East Asia and Latin America) and 0.75 (Sub-Saharan Africa).

Figure 3: Youth dependency by region and permanent income



The relation between permanent income and the absolute number of dependent children looks more nuanced across regions. In three of the four regions, the number of children is largest in the second (poorest) income group, and declines for income groups 3 to 5. The latter statement does not hold for Sub-Saharan Africa, where all income groups except the second appear to have the same average number of children.

It is worth noting that old-age-dependency rates are - as illustrated in Figure 1 - very small in in our sample, so that the TDRs displayed look virtually identical to youth-dependency ratio (YTR – not shown) and is ignored for the rest of the paper.

3.2 Wealth and youth dependency over time

In Hausmann and Szekely (2001), the authors analyze household level data in Latin America and argue that the demographic transition was a phenomenon predominantly enjoyed by the wealthy in Latin American countries. This claim seems consistent with the cross-sectional results presented in the previous section, as only households classified as high SES appear to achieve low dependency ratios and high levels of human capital investment critical for the income and welfare of future generations. In this section, we try to further investigate the relation between the demographic transition and both the mean and the distribution of outcomes by exploring variations over time. Since we want to investigate whether declines in dependency ratios affect all SES groups equally, we estimate the following model:

$$YD_{ijt} = \alpha + PI_{ijt}\beta + \gamma\delta_t + \phi\delta_t * PI_{ijt} + \rho\delta_i + \varepsilon_{ijt}, \qquad (1.1)$$

where YD is our measure of youth dependency of household i in country j and period t, PI is our measure of permanent income and δ_t and δ_i are time and country fixed effects, respectively. Our sample covers the period 1990-2008, a period associated with substantial fertility decline in some, and modest fertility decline in other countries. The hypothesis we wish to investigate is whether the changes in youth dependency equally accrued to all SES groups in the country. If the hypothesis is true, all changes in youth dependency across surveys should be captured by time effects, and ϕ, the estimated coefficient on the interaction between the permanent income variable and the time dummies should be zero.

Table 3 displays the results of this estimation in our sample. We show four main specifications. In column 1, we take the youth dependency ratio - defined as before as the number of children under the age of 15 per adult of working age in the household - as dependent variable, and regress it on the wealth quintiles, a *post* indicator which marks the 50% of the more recent surveys (collected after 2000), and the interaction terms between the wealth quintiles and the post dummy. Since the composition of countries before and after 2000 varies, we control for country fixed effects in column 2 of Table 3. In columns 3 and 4, we repeat the regressions from

the first two columns, but use the number of children under 15 as dependent variable rather than the youth dependency ratio. The results are highly consistent across specifications. The estimated coefficients in columns 1 and 2 imply that the wealthiest households have on average dependency ratios .33 - .35 lower than the poorest households (a difference of about 35%), while the number of children under 15 is about 0.15 lower (column 4) in the cross-section, consistent with the basic patterns displayed in Figure 3.

Table 3: Regression results

Dependent Variable	**Youth Dependency Ratio**		**Children under 15 per household**	
	(1)	(2)	(3)	(4)
Second SES quintile	-0.0189	-0.0312**	0.259***	0.307***
	(0.0188)	(0.0124)	(0.0666)	(0.0509)
Third SES quintile	-0.203***	-0.148***	-0.234***	0.00592
	(0.0265)	(0.0187)	(0.0652)	(0.0633)
Fourth SES quintile	-0.271***	-0.216***	-0.254***	0.0531
	(0.0261)	(0.0184)	(0.0607)	(0.0674)
Fifth SES quintile	-0.351***	-0.335***	-0.400***	-0.157*
	(0.0425)	(0.0271)	(0.113)	(0.0845)
post	0.0432	0.00832	-0.0652	-0.129**
	(0.0365)	(0.0200)	(0.0681)	(0.0577)
Post * second quintile	-0.0492*	-0.0591***	0.0310	-0.104
	(0.0273)	(0.0184)	(0.105)	(0.0700)
Post*third quintile	-0.0748*	-0.0819***	-0.0982	-0.0948
	(0.0450)	(0.0251)	(0.117)	(0.0787)
Post*fourth quintile	-0.101***	-0.0911***	-0.207**	-0.196**
	(0.0352)	(0.0255)	(0.0850)	(0.0764)
Post*fifth quintile	-0.143***	-0.0930***	-0.282**	-0.180**
	(0.0535)	(0.0320)	(0.141)	(0.0899)
Constant	1.023***	1.013***	2.267***	2.133***
	(0.0295)	(0.0136)	(0.0440)	(0.0487)
Observations	1594422	1594422	1651662	1651662
R-squared	0.038	0.061	0.024	0.085

Robust standard errors in parentheses are clustered at the country level.
*** p<0.01, ** p<0.05, * p<0.1

More importantly, we strongly reject the hypothesis of equal change across SES groups. The estimated coefficients in columns 1 and 2 imply that the declines in the dependency ratios

increase with SES; on average, households in the fifth quintile experienced an additional dependency ratio decrease of 0.1 (more than 10% of their baseline dependency ratio) relative to the poorest households. In terms of absolute numbers of children, we estimate that the average number of children supported decreased by about 50% more in the highest SES group than it did among the poorest households (-0.18 vs. -0.129).

3.3 Major demographic changes: 3 case studies

To provide a better sense of magnitudes of these group-specific differences and their respective contributions to the broad demographic trends observed, we take a closer look at the three countries with the largest declines in youth dependency in our sample: Cote d'Ivoire, Namibia, and Peru. As Table 4 shows, all countries have not only experienced rapid declines in total fertility rates, but also substantial improvements in terms of their youth dependency ratio and the average number of children under 15 per household.

Table 4: Top 3 countries in terms of you dependency decline

	Survey	Children under 15	Youth dependency ratio	Total fertility rate
Cote d'Ivoire	1994	3.03	0.91	6.01
	1998	2.61	0.76	5.51
	2005	2.38	0.82	4.82
Namibia	1992	2.77	0.92	5.93
	2000	2.04	0.84	4.29
	2006	1.82	0.77	3.66
Peru	1991	2.13	0.84	3.86
	1996	1.96	0.82	3.30
	2000	1.65	0.71	3.00
	2003	1.33	0.60	2.82

Following the approach taken in the previous section, we can decompose the experienced declines at the country level into two main contributing factors: changes in the distribution of incomes, and changes in dependency ratios for a given SES level. As we have shown in the

previous section, dependency ratios have changed for all groups; in order to get to the total change in dependency, we need to also take shifts in the income distribution over time into consideration. Table 5 shows both factors for the three selected countries. The right hand side of the table shows the percentage of households in each income category. Progress in terms of income is visible n all three countries. While 38% of households in Cote d'Ivoire were placed in the lowest income quintile in the first survey sround, the same was true for only 23% of households in 2005. Similar declines were observed in Peru, while the picture for Namibia is more nuanced, with a higher fraction of households ranking in the poorest quintile in 2006 than in 1992, but also substantial increases at the very top of the distribution.

As to the relative declines in the average number of dependent children across wealth quintiles, the three selected countries display patterns only partially consistent with the large-sample results presented in section 3.2.

Table 5: Decomposition of dependency declines

	Children under 15					Population share				
Cote d'Ivoire	Q1	Q2	Q3	Q4	Q1	Q1	Q2	Q3	Q4	Q1
1994	2.68	3.46	2.53	3.59	3.82	38%	21%	20%	11%	10%
1998	2.30	2.92	2.14	2.88	3.32	17%	16%	29%	30%	8%
2005	2.34	2.61	2.16	2.36	2.61	23%	21%	23%	23%	9%
Change	-13%	-25%	-15%	-34%	-32%	-39%	0%	17%	113%	-9%
Namibia										
1992	2.61	3.40	2.79	2.45	1.80	30%	35%	14%	6%	16%
2000	2.12	2.48	1.80	1.85	1.64	21%	29%	14%	14%	22%
2006	1.99	1.97	1.87	1.67	1.50	41%	10%	15%	9%	25%
	-24%	-42%	-33%	-32%	-17%	40%	-71%	7%	59%	56%
Peru										
1991	2.45	2.48	2.34	2.22	1.69	12%	16%	16%	21%	35%
1996	2.04	2.39	2.04	1.90	1.35	12%	20%	16%	37%	14%
2000	1.65	2.01	1.74	1.64	1.15	13%	19%	16%	38%	15%
2003	1.31	1.56	1.38	1.37	1.05	8%	18%	15%	37%	23%
	-47%	-37%	-41%	-38%	-38%	-34%	11%	-10%	73%	-34%

While in Cote d'Ivoire the largest changes are observed among the richest quintiles, the same is not true for Namibia, where the largest change is observed for the second income quintile households; for Peru, the changes appear to be more or less equal across all income quintiles.

To see how important these changes in the income distribution are relative to the behavioral changes, we calculate the time path of the average number of children under two counterfactual assumptions. In the first counterfactual, we assume that the original wealth distribution stays unchanged, but that behavior moves as empirically observed. In the second counterfactual, we make the opposite assumption, and calculate how dependency ratios would have changed if behavior had stayed the same as in the first survey, but the distribution of income had changed as it did empirically. The results of these two counterfactuals are displayed in columns 3 and 4 or Table 6, respectively. While the effects of wealth appear marginal, the effects of behavioral change seem to more or less exclusively drive the overall declines observed. Our calculations imply that dependency ratios would have changed very little (Namibia) or even would have even increased (Cote d'Ivoire, Peru) if SES specific behavior had not changed over the sample period.

Table 6: Counterfactual scenarios

Cote d'Ivoire	Actual	Original wealth	Original behavior
1994	3.03	3.03	3.03
1998	2.61	2.57	3.12
2005	2.38	2.39	3.13
Namibia			
1992	2.77	2.77	2.77
2000	2.04	2.11	2.66
2006	1.82	1.87	2.50
Peru			
1991	2.13	2.13	2.13
1996	1.96	1.83	2.25
2000	1.65	1.55	2.23
2003	1.33	1.28	2.18

4. Summary and Conclusion

In this paper, we have used pooled micro-data from 57 low and middle income countries to investigate the degree to which the demographic dividend generally measured at the country-level is realized at the household level. The available cross-country evidence suggests that the decline in fertility rates triggered by improvements in mortality during the demographic transition is associated with lower dependency ratios, higher human (and physical) capital investment as well as higher female labor force participation. In this paper we show that a similar association between income and dependency ratios can be found at the micro level. On average, households with higher incomes have fewer children to support and lower dependency ratios.

Despite the strong association between wealth and age structure at the household level, the implications for the demographic transition on inequality are not obvious from dynamic perspective. The country case studies presented in this paper suggest that in the more advanced stages of the demographic transition all socioeconomic groups experience smaller dependency ratios, fostering increased investment in child quality and human capital across all socioeconomic groups. While these effects are undoubtedly positive for the long-term economic development of countries, the relative improvements across groups appear highly heterogeneous, so that the overall effect of the demographic transition on inequality remains ambiguous.

References

Angeles, L. (2010). "Demographic Transitions: Analyzing the Effects of Mortality on Fertility." Journal of Population Economics **23**: 99-120.

Becker, G. S., K. M. Murphy, et al. (1990). "Human Capital, Fertility, and Economic Growth." Journal of Political Economy **98**(5): S12-S37.

Bloom, D. E., D. Canning, et al. (2003). "Longevity and Life-Cycle Savings." Scandinavian Journal of Economics **105**(3): 319-38.

Bloom, D. E., D. Canning, et al. (2003). "The Demographic Dividend: A New Perspective on the Economic Consequences of Population Change." Population Matters Monograph MR-1274, RAND, Santa Monica.

Galor, O. (2006). "Human Capital, Fertility and Growth." Prepared for the New Palgrave Dictionary of Economics, 2nd Edition S. Durlauf and L. Blume, eds. **Draft**.

Hausmann, R. and M. Szekely (2001). Inequality and the Family in Latin America. Population matters : demographic change, economic growth, and poverty in the developing world N. Birdsall, A. C. Kelley and S. Sinding. New York, Oxford University Press.

Measure DHS (1996). DHS Sampling Manual. http://www.measuredhs.com/pubs/pub_details.cfm?ID=715. M. International. Calverton, Maryland.

Schultz, T. P. (1997). Demand for Children in Low Income Countries. Handbook of Population and Family Economics. M. R. Rosenzweig and O. Stark. Amsterdam, North-Holland. **1A:** 643.