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Public Policy and Anthropometric Outcomes in Côte d'Ivoire

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Public Policy and Anthropometric Outcomes in Côte d'Ivoire

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ABSTRACT

Using data from Côte d'Ivoire, we examine the impact of public policies on three anthropometric outcomes: height for age and weight for height of children as well as body mass index of adults. During the eighties, low growth rates in Côte d'Ivoire were accompanied by an economic adjustment program which included substantial cuts in public spending together with increases in the relative price of foods. If reductions in social spending resulted in lower availability and quality of health care services, then our results suggest that child health (particularly height for age) will have been adversely affected. The provision of basic services (such as immunizations) and ensuring facilities are equipped with simple materials (such as having basic drugs in stock) will yield high social returns in terms of improved child health. Food prices have tended to rise in Côte d'Ivoire during the eighties and we find that higher food prices have had a significantly detrimental impact on the health of Ivorian children (as measured by weight for height) and adults (as indicated by lower body mass indices). In contrast, the effects of income on health are significant but quite small, except in the case of adult women.

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FOREWORD

This paper is part of a broader program of research in the Population and Human Resources (PHR) Department on the effects of availability and quality of social services on outcomes of investment in human capital. This research program is located in the Poverty Analysis and Policy Division. The data used here are from the third year (1987) Côte d'Ivoire Living Standards Survey, which is one of the Living Standard Measurement Survey (LSMS) household surveys which the World Bank has implemented in many developing countries.

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1. INTRODUCTION

During the 1980s there has been substantial re-alignment of public budgets in many countries, especially in Africa. Many governments have attempted to reduce budget deficits, often as part of structural adjustment or stabilization programs, with, *inter alia*, price policies and public expenditures on social services being subjected to particular scrutiny.

Economists have traditionally been concerned with the impact of these policies on resource allocation and economic growth but have tended to pay rather less attention to their broader socio-economic ramifications. This paper examines the impact on indicators of child and adult health status of the availability and quality of health infrastructure as well as local market food prices, while also controlling for household resources. To the extent that stabilization programs are associated with increases in food prices as well as reductions in public spending on social services -- and they often are (Jimenez, 1987) -- the empirical results will be suggestive of how these policies are likely to affect the health of a community.

The task of measuring health status is far from trivial. At a conceptual level, health is multi-dimensional and context sensitive (Ware, 1989). At a practical level, clinical measurements are prohibitively expensive to be collected in large scale surveys and so researchers and policy makers have tended to rely on self-reported morbidities. It is not entirely clear, however, how to interpret self-reported perceptions of health. We examine, in this paper, anthropometric outcomes which are objectively measured and reflect the nutritional status of an individual. In a poor country, this is likely to be not unrelated to general health status. We focus on child height (conditional on age and sex) and weight (conditional on height) as well as adult body mass index (weight divided by the square of height).

While there is scope for some adaption of the body to nutritional stress (Srinivasan, 1981; Sukhatme, 1982) a large literature suggests that child height for age is a good indicator of longer run child nutritional status. The evidence indicates that well-nourished children of diverse ethnic backgrounds from around the world follow remarkably similar growth curves (Habicht *et al.*, 1974; Martorell and Habicht, 1986). Whereas height for age reflects the cumulation of past outcomes, weight for height is thought to be a good shorter run measure of health status (Falkner and Tanner, 1986).

The household level determinants of these outcomes have been documented in many studies and it has often been demonstrated that parental education, especially maternal education, together with household resources tend to be positively associated with both outcomes (see Behrman (1990) for an excellent review of the literature). Rather less is known about the impact of community characteristics on child health. Several studies indicate the availability of infrastructure -- in particular modern water or sewerage systems -- tends to be positively associated with child health.[1] The evidence on the impact of the availability of health facilities is more ambiguous and there is very little known about the returns (to health) of raising the quality of health services.[2] The effect of prices on child health are perhaps even less well understood.[3]

Outside the biomedical literature, adult health has received little attention (Mueller, 1986) and so there is scant evidence on its socio-economic determinants, especially in developing countries (Feachem, Graham and Timaeus, 1989; Birdsall, 1990). A small number of papers have examined the determinants of self-reported indicators of general ill-health[4] (Wolfe and Behrman, 1984; Pitt and Rosenzweig, 1985; Behrman and Wolfe, 1989) specific illnesses, such as malaria, (Castro and Mokate, 1988; Fernandez and Sawyer, 1988) or problems with activities of daily living (Strauss, Gertler and Ashley, 1991). Alderman (1989) has studied the impact of education, expenditure and parity on the BMI of adult women in Ghana.

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[1]See Horton (1986), Behrman and Wolfe (1987), Barrera (1990), Strauss (1990), Thomas, Strauss and Henriques (1990) and Thomas and Strauss (1991).

[2]Strauss (1990) finds the presence of a traditional healer in rural Côte d'Ivoire reduces child height as does the absence of drugs and congestion problems in the nearest health facility. Barrera (1990) reports an inverse relation between distance to a clinic and child height in the Philippines. Thomas and Strauss (1991) find that, in Brazil, child height is inversely related to the number of nurses and beds in the community. Rosenzweig and Schultz (1982) indicate that fertility and child mortality are invariant to health facilities in rural Colombia but tend to be lower with more clinics, and possibly hospitals, in the urban areas.

[3]Changes in child weight for height are negatively correlated with changes in rice prices in Bangladesh (Foster, 1990). Higher sugar and dairy prices are associated with lower height for age in Brazil (Thomas and Strauss, 1991). Behrman and Deolalikar (1989) find that in India the prices of sorghum, pulses and rice are positively associated with child weight for height in the lean season and have no impact in the surplus season; price effects on nutrient intakes are also significant but in the opposite direction. The reasons for these possibly contradictory results are not entirely clear.

[4]The interpretation of some of these results is not unambiguous since it is not entirely clear what is being reported (Behrman, 1990).

Although little is known about the socioeconomic correlates of adult body mass index, there is evidence that, within certain ranges, adult BMI is significantly associated with higher risk of mortality.[5] Lean body mass index, which is related to BMI, is positively associated with the maximum rate of oxygen intake (Spurr, 1983) which is, in turn, related to maximum work capacity and thus, potentially, to labor productivity. Several studies have indeed demonstrated a positive correlation between adult BMI and labor productivity or wages. Many of the earlier studies in this literature, however, failed to take account of the fact that weight for height or body mass index is likely to vary in the shorter run and respond to changes in energy inputs and outputs (see Strauss, 1986, for a review and discussion); interpretation of these studies is not unambiguous since reverse causality remains a possibility. More recent work has addressed the issue of endogeneity and indicate that adult weight for height or body mass index has a positive impact on wages in India (Deolalikar, 1988) and the Philippines (Haddad and Bouis, 1991).[6]

The data used in this study are drawn from the third round (carried out in 1987/88) of Côte d'Ivoire Living Standards Survey (CILSS), a household survey conducted by the Direction de la Statistique in collaboration with the Living Standards Unit at the World Bank. (See Ainsworth and Munoz, 1986, for a description of the survey methodology). Simultaneously with the household survey, enumerators collected information on local food prices and, in 1989, a very detailed health facility survey was specially conducted in exactly the same communities as covered by the household survey. We match these community level data with the household and individual information to create a very rich multi-level database for our empirical analysis of the impact of health infrastructure and food prices on anthropometric outcomes of Ivorians.[7]

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[5]Dangerous ranges for European populations appear to be under 20 and over 30; see studies by Keys (1980) and Waaler (1984); Payne (1985) provides a good summary.

[6]See also Strauss (1986).

[7]Child anthropometric data from the first two rounds of the CILSS are described in Strauss and Mehra (1989). The household level determinants of child anthropometry are presented in Strauss (1990) for the first round and Sahn (1990) for the second round; Strauss (1990) also examined the impact of community level infrastructure in the rural sector. Haddad and Hoddinott (1991) find little evidence for gender differences in the determinants of child anthropometry using data from the second round of the survey. The demand for health care in the Côte d'Ivoire is discussed in Gertler and van der Gaag (1991).

Côte d'Ivoire enjoyed rapid growth during the two decades after Independence (averaging 7% *per annum* during the sixties and seventies); government expenditures grew even faster with investments in the health sector being concentrated on large hospitals (in urban areas).[8] During the seventies, there was a shift in focus towards the provision of basic health services to the entire population and so during that decade a large number of health centers were opened throughout the country and, especially, in rural areas.

Growth rates have been lower during the eighties and were negative for the first few years of the decade (1979-83). Over the last ten years, therefore, the government has instituted a series of economic adjustment programs which have included substantial cuts in public spending. Real government spending rose by about 60% during the seventies and peaked in 1982 when it accounted for 17% of GDP. Over the following four years, however, the public budget declined in real terms by 14% and expenditures on social services have borne even deeper cuts. In 1981, 7.7% of the public budget was spent on health; that share declined to below 7% in 1986, although the share has recovered slightly since then. In real terms, however, public resources devoted to health declined by 12% between 1981 and 1984 which more than offsets the growth in health expenditures during the previous decade. In 1984, therefore, real public spending on health was reduced to its level in 1972. Although private health care is emerging in Côte d'Ivoire, it remains small and concentrated in Abidjan.

Within the health sector, personnel costs have remained resilient to cuts in public spending during the eighties and their share of the public health budget rose during the early years of the economic adjustment program and so, in 1984, personnel accounted for three-quarters of the total health budget. Thus real public expenditures on medicines and materials were cut by over one third during the first half of the eighties. Although health policy has shifted in focus away from large hospitals, trained personnel remain heavily concentrated in large, urban facilities: it is likely, therefore, that less well equipped (rural) facilities have borne the brunt of cuts in the health budget during the early eighties.

Historically, food prices in Côte d'Ivoire have been below world prices, partly because of over-valued exchange rates (Krueger, Schiff and Valdes, 1988). During the eighties, however, food prices have tended to rise

[8]The following discussion is based on data drawn from République de Côte d'Ivoire, (1979, 1981, 1985, 1990); République de Côte d'Ivoire/UNICEF, (1988); Economist Intelligence Unit, (1986, 1987, 1990, 1991).

(relative to non-food exports) as public policy has shifted towards promoting food self-sufficiency and, presumably, economic efficiency. Food prices have also tended to rise relative to non-foods during the eighties and particularly since 1985. In 1988 there was a dramatic increase in the relative price of foods when the food price index (for lower income households) rose by over 20% while the general price index rose by less than 4%. Unfortunately, no time series data are available on consumption prices of individual food goods.

How have these changes affected the health of the Ivorian population? The next section sketches a conceptual framework which guides our attempt to answer this question. We also discuss some potentially important econometric issues and introduce the estimator we have adopted. The data are described in the third section which is followed by our empirical results.

In Côte d'Ivoire, the availability and quality of health infrastructure does affect child health and, in particular, height for age. Food prices have a bigger impact on the shorter run health indicators: weight for height of children and body mass index of adults. In the case of children, price effects are (absolutely) larger among poorer households. Adult health, and in particular women's BMI, is significantly improved as levels of resources in the household rise although income effects on child health appear to be small.

2. MODEL

Assume that preferences of household members are inter-temporally separable and that in the current period, the household maximizes a quasi-concave utility function which depends on the consumption of commodities and services, x_t, the leisure, ℓ_t, and health status, θ_t, of each member (Becker, 1981). Let anthropometric measurements, h_t, be one dimension of the health status vector. Abstracting from complications of exactly how household resource allocation decisions are made[9] then the household chooses to

$$[1] \quad \max_{x \ell \theta} U(x_t, \ell_t, \theta_t; z_{ht}, \varphi_t)$$

where φ_t represents unobserved heterogeneity in preferences. Allocation choices are conditional on current period time and budget constraints:

$$[2] \quad p_t\, x_t = w_t(T_t - \ell_t) + y_t$$

where p_t is a vector of prices, w_t a vector of wages, one for each household member, T_t is a vector of the maximum number of hours each household member can work and y_t is household nonwage income.

Household anthropometric outcomes (be they height for age, weight for height or adult body mass index) are also constrained by the parameters of the biological health production function. Anthropometry in the current period, h_t, depends on anthropometric measures in the previous period, h_{t-1}, and current inputs, M_t, into the production function such as disease incidence, health care practices, nutrient intake and energy output. Time at work, $T_t - \ell_t$, may thus be an element of the input vector M_t. Individual characteristics, z_{it}, (such as age and gender) as well as household characteristics, z_{ht}, (such as the education of the head or spouse) are likely to affect health outcomes through their impact on allocation decisions but they may also have a direct impact through the health production function. Similarly, conditional on inputs, the environment in the local community, $\tilde{z}_{ct}$, may have a direct impact on anthropometric outcomes. The anthropometric production function is:

[9]Chiappori (1988, 1991) and McElroy (1990) discuss the conceptual and modelling issues regarding altruism within the household. Schultz (1990), Quisumbing (1991) and Thomas (1990) provide recent empirical evidence regarding the assumption that the household may be treated as an homogeneous unit. While intra-household resource allocations seem to be important, inclusion of these complications in our model adds nothing to the empirical model that we can estimate with the CILSS. They are, therefore, ignored.

$$[3] \quad h_{it} = f_t(h_{it-1}, M_t, z_{it}, z_{ht}, \tilde{z}_{ct}, \upsilon_{it})$$

where υ_{it} are unobservable individual, household and community characteristics which affect the individual's health.

In many instances, estimation of the parameters of the health production function is of primary interest (see, for example, Akin, Guilkey and Popkin, 1990, Barrera, 1990, and Cebu Team, 1988, 1991.) In this study, however, we focus on determining whether and how community characteristics, such as availability of health services and food prices, affect health outcomes. We wish to measure the *total* impact of these factors rather than their impact conditional on a set of choices into the health production function and so solve for all choice variables in the optimization problem [1] through [3]. This leads to a reduced form anthropometric outcomes function:

$$[4] \quad h_{it} = g(z_i, z_h, y, z_c, \xi_{it})$$

where z_c is the set of all community characteristics which affect anthropometry directly, $\tilde{z}_c$, as well as through input choices. By assumption, all covariates in [4] including the community characteristics are exogenous and thus we rule out selective migration to places because of the availability of better health infrastructure or more favorable food prices (Rosenzweig and Wolpin, 1988) and public program placement in response to, say, poor child health (Rosenzweig and Wolpin, 1986). We also assume ξ_{it}, which represents unobserved heterogeneity in anthropometric outcomes, is uncorrelated with the other elements of the demand function. Since lagged anthropometry enters the health production function, [3], the determinants of current anthropometry include both their current and lagged values (dating back, in principle, to at least date of birth). Many of the covariates used in the empirical work are time invariant; for the remainder, we assume they change only slowly. For health facility characteristics, this may not be a bad assumption. In the case of prices, we know that the food price index has risen relative to non-foods; we assume that *relative* prices of different food commodities have remained stable during the eighties.

It is generally the case that poorer households live in areas with fewer social services and so without good controls for household resources, the estimated effects of community health facility and price characteristics,

z_c, may largely reflect household resources. Given that a primary motivation of this study is the estimation of the effects of these community factors, it is key that resource availability be adequately measured. Nonwage income, y, which is notoriously difficult to measure, is not likely to adequately reflect long run resources. Furthermore, if households smooth consumption over income shocks then expenditure is likely to be a better indicator of long run resource availability. We assume that leisure is (weakly) separable from commodity consumption and health in the utility function, in which case it is possible to derive a conditional demand function (Pollak, 1969) which is analogous to [4] but depends on total expenditure (or income).

If consumption decisions (including leisure) are jointly determined with anthropometric outcomes, then total household expenditure should be treated as endogenous in the conditional demand function. Under the assumption of weak separability between leisure and other elements of the utility function, nonwage income (or the value of assets) is an appropriate instrument.

In models of health of household members, it is inappropriate to treat household composition as exogenous; we control rather crudely for household size by including household *per capita* expenditure, PCE, as the indicator of resources in the conditional demand function. Partition z_h into {PCE $\tilde{z}_h$} then:

$$[5] \qquad h_{it} = h(z_i, \ PCE_t, \ \tilde{z}_h, \ z_c, \ \varepsilon_{it})$$

It is this model that we will estimate for child and adult anthropometric outcomes. Before turning to the data, however, we need to address some issues of estimation.

Empirical model

For ease of exposition, we write the model to be estimated, [5], in linear form:

$$[6] \qquad h_i = Z\beta + \varepsilon_{ic}$$

where h_i is a vector of anthropometric outcomes, measured at the individual level, $Z = \{z_i, z_h, z_c\}$ is a vector of all covariates included in each regression, and ε_{ic} are disturbances with zero mean. The time subscripts are dropped for notational convenience. By construction, the data used in estimation have a two-level design with the community characteristics being measured at the cluster level within the household survey. There may well be omitted cluster-specific factors since it is most unlikely that with survey data, it will be possible to completely characterize the local environment. More generally, it is possible that the regression errors in [6], conditional on covariates, are not statistically independent. The issue has received a good deal of attention in statistics, emanating out of the traditional sampling literature. In the context of the linear regression model, if the errors are correlated within clusters then the least squares coefficient estimates are consistent (although not efficient) but the variance-covariance matrix is not consistent. (See Holt and Scott, 1981, Kloek, 1981, Scott and Holt, 1982; the same point has also been made recently by Moulton, 1990).[10]

Assuming ε_{ic} are independent across clusters and equi-correlated within clusters then

$$E(\varepsilon_{ic}\varepsilon_{jd}) = \sigma^2 \delta_{ij} [(1-\rho)\delta_{cd} + \rho]$$

where δ is the Kronenker delta, ρ is the intra-cluster correlation of disturbances and the errors are assumed to have constant common variance σ^2. Under these assumptions, a consistent estimate of the variance matrix is given by

$$V_c = (Z'Z)^{-1} D_c$$

with

$$D_c = \sigma^2 [(1-\rho)I_n + \rho CC']$$

I_n is an identity matrix of size n, the number of observations, and C is an (n x c) design matrix identifying each of c clusters. The statistical model is identical to the time-series cross-section error components model (Fuller and Battese, 1973) and, in the context of that model, Breusch and Pagan (1980) derive a score test for ρ equal to zero. Deaton and Irish (1983) derive a similar Lagrange Multiplier test appropriate for the cluster effects model, permitting variable cluster sizes, n_c, (or an unbalanced design):

$$[7] \qquad g^2 = \frac{2}{\Sigma_c n_c(n_c-1)} \left[\frac{\Sigma_i\Sigma_j\Sigma_{k<j} \hat{\varepsilon}_{ij} \hat{\varepsilon}_{ik}}{\Sigma_i\Sigma_j \hat{\varepsilon}^2_{ij} / n} \right]^2$$

[10]Efficiency may be gained by adopting a random effects estimator. It turns out, however, that a random effects specification is not accepted for all the models estimated below. For the sake of comparability across specifications, we ignore the efficiency losses associated with using least squares but correct the standard errors.

Under the null hypothesis that $\rho=0$, then g^2 is distributed as χ^2_1. We can, therefore, *test* for intra-cluster correlations and will present these test statistics below.

It has been assumed thus far that the disturbances, ε_{ic} have constant variance, σ^2. In large scale micro survey data, this assumption is seldom satisfied and failure to take account of heteroskedasticity also results in consistent coefficient estimates but inconsistent estimates of the variance-covariance matrix. The infinitesimal jackknife (Jaeckel, 1972; also proposed by Hampel, 1974, and White, 1980) estimate of variance is:

[8]

$$V_h = (Z'Z)^{-1} \; (Z'D_hZ) \; (Z'Z)^{-1}$$

with

$$D_h = \text{diag}\{\varepsilon_{ic}^2\} = \varepsilon^2 \otimes I_n$$

and is consistent in the presence of heteroskedasticity of arbitrary form (White, 1980). Breusch and Pagan (1983) demonstrate the score test statistic for homoskedasticity is simply the number of observations multiplied by ½the R^2 from a subsidiary regression of squared standardized residuals (less one) on all covariates included in the primary regression. The Lagrange Multiplier statistic is distributed as a χ^2 with degrees of freedom given by the number of covariates in the model. We also present these score test statistics in the empirical results below.

It turns out that in many of the models we estimate, both the assumption of no intra-cluster correlation and the assumption of homoskedastic disturbances are rejected. We therefore estimate the variance matrix

[9]

$$V_* = (Z'Z)^{-1} \; (Z'D_*Z) \; (Z'Z)^{-1}$$

with

$$D_* = \; [(1-\rho)\varepsilon\otimes I_n \; - \; \rho BB']$$

where B is the direct product of the design matrix C and the residuals ε. V_* is a consistent estimate of the variance-covariance matrix in the presence of both heteroskedasticity and equi-correlated disturbances within clusters. All standard errors and test statistics reported in the tables below are based on this estimator. According to the model [5], some of the regressors, Z, should be treated as endogenous: the estimator of variance is slightly more complicated with Z in [9] being replaced by $\hat{Z} = (V'V)^{-1} (V'Z)$ where V includes all exogenous elements of Z as well as a set of identifying instruments.

A more general model would relax the assumption of equi-correlated errors and permit intra-cluster correlations to differ across clusters. This model is likely to perform rather poorly unless cluster sizes are large enough to precisely estimate ρ. In the empirical work reported below, cluster sizes are on average about 35, which is unlikely to be large enough, and so we assume ρ is constant across clusters.

The infinitesimal jackknife estimator of variance is closely related to the jackknife and both estimators can be viewed as linearizations of the bootstrap (Efron, 1982). The jackknife is known to perform very well, even in the presence of heteroskedastic errors (MacKinnon and White, 1985), but the infinitesimal jackknife is not robust to the presence of leverage points. Since we are relying on the infinitesimal jackknife, we have checked whether there are no leverage points in the empirical models reported below. It turns out that estimates based on the jackknife (ignoring cluster effects) and the infinitesimal jackknife incorporating cluster effects are very similar indeed and that inferences are virtually the same. Apparently for our model and data, the jackknife would be a good estimator of variance; see the Appendix for a discussion.

3. DATA

To study the determinants of anthropometric outcomes, we use individual and household level data from the third wave of the Côte d'Ivoire Living Standards Survey (CILSS) carried out in 1987/88. The survey has a two stage sampling design; 100 clusters were randomly drawn from a national frame and then 16 households were drawn from each cluster. Half of the clusters are from rural areas, the other half from the urban sector.

Community characteristics

In 1989, a survey of health facilities in Côte d'Ivoire was conducted by the Direction de la Statistique to supplement the 1987/88 household survey. The health facility data are very detailed providing extensive information on both the availability and quality of services in the community. For example the survey reports the number of doctors, pharmacists, dentists and surgeons who are supposed to work at the facility as well as the number who were present in the last twenty four hours. On average, there are almost 2 doctors per facility on the books but only 85% of them had been at work during the last day. In the urban sector, there are 3.4 doctors per facility and almost 90% had been in attendance whereas in the rural sector, not only is the number of doctors on the books smaller (0.53) but only 75% had been at work during the last day.

Summary statistics of the health service measures used in the regressions are reported in the top panel of Table 1.[11] On average, there are about seven nurses per doctor and 10 to 15 support personnel (drivers, cleaning staff, administrators) per doctor. While every community has at least one nurse (and one support worker), there is at least one doctor in about 90% of urban communities but only in 40% of rural communities.

About 85% of clusters have facilities with in-patient services. On average there are about 19 beds per

[11]For each of the 100 clusters, the nearest facility was included in the survey. If that facility was not public, then the nearest public facility was also included. In addition, the nearest drugstore or pharmacy was enumerated as was the nearest source of family planning. It turns out that there are very few private health facilities in the Côte d'Ivoire: of the 118 facilities surveyed, only 3 are private. In those clusters with more than one facility included in the survey, a service is considered available if it is provided at any of the facilities in the survey; the other measures of health services, such as numbers of doctors, are the sum across all facilities within the community.

Table 1: Sample Characteristics
Means and [Standard Errors]

A: COMMUNITY

	ALL		URBAN		RURAL	
Health personnel						
# doctors, surgeons dentists present	1.68	[0.24]	2.96	[0.39]	0.40	[0.11]
# nurses, nursing staff present	11.53	[1.53]	19.74	[2.52]	3.32	[0.57]
# support personnel present	19.16	[2.90]	32.12	[5.07]	6.20	[1.22]
Infrastructure						
# usable beds in facility	15.30	[2.07]	20.08	[3.33]	10.52	[2.31]
# working vehicles in facility	1.37	[0.21]	1.87		0.87	
Drug availability						
proportion with antibiotics in stock	0.77		0.78		0.76	
aspirin in stock	0.85		0.86		0.84	
quinine in stock	0.74		0.74		0.74	
Services						
proportion with immunizations available	0.68		0.78		0.58	
child birth facilities	0.60		0.58		0.62	
growth monitoring program	0.57		0.70		0.44	
Community Prices						
beef with bones	0.823	[0.013]	0.863	[0.013]	0.784	[0.021]
fresh fish	0.429	[0.016]	0.427	[0.022]	0.431	[0.022]
rice (imported)	1.617	[0.008]	1.614	[0.012]	1.620	[0.009]
palm oil	0.637	[0.022]	0.671	[0.039]	0.603	[0.022]
eggs (chicken)	0.083	[0.002]	0.065	[0.002]	0.096	[0.003]
sugar	0.464	[0.070]	0.605	[0.138]	0.324	[0.016]
plantain	0.118	[0.012]	0.135	[0.015]	0.101	[0.019]
manioc (unprocessed)	0.111	[0.011]	0.134	[0.019]	0.089	[0.009]

B: CHILDREN

(All children measured in 1987 Survey)	ALL		URBAN		RURAL	
Height for age						
z-score	-0.728	[0.03]	-0.586	[0.04]	-0.856	[0.04]
% US median	96.93	[0.11]	97.54	[0.16]	96.39	[0.16]
per cent <90% median	13.6		10.1		16.8	
Weight for height						
z-score	-0.341	[0.02]	-0.308	[0.03]	-0.370	[0.03]
% US median	97.92	[0.22]	98.30	[0.35]	97.57	[0.28]
per cent <80% median	5.1		4.6		5.5	
Child characteristics						
(1) child of hh head	0.75		0.77		0.74	
(1) male (0) female	0.51		0.49		0.53	
age of child (months)	70.15	[0.64]	70.81	[0.93]	69.55	[0.89]
Household characteristics						
HH per capita expenditure (CFAF 000)	163.52	[2.32]	225.88	[4.28]	107.56	[1.23]
ℓn(hh per capita expenditure)	11.77	[0.01]	12.11	[0.01]	11.46	[0.01]
senior female height for age z-score	-0.78	[0.02]	-0.59	[0.02]	-0.95	[0.02]
(1) can write	0.19		0.33		0.06	
years of education	1.51	[0.05]	2.74	[0.09]	0.41	[0.03]
senior male height for age z-score	-1.16	[0.02]	-0.91	[0.02]	-1.38	[0.02]
(1) can write	0.36		0.55		0.18	
years of education	3.08	[0.07]	5.04	[0.12]	1.32	[0.06]
(1) female head/spouse exist	0.99		0.98		0.99	
(1) male head/spouse exist	0.95		0.91		0.97	
(1) head Ivorian	0.83		0.80		0.87	

C: ADULTS

	ALL		URBAN		RURAL		FEMALE		MALE	
body mass index = wt/ht*ht	22.38	[0.05]	23.26	[0.09]	21.52	[0.06]	22.50	[0.08]	22.23	[0.07]
ℓn(body mass index)	3.10	[0.003]	3.13	[0.004]	3.06	[0.003]	3.10	[0.004]	3.09	[0.004]
HH per capita exp (CFAF 000)	207.80	[3.78]	291.68	[6.95]	125.63	[1.95]	190.43	[4.49]	228.85	[6.32]
ℓn(per capita expenditure)	11.94	[0.01]	12.31	[0.02]	11.57	[0.01]	11.87	[0.02]	12.02	[0.02]
years of education	2.97	[0.07]	4.91	[0.12]	1.08	[0.06]	1.81	[0.08]	4.38	[0.12]
(1) if male	0.45		0.48		0.42		.		.	
(1) head of household	0.34		0.37		0.31		0.06		0.68	
(1) spouse of head	0.38		0.33		0.42		0.68		.	
(1) Ivorian	0.84		0.80		0.88		0.85		0.83	
(1) married	0.73		0.68		0.80		0.78		0.69	

cluster but of these almost 4 were unusable at the time of the survey. In the urban sector, facilities tend to be larger (22 beds per facility) and have a larger proportion of useable beds (85%). The average cluster in the rural sector has 15.5 beds of which almost a third were unusable leaving only 10.5 available beds.

In three quarters of urban communities and just over half rural communities, health facilities have access to vehicles. Although the number of available vehicles is, on average, much larger in urban (2.38) than rural areas (0.96), the proportion of working vehicles is larger in the rural sector (91% relative to 79%) and so the inter-sectoral difference in the number of working vehicles in communities with any vehicles is considerably smaller.

Apparently in all these measures of services, there are substantial differences in the resources which are supposed to be available and those that are actually available in each facility. Few facility surveys, that can be matched with individual data, have collected this sort of detail although as we shall demonstrate below, the inclusion of poorly measured indicators of service availability can be very misleading.

Several measures of drug availability are reported in the survey; we focus on three drugs -- antibiotics, aspirin and quinine -- and whether they were in stock at the time of the survey. Drug stocks are very similar across sectors and about three quarters of clusters have access to each drug at any time. The facility survey also reports whether particular health services were available. About two thirds of communities have access to immunization services and about 60% have child birth and growth monitoring services. Whereas immunizations and child growth monitoring is significantly more common in urban areas, child birth facilities are slightly more common in the rural sector.

In conjunction with the household survey, a price survey was also conducted. Enumerators were instructed to visit local markets, purchase a range of standardized commodities and record the weight and cost. For each commodity, up to three prices are recorded. Cluster average prices are reported in the lower part of Table 1, panel A. Prices tend to be lower in the rural sector, particularly for those commodities which do not require much processing such as sugar (for which the urban price is nearly double the rural price), plantains and (unprocessed) manioc.

It is these detailed health facility and price data which will form the community covariates, z_c, in the regressions below. The CILSS also collects information on infrastructure in the community, but only in the rural sector;[12] since we wish to examine the entire country (and stratify the data in several different dimensions), we chose not to use these data.[13]

Individual and household characteristics

The characteristics of individual, z_i, and households, z_h, are drawn from the household survey. The CILSS is a broad purpose socio-economic survey which provides information on household composition and demographics, time use including labor supply, labor income and self-employment enterprises, non-labor income and asset ownership, commodity consumption and the health of each individual in the household. The breadth of the survey permits the inclusion of comprehensive controls for household resources: in both the child and adult anthropometry regressions, we include (the logarithm of) *per capita* expenditure[14] together with other indicators of human capital in the household.

All children under 12 years of age are included in our sample.[15] Since child height and weight are

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[12]Furthermore these data have been analyzed by Strauss (1990) using the first round of the CILSS.

[13]Experiments with the rural infrastructure data indicate our results are robust to their inclusion (where possible). Our experience has been that with these sorts of data, correlations across groups of characteristics (such as health services and availability of modern sewerage) tend to be quite small although intra-group correlations are typically quite high.

[14]Defined to include the value of all consumption expenditures and the imputed value of own consumption. Imputed rents are based on hedonic housing regressions controlling for selection of owner-occupiers. Lumpy expenditures (such as durable purchases and large expenditures on ceremonies or health case) are excluded.

[15]All households were visited by an anthropometrist twice within a fortnight. Those household members who were absent at the first visit were measured at the second visit. If data checks suggested a measurement from the first visit was unlikely, that person was re-measured, as were a random sub-sample of individuals. Nevertheless, for about 10% of the children included in the survey, we do not have valid height for age measures (either because they were not measured or because the recorded measurements are obviously wrong). Children included in the sample come from slightly higher income and better educated households: comparing the 500 excluded children with those in the sample we analyze, ℓnPCE is 11.68 and 11.77 respectively; the senior male in the household has 2.3 and 3.1 years of education respectively. Another 10% of children are excluded from the weight for height regressions (for the same reasons) and there are no differences in the household characteristics of those children included and

systematically related to age and gender, it makes sense to control for these characteristics. One strategy would be to include high order polynomials in age and gender in the regressions. We adopt a more parsimonious approach and relate each child's height and weight (conditional on height) to that of a well nourished United States child of the same age and gender (using the NCHS, 1976, tables). Relative to the US median, the average Ivorian child is about 97% as tall and has a mass, given height, of about 98%. Slightly less than 14% of Ivorian children are chronically malnourished (or stunted, height for age less than 90% of the US median) and about 5% are acutely malnourished (or wasted, with weight for height less than 80% of the US median). Urban children in Côte d'Ivoire tend to be taller, heavier given height, and are less likely to be stunted or wasted.

The household roster in the CILSS records the relation of each individual to the household head. About one quarter of the children in the sample are not children of the head or spouse; most of these children are other relatives of the head. Recent studies of child anthropometry have restricted the sample to those children for whom the parents' characteristics are reported (see Strauss, 1990; Sahn, 1990 on Côte d'Ivoire) in order to control for household background (Thomas, Strauss and Henriques, 1990). If we restrict the sample to those children for whom maternal characteristics are reported, we lose 17% of the children; requiring observations on paternal characteristics as well cuts the sample another 13%. Yet, it is these 30% of all children who may be the most vulnerable to price fluctuations and reduced social spending: we therefore prefer not to exclude them from our analysis. We choose, instead, to include the characteristics of the head and spouse as measures of household resources in the child anthropometry regressions.

If the head is male, we assign his characteristics to the *senior male*, and the characteristics of his spouse to the *senior female*. If the head is a woman, then her characteristics are assigned to the *senior female*. The education of the head and spouse are likely to affect resource availability, through their impact on the value of time, and also, possibly, through resource allocation decisions. About a fifth of senior women and almost twice that proportion of men are literate and men have spent about twice as long at school as women; these differences are even wider in the rural sector. The (standardized) height of the senior male and female are included as

excluded from this sample except that the excluded children tend to be slightly older.

controls for genetics, endowments and other background factors. Controls for the existence of a senior male and female in the household as well as whether the head is Ivorian are included.

Characteristics of adults aged 20 through 60 are included in the final panel of Table 1. Body mass index (measured in kilograms per meter^2) is, on average, 22 and is slightly higher in the urban sector; men have slightly lower BMIs. Households in the child sample tend to be early in the life cycle and thus have relatively young heads whereas those in the adult sample are later in the life-cycle: *per capita* expenditure is thus higher in the adult sample. Slightly less than half the sample is male, a third are heads of their own households, another third are spouses and almost three quarters are married. Urban residents are much better educated than their rural counterparts and, on average, men have received more than twice the education of women.

4. RESULTS

Estimates of the conditional anthropometric output functions [5] are presented in Tables 2 and 3 for child height for age and weight for height and in Tables 4 and 5 for adult body mass index. All these models include (the logarithm of) *per capita* expenditure which is treated as endogenous: instruments include (polynomials of) the value of land owned and livestock, financial and business assets.[16] Test statistics in the tables are based on heteroskedasticity consistent estimates of the variance-covariance matrix, [9], which permit intra-cluster correlations and take account of the endogeneity of *per capita* expenditure.

Child anthropometry

The community and household determinants of child height for age and weight for height are reported in Table 2 for all children in the sample and separately for those living in the rural and urban sector. In Table 3, the data have been stratified by age of the child (into two groups, less than three and older than three) and also by education of the head or spouse (again into two groups, households in which neither the head or spouse has any education and households in which either has some education).[17] The dependent variables have been standardized on age and gender and are expressed as z-scores.[18] Since the household determinants have been described elsewhere (Sahn, 1990; Strauss, 1990; Strauss and Mehra, 1990), we focus on the effects of community

[16]Over 50% of the variance of ℓnPCE is explained in the instrumenting equations for the whole country. In the child height for age regressions, reported in Table 2, for example, the R^2 is 0.54 for the entire country with an $F_{58,4180}$ of 94.7. Taken together, the identifying instruments are jointly significant ($F_{15,4180}$ = 17.8) with the value of land and livestock ($F_{6,4180}$ = 14.8) and financial assets ($F_{2,4180}$ = 35.4) being particularly important determinants of ℓnPCE. In the urban sector, the R^2 is also 0.54 ($F_{57,1977}$ = 44.2) and the value of financial assets is a key instrument ($F_{2,1977}$ = 50.9). The regressions are not as good in the rural sector where only a third of the variation in ℓnPCE is explained by the covariates ($F_{56,2203}$ = 20.6) and, not surprisingly, the value of land and livestock are important determinants of household consumption ($F_{6,2203}$ = 11.0).

[17]Stratification on gender turns up little of interest; see Haddad and Hoddinott, 1991.

[18]The descriptions in the last section were based on percentages of US medians to be comparable with other studies (Waterlow *et al.*, 1977). In order to account for the fact that measures of both location and dispersion of child anthropometric outcomes vary with age and gender, we use z-scores, $(h - h_{med})/\sigma_h$, in the regressions.

Table 2

Community Determinants of Child Height for Age and Weight for Height

(z scores) *(children under 12)*	*Height for age* All	Urban	Rural	*Weight for height* All	Urban	Rural
Health services and facilities						
Health personnel (*10)						
# doctors, surgeons and dentists	0.757	0.592	-1.902	-0.339	-0.406	0.994
	[2.96]	[2.11]	[1.32]	[1.27]	[1.30]	[0.75]
# nurses, nursing staff	-0.121	-0.150	0.315	0.091	0.118	0.394
	[2.25]	[2.73]	[0.83]	[1.64]	[1.88]	[1.27]
# support staff	-0.029	-0.021	0.411	0.020	0.028	-0.322
	[1.07]	[0.75]	[1.82]	[0.72]	[0.88]	[1.90]
Infrastructure						
# usable beds (*100)	-0.286	-0.209	-1.984	-0.479	-0.151	0.117
	[1.77]	[0.99]	[3.06]	[3.34]	[0.73]	[0.24]
# working vehicles	0.010	0.042	-0.087	0.001	-0.009	0.062
	[0.72]	[2.72]	[1.41]	[0.04]	[0.60]	[1.31]
Drug availability: (1) if						
antibiotics in stock	0.236	0.268	0.236	0.111	0.221	0.052
	[3.23]	[2.85]	[1.28]	[1.72]	[2.52]	[0.38]
aspirin in stock	-0.032	0.057	-0.175	0.033	0.156	-0.188
	[0.39]	[0.49]	[1.16]	[0.44]	[1.48]	[1.45]
quinine in stock	0.093	-0.194	0.291	-0.005	-0.018	-0.013
	[1.31]	[1.82]	[2.17]	[0.07]	[0.18]	[0.13]
Services: (1) if available						
immunizations	0.209	-0.124	0.258	-0.010	0.037	0.010
	[2.94]	[1.05]	[2.48]	[0.16]	[0.31]	[0.12]
child birth services	0.039	0.278	-0.023	-0.119	-0.242	-0.272
	[0.54]	[2.34]	[0.19]	[1.82]	[2.09]	[2.75]
growth monitoring pgm	-0.110	-0.164	-0.000	-0.009	0.023	0.090
	[1.67]	[1.73]	[0.00]	[0.14]	[0.25]	[0.98]
Community prices						
beef with bones	0.074	-0.967	0.518	-0.132	-0.107	-0.570
	[0.25]	[2.02]	[1.20]	[0.52]	[0.23]	[1.74]
fresh fish	-0.411	0.076	-0.406	-0.495	0.566	-0.981
	[1.68]	[0.18]	[1.03]	[2.68]	[1.42]	[3.57]
rice (imported)	0.108	-0.279	-0.037	-0.841	-1.813	-0.643
	[0.29]	[0.49]	[0.06]	[2.75]	[3.72]	[1.47]
palm oil	0.127	0.054	-0.140	-0.524	-0.252	-1.954
	[0.99]	[0.35]	[0.38]	[4.42]	[1.71]	[6.09]
eggs (chicken)	0.373	1.222	-0.014	-0.281	-0.276	-0.612
	[1.85]	[2.81]	[0.05]	[2.03]	[0.79]	[3.45]
sugar	-0.045	-0.204	-0.516	-0.104	-0.251	0.518
	[0.76]	[2.83]	[1.33]	[1.74]	[3.86]	[1.62]
plantains	0.116	-2.052	0.517	-0.425	-1.305	0.175
	[0.45]	[4.12]	[1.62]	[1.87]	[2.31]	[0.67]
manioc (unprocessed)	0.806	2.018	0.244	-1.005	0.124	-4.659
	[1.93]	[3.59]	[0.23]	[2.54]	[0.24]	[5.92]
Wald test statistics for joint significance						
Health facilities: personnel	14.28	14.06	12.51	6.93	9.65	4.81
	[0.00]	[0.00]	[0.01]	[0.07]	[0.02]	[0.19]
drug availability	18.87	10.65	18.60	4.17	9.73	2.28
	[0.00]	[0.01]	[0.00]	[0.24]	[0.02]	[0.52]
services	11.05	10.32	7.12	4.29	4.47	7.82
	[0.01]	[0.02]	[0.07]	[0.23]	[0.21]	[0.05]
all health characs	54.59	42.48	42.16	30.43	21.38	22.41
	[0.00]	[0.00]	[0.00]	[0.00]	[0.03]	[0.02]
Prices	14.71	36.55	11.15	90.48	71.52	111.70
	[0.06]	[0.00]	[0.19]	[0.00]	[0.00]	[0.00]

Table 2 (continued)

Household Determinants of Child Height for Age and Weight for Height

(z scores)	*Height for age* All	Urban	Rural	*Weight for height* All	Urban	Rural
ln(per capita expenditure)	0.294	0.613	0.127	0.207	0.075	0.317
	[1.17]	[2.53]	[0.44]	[1.12]	[0.29]	[1.71]
Standardized height						
senior female	0.122	0.103	0.153	-0.037	-0.047	-0.050
	[4.19]	[2.27]	[4.00]	[1.57]	[1.26]	[1.75]
senior male	0.133	0.087	0.165	-0.013	0.006	0.003
	[4.82]	[1.94]	[4.53]	[0.60]	[0.16]	[0.11]
Education						
senior female:	0.217	0.316	0.282	0.013	-0.150	0.354
(1) can write sentence	[1.14]	[1.33]	[0.86]	[0.07]	[0.60]	[1.42]
years of education	-0.032	-0.061	0.081	0.010	0.052	-0.141
	[0.74]	[1.15]	[0.88]	[0.23]	[0.91]	[1.99]
years education**2	-0.001	-0.001	-0.018	0.001	-0.001	0.011
	[0.30]	[0.21]	[1.98]	[0.40]	[0.25]	[1.38]
senior male:	0.316	0.460	0.330	-0.237	-0.121	-0.139
(1) can write sentence	[1.98]	[2.44]	[1.07]	[1.86]	[0.80]	[0.55]
years of education	-0.108	-0.119	-0.158	0.032	0.034	-0.013
	[3.01]	[2.90]	[1.99]	[1.07]	[0.98]	[0.21]
years education**2	0.007	0.007	0.012	-0.002	-0.002	0.001
	[3.51]	[3.19]	[2.05]	[1.13]	[1.14]	[0.13]
Household composition						
(1) senior female exists	0.131	-0.052	0.755	0.036	0.069	-0.069
	[0.62]	[0.19]	[2.51]	[0.22]	[0.30]	[0.32]
(1) senior male exists	0.280	0.066	0.634	-0.014	-0.024	-0.183
	[2.26]	[0.43]	[2.87]	[0.13]	[0.17]	[1.05]
(1) head of hh Ivorian	0.112	-0.256	0.402	0.206	0.318	-0.045
	[1.27]	[2.08]	[2.96]	[2.79]	[2.93]	[0.41]
Child characteristics						
(1) child of head	-0.078	-0.157	0.007	0.242	0.187	0.209
	[1.22]	[1.69]	[0.08]	[4.90]	[2.34]	[3.32]
(1) male	-0.080	-0.121	-0.032	-0.089	-0.115	-0.087
	[1.56]	[1.64]	[0.44]	[2.03]	[1.61]	[1.57]
Wald test statistics for joint signficance						
Education of senior female (include can write)	2.96 [0.40]	6.17 [0.10]	6.31 [0.10]	3.08 [0.38]	2.48 [0.48]	4.14 [0.25]
(years of education only)	2.86 [0.24]	6.10 [0.05]	5.57 [0.06]	1.22 [0.54]	1.63 [0.44]	4.13 [0.13]
Education of senior male (include can write)	12.68 [0.01]	10.48 [0.01]	5.49 [0.14]	4.73 [0.19]	1.41 [0.70]	3.63 [0.30]
(years of education only)	12.39 [0.00]	10.17 [0.01]	4.36 [0.11]	1.30 [0.52]	1.30 [0.52]	0.06 [0.97]
F(all covariates)	8.22 [0.00]	5.17 [0.00]	5.00 [0.00]	7.32 [0.00]	3.83 [0.00]	7.78 [0.00]
LM test statistics						
Heteroskedasticity	117.03 [0.00]	67.76 [0.01]	70.82 [0.00]	69.22 [0.01]	34.64 [0.84]	52.53 [0.03]
Block effects	34.88 [0.00]	4.42 [0.04]	0.36 [0.55]	327.41 [0.00]	56.75 [0.00]	101.15 [0.00]
Number of observations	4180	1977	2203	3726	1752	1974

Notes:

See text for definition of covariates; regressions include 9 age dummies and dummies for location of household in Abidjan and in rural sector. lnPCE treated as endogenous; identifying instruments are measures of household assets and non-labor income. Health services and community prices measured at cluster level. Variance covariance matrices estimated by infinitesimal jackknife accounting for block structure of community data. Wald and LM test statistics are χ^2. Degrees of freedom for Wald tests equal number of covariates included in test; LM test for heteroskedasticity has dof equal number of covariates in regression (=45 in first and fourth columns); block effects LM test has 1 dof. [t statistics] below coefficient estimates; [p values] below test statistics.

characteristics; the impact of household characteristics are reported only in Table 2 (although the same covariates are included in the regressions reported in Table 3).

The assumption of homoskedasticity is rejected in all regressions in Table 2 except weight for height in the urban sector. In the subsidiary regression of squared standardized residuals on all covariates (Breusch and Pagan, 1983), it turns out that the only consistently significant covariates are the child age dummies (suggesting that the z-score standardizations are not fully capturing heterogeneity in dispersion across age groups). The assumption that ρ is zero is also rejected in all but one case (height for age in the rural sector). Apparently it is prudent to take account of both block effects and heteroskedasticity in these models; a comparison of alternative estimators is presented in Appendix 1.

Health services and facilities

We discuss first the health facility characteristics which, taken together explain a significant proportion of the variance in both child anthropometric outcomes, in rural areas, urban areas and in the country as a whole. Health personnel characteristics are significantly associated with child height but not with weight for height. Children tend to be taller in communities with more doctors (in the urban sector and in the country as a whole), but facilities with more nurses tend to be associated with shorter children. This could reflect quality of services in dimensions we cannot measure: those facilities with more doctors may provide better services, perhaps because of better equipment and infrastructure within the facility. We also find that the number of working vehicles is positively associated with child health (at least height in the urban sector).

On the other hand, communities with larger facilities tend to be associated with less healthy children: weight for height is significantly negatively correlated with the number of useable beds as is height for age, especially in the rural sector. This correlation may be due to public policy decisions to locate larger facilities in areas which need them most (Rosenzweig and Wolpin, 1986).

Recall that because of the detail of the health facility survey, our measures of health services probably better reflect what is actually available in the community than what is recorded as supposed to be available. Does this distinction make any difference? In theory, if the services that are actually available are measured with random error by the services that are supposed to be available, then invoking a standard errors-in-variables argument, their estimated impacts should be smaller.

Replacing the health personnel and infrastructure characteristics with what is supposed to be available in the height regressions in Table 2, then we find that the impact of the number of nurses hardly changes (in the urban sector and whole country.)[19] In the urban sector and whole country regressions, however, the estimated effects of doctors on child height are reduced to half their value in Table 2 and also become insignificant; in the rural sector, the impact of doctors switches from negative (and insignificant) to positive (and insignificant). The effect of vehicles is also cut in half (in urban Côte d'Ivoire) and switches sign in the rural sector. The (absolute value of the) impact on child height of the number of beds collapses to about a quarter of its value in Table 2 and turns insignificant in the rural sector; the estimated effect switches sign in the urban sector (and for the whole country).

In Côte d'Ivoire, there is a divergence between health services that are supposed to be available and those that are actually available. Apparently, failure to take account of this fact when evaluating the returns to public investments is likely to result in severely misleading conclusions.

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Effect of different measures of health services on child height for age

	All			*Urban*			*Rural*		
	(1)	*(2)*	*[se]*	*(1)*	*(2)*	*[se]*	*(1)*	*(2)*	*[se]*
#doctors	0.76*	0.34	[0.26]	0.59*	0.31	[0.28]	-1.90	1.98	[1.44]
#nurses	-0.12*	-0.12*	[0.05]	-0.15*	-0.14*	[0.05]	0.32	-0.16	[0.38]
#support	-0.03	-0.02	[0.03]	-0.02	-0.03	[0.03]	0.41	-0.15	[0.23]
*#beds(*100)*	-0.29	0.02	[0.16]	-0.21	0.11	[0.21]	-1.98*	-0.49	[0.65]
*#vehs(*10)*	0.10	0.22	[0.14]	0.42*	0.23	[0.15]	-0.87	0.45	[0.62]

Specification (1) includes those services that are *supposed* to be available in the community; specification (2) is based on services *actually* available (and is reported in Table 2). Both specifications include all other covariates in Table 2. Standard errors in both specifications are similar: only the standard errors associated with specification (2) are reported. Asterisks denote significance (at 5% size of test). See Table 2 for more detail.

The availability of drugs in the community has a positive effect on child height (in both the rural and urban sector) and also on weight for height (in the urban sector). The availability of antibiotics (in the urban sector) and quinine (in the rural sector) are individually significant although it seems likely that these are only indicative of an entire package of drugs being available in the facility. The effect of having all three drugs in stock is both statistically significant ($\chi_3^2 = 18.9$) and quite substantial. For the country as a whole, the z-score of a child's height in a community where all three drugs are available would be about 0.3 higher than, *ceteris paribus*, the height of a child where none of the drugs is in stock: this would reduce the deficit in height of the average Ivorian child, relative to a US child, by over a third. Ensuring facilities have a stock of basic drugs is likely to realize a substantial return in terms of improved child health.

The availability of immunizations, child birth services and child growth monitoring programs (which typically incorporate a nutrition education component) are also associated with taller children. Immunizations are especially important in the rural sector (where just over half the communities have these services) whereas child birth services are more important in the urban sector. Weight for height, in contrast, is negatively correlated with the availability of child birth services (in both the urban and rural sector) although this negative correlation is significant only for infants and babies, and not older children (Table 3).

The availability of immunizations, of drugs (particularly antibiotics and possibly quinine) and the number of doctors in the community have a significantly positive impact on the height of only older children (three years or more). The presence of growth monitoring programs appears to be negatively correlated with their height and positively, but not significantly, correlated with the length of infants and babies. Larger facilities are associated with shorter infants and babies (but older children near large facilities and those with more doctors tend to be lighter, given height). Taking all the health facility characteristics together, they affect the height only of older children but the weight for height of both infants and older children seems to respond to changes in these services.

It is also of interest to determine whether a reduction in social service expenditures is likely to have a bigger effect on children from poorer households. Simply stratifying on household expenditure, which is

Table 3: Community Determinants of Height for Age and Weight for Height by Age of Child and Level of Education of Head or Spouse in Household

	Height for age				*Weight for height*			
	Age of child (in months)		**Education of head or spouse**		**Age of child (in months)**		**Education of head or spouse**	
	0-35	**36-143**	**none**	**some**	**0-35**	**36-143**	**none**	**some**
Health services and facilities								
Health personnel: (*10)								
# doctors, surgeons & dentists	-0.330	1.247*	1.529	0.255*	0.500	-0.741*	-0.432	-0.150
	[0.56]	[4.63]	[3.19]	[0.83]	[1.18]	[2.33]	[1.22]	[0.41]
# nurses, nursing staff	-0.217	-0.106	-0.300	-0.082*	0.167	0.072	0.048	0.135
	[1.45]	[1.89]	[3.21]	[1.15]	[1.16]	[1.39]	[0.53]	[1.98]
# support staff	0.043	-0.047	-0.015	-0.027	0.011	0.015	0.083	-0.013
	[0.59]	[1.69]	[0.30]	[0.78]	[0.16]	[0.56]	[1.80]	[0.35]
Infrastructure:								
# usable beds (*100)	-0.925	-0.071*	-0.423	-0.094	-0.304	-0.577	-0.675	-0.519
	[2.10]	[0.44]	[1.68]	[0.37]	[0.80]	[4.27]	[3.33]	[2.29]
# working vehicles	0.018	0.011	-0.027	0.047*	-0.024	0.014	0.046	-0.036*
	[0.49]	[0.71]	[1.10]	[2.41]	[0.79]	[1.04]	[2.07]	[2.29]
Drug availability: (1) if								
antibiotics in stock	0.102	0.269	0.237	0.225	0.257	0.068	0.047	0.252
	[0.57]	[3.42]	[2.26]	[1.93]	[1.67]	[1.09]	[0.56]	[2.32]
aspirin in stock	0.216	-0.100	-0.038	-0.013	-0.045	0.062	-0.049	0.106
	[1.10]	[1.11]	[0.34]	[0.08]	[0.28]	[0.83]	[0.48]	[0.90]
quinine in stock	0.035	0.131	0.200	-0.063	-0.097	0.033	0.088	-0.220*
	[0.19]	[1.77]	[2.20]	[0.50]	[0.69]	[0.52]	[1.16]	[2.09]
Services: (1) if available								
immunizations	0.228	0.182	0.379	0.003*	0.171	-0.085	-0.101	0.022
	[1.28]	[2.44]	[4.02]	[0.02]	[1.22]	[1.37]	[1.31]	[0.18]
child birth services	0.088	0.029	-0.162	0.291*	-0.316	-0.029	-0.049	-0.248
	[0.47]	[0.40]	[1.55]	[2.51]	[2.06]	[0.47]	[0.58]	[2.48]
growth monitoring	0.207	-0.213*	-0.009	-0.116	-0.242	0.083*	-0.030	0.074
	[1.18]	[3.18]	[0.09]	[1.11]	[1.76]	[1.35]	[0.37]	[0.79]
Community prices								
beef with bones	0.218	0.091	0.141	-0.256	0.233	-0.334	-0.335	-0.274
	[0.30]	[0.29]	[0.41]	[0.56]	[0.45]	[1.33]	[1.13]	[0.65]
fresh fish	0.526	-0.763*	-0.181	-0.585	-0.799	-0.356	-0.944	-0.030*
	[0.91]	[2.99]	[0.60]	[1.36]	[2.21]	[1.85]	[3.74]	[0.11]
rice (imported)	-0.405	0.288	-0.160	-0.480	-0.795	-0.817	-0.748	-1.540
	[0.48]	[0.69]	[0.31]	[0.79]	[1.30]	[2.64]	[2.01]	[2.98]
palm oil	1.024	-0.114*	0.238	-0.073	-0.887	-0.441	-0.693	-0.396
	[3.49]	[0.81]	[1.58]	[0.33]	[3.47]	[3.70]	[4.78]	[2.14]
eggs (chicken)	0.671	0.260	0.592	0.415	0.002	-0.383	-0.568	-0.148
	[1.25]	[1.28]	[2.37]	[1.05]	[0.01]	[3.02]	[3.70]	[0.55]
sugar	-0.246	0.010	-0.055	-0.091	0.081	-0.155	-0.150	-0.188
	[1.56]	[0.17]	[0.40]	[1.22]	[0.62]	[2.56]	[1.54]	[2.61]
plantains	-1.423	0.480*	0.484	-1.345*	0.431	-0.650	-0.211	-0.655
	[1.99]	[1.84]	[1.60]	[2.08]	[0.68]	[3.04]	[0.83]	[1.34]
manioc (unprocessed)	1.662	0.476	0.532	1.454	-1.402	-0.772	-1.481	-0.102
	[1.42]	[1.09]	[0.71]	[2.46]	[1.57]	[2.06]	[2.15]	[0.20]
Test statistics								
χ^2 Wald tests for joint significance:								
Health facilities: personnel	4.02	23.81	17.44	4.92	8.60	5.64	8.46	4.77
	[0.26]	[0.00]	[0.00]	[0.18]	[0.04]	[0.13]	[0.04]	[0.19]
drug availability	2.56	24.16	18.48	3.96	2.81	4.12	2.26	6.85
	[0.47]	[0.00]	[0.00]	[0.27]	[0.42]	[0.25]	[0.52]	[0.08]
services	6.87	14.41	17.01	8.28	11.78	3.04	3.84	6.48
	[0.08]	[0.00]	[0.00]	[0.04]	[0.01]	[0.39]	[0.28]	[0.09]
all health characteristics	17.99	65.52	53.16	23.90	24.90	39.54	31.01	32.88
	[0.08]	[0.00]	[0.00]	[0.01]	[0.01]	[0.00]	[0.00]	[0.00]
Prices	20.44	15.88	15.62	12.73	30.21	101.58	65.32	54.02
	[0.01]	[0.04]	[0.05]	[0.12]	[0.00]	[0.00]	[0.00]	[0.00]
F(all covariates)	3.74	7.18	6.05	4.27	3.36	7.13	7.31	3.71
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
χ^2 LM(block effects)	2.50	23.62	3.18	6.60	4.70	10.03	1.94	4.82
	[0.11]	[0.00]	[0.07]	[0.01]	[0.03]	[0.00]	[0.16]	[0.03]
χ^2 LM(heteroskedasticity)	33.14	59.69	84.92	52.19	27.26	37.98	78.66	28.31
	[0.73]	[0.02]	[0.00]	[0.21]	[0.92]	[0.52]	[0.00]	[0.98]
Number of observations	1098	3082	2470	1710	1082	2644	2212	1514

Notes:

See Table 2. All regressions include same household and child covariates as in Table 2 (except education and age dummies appropriately redefined for each sample). If either head or spouse has any education, then child included in "some" regression, otherwise included in "none" regression. * denotes significant difference in pairs of estimates.

endogenous, complicates interpretation;[20] instead we stratify on the education of household members (which is, itself, a good predictor of long run resource availability). The sample is split into two groups: those in which either the head or spouse has at least some education (about 40% of the sample) and those with neither having any schooling. Household *per capita* expenditure is around CFAF 184,000 and 100,000 for the two groups, respectively. For the sake of brevity, we will refer to the latter as poorer households although we recognize that education does not only affect household income but may also be related to the gathering and processing of information related to child-rearing and health care practices (Thomas, Strauss and Henriques, 1991).

On the one hand, more operational vehicles and the availability of child birth services have a positive impact on the height only of children in less poor households. On the other hand, more doctors and fewer nurses only affect the heights of only children in poorer households. These results are quite difficult to interpret and they may reflect (unobserved) heterogeneity in both the availability and quality of services.

Less ambiguous, however, is the fact that immunizations have a significant impact only on the heights of poorer children and that these effects are significantly larger than they are on less poor children. Similarly, the availability of drugs (in particular antibiotics and quinine) has a signficantly positive impact only on children from poorer households. The provision of these very basic services will not only have a positive effect on the health of children in Côte d'Ivoire but will have the biggest effect on those who are worst off. For example, the z-score of the height of a child in a household with neither head or spouse educated will, on average, be 0.8 higher if there is an adequate supply of drugs and immunizations are accessible than if none of these services is provided; this is a big difference and more than offsets the difference between the average child in Côte d'Ivoire and United States. If distributional issues are of concern in the formulation of public policy, then these results suggest that investing in basic health services will realize a substantial pay-off.

[20]Including interactions among all covariates and household expenditures results in problems with multicollinearity.

Local market prices

In general, the availability and quality of health infrastructure has a larger effect on height for age, a longer run measure of health status. A shorter run measure of child health, weight for height, on the other hand, is very responsive to price variation, whereas height for age is little affected by prices especially in the rural sector. There are also striking differences in the impact of prices across sectors.

Weight for height is negatively affected by the prices of fresh fish, eggs, palm oil and manioc in the rural sector and the whole country but in the urban sector it is the prices of rice, sugar and plantains which are negatively associated with weight for height. Furthermore, price elasticities are larger in the rural sector (greater than unity for fish, palm oil and manioc) than in the urban sector (where the elasticity for sugar and plantains is close to 0.5). Prices (individually or jointly) have no significant impact on the height for age of rural children but in the urban sector, prices of plantains and beef have a negative effect on height for age whereas higher manioc and egg prices are associated with *taller* children.

The weight for height of babies and infants is somewhat protected from price rises since these effects tend to be more negative on older children (except for fish and palm oil which are the only commodity prices which significantly reduce the mass, given length, of young children). In contrast, all but beef and fish prices have a significantly negative impact on the weight for height of children aged 3 and older. Price rises also tend to have an (absolutely) larger impact on the weight for height of children in poorer households (those with neither the head or spouse educated): this is true for palm oil, eggs, manioc and, especially, fish. Stabilization programs which induce increases in food prices are likely, therefore, to have a deleterious impact on child weight for height with older children and possibly those from poorer households being the most vulnerable.

Household characteristics

The household determinants of child height for age and weight for height using the first two waves of the CILSS have been described elsewhere (see footnote 7); we thus discuss these results only briefly. Household resources (ℓnPCE) have a positive impact on child health but this is significant only in the case of height for age among urban children. The heights of the senior male and female in the household also have a positive impact on child height (but not weight) reflecting both genetic and family background influences. Few women in Côte d'Ivoire have much education and child health is unrelated to the level of education of the senior female in the household. The education of the senior male does affect child height (but not weight for height) and, again, these effects are significant only in the urban sector. If the senior male is literate (can write a simple sentence) then child height is significantly greater but additional years of education are associated with *lower* height (until 8 years of schooling which accounts for about half the sample). A literate male with five years of schooling (the average) would, nevertheless, tend to have taller children in his household relative to an illiterate head with no education.

About 75% of the sample are children of the head: there is very little evidence suggesting that they receive preferential treatment in resource allocation. On average, their height for age is no different from other children but sons of the head are significantly taller than other boys in the household. While children of the head tend to be heavier, given height, than other children, this pattern is reversed among older children; this might be, perhaps, because these older children provide labor services to the household which seeks to maintain them in good health (see Ainsworth, 1989, for a discussion of child fostering practices in Côte d'Ivoire). The height of the senior male and female in the household has a slightly bigger effect on the height of their own children but the impact remains significant on all other children. Either those children who are not direct descendants of the head and spouse are quite closely related or the height of senior household members reflects more than just genotype influences. Among the prices and health facility services, only the availability of drugs (in particular antibiotics) has a significantly different effect on children of the head, relative to others, with the impact being bigger on the height for age of those who are not sons or daughters of the head.

Adult anthropometry

The individual, household and community determinants of (the logarithm of) adult body mass index are reported in Table 4 for all (measured) adults aged 20 through 60, for males and females separately and for urban and rural dwellers separately. Regressions stratifying on both gender and sector are presented in Table 5.[21]

The measures of availability and quality of health services in the community used in the child regressions have no impact (individually or jointly) on the body mass index of adults in Côte d'Ivoire; local market prices, on the other hand, do significantly affect adult health outcomes. We report regressions, therefore, excluding health facility characteristics.[22]

In general, higher food prices are associated with lower BMI of adults and these effects are strongest among rural dwellers: for example, doubling beef and fish prices in rural areas is likely to reduce adult BMI by 10 to 20% there. The impact of increasing the price of eggs and manioc will be even larger (with elasticities around 0.80) and falls mainly on the shoulders of men. The most dramatic effects, however, are in the price of plantains which reduce the BMI of urban women and rural men (with elasticities of 1.0 and 0.7 respectively). Stabilization programs which involve large increases in prices are likely to have a substantial impact on the health of both adults and children in Côte d'Ivoire and these effects are not uniformly distributed across the population.

We turn next to the role of individual and household characteristics. The impact of household *per capita* expenditure and an individual's years of education are not, in general, linear: both are permitted to be quadratic. Overall, adult BMI is positively associated with PCE which, recall, is treated as endogenous. It should not,

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[21]Of all adults in this age group who were enumerated in the CILSS, 14% are excluded from the sample because either height or weight is missing. There are no systematic differences by gender or household *per capita* expenditure between those included in our sample and those excluded. Almost all heads (96%) and 90% of their spouses are included in our sample; bmi is missing, however, for about a quarter of their children. Those excluded are thus younger, they are more likely to live in urban areas and are, therefore, slightly better educated.

[22]Some of the health service indicators are clearly child specific (availability of immunizations) and so should not directly affect adult health; we have experimented with other indicators of health infrastructure and found little of interest.

Table 4: Determinants of Adult (log) Body Mass Index

*ℓn(BMI)*100*	*All*	*Male*	*Female*	*Urban*	*Rural*
Community prices					
beef with bones	-6.016	1.445	-16.163	-2.330	-9.384
	[1.90]	[0.38]	[3.38]	[0.46]	[3.27]
fresh fish	-5.361	-6.536	-5.786	0.957	-6.705
	[3.08]	[2.78]	[2.16]	[0.25]	[3.90]
rice (imported)	5.976	13.745	-3.745	13.667	-8.944
	[1.14]	[1.63]	[0.62]	[1.49]	[2.05]
palm oil	-0.941	-2.129	-1.114	0.624	-4.470
	[0.69]	[1.20]	[0.56]	[0.41]	[1.72]
eggs (chicken)	-6.402	-7.417	-5.470	-15.538	-3.095
	[2.18]	[1.86]	[1.28]	[1.71]	[2.07]
sugar	-0.428	-0.013	-0.744	-0.788	-1.303
	[0.76]	[0.02]	[1.09]	[1.45]	[0.41]
plantains	-4.317	-4.651	-3.098	-9.927	-3.102
	[2.05]	[1.41]	[1.20]	[1.96]	[1.48]
manioc (unprocessed)	-9.446	-18.968	2.768	-11.758	-12.435
	[1.60]	[1.81]	[0.49]	[1.24]	[2.21]
Household characteristics					
ℓn(per capita expenditure)	-27.149	-39.641	47.088	17.084	64.190
	[0.74]	[0.78]	[1.02]	[0.40]	[1.39]
ℓn(per capita expendit)**2	1.451	1.761	-1.477	-0.320	-2.481
	[0.96]	[0.84]	[0.78]	[0.18]	[1.25]
Education: years	0.670	0.268	0.913	0.684	0.375
	[3.05]	[0.96]	[2.58]	[2.50]	[1.18]
years**2	-0.061	-0.007	-0.089	-0.050	-0.035
	[2.97]	[0.24]	[2.70]	[2.35]	[1.04]
(1) male	-2.638	.	.	-4.872	0.282
	[3.08]			[3.78]	[0.30]
(1) head of household	-0.496	-1.407	2.129	0.497	-1.500
	[0.48]	[1.13]	[1.06]	[0.34]	[1.21]
(1) spouse of head	-1.674	.	-1.120	1.405	-2.657
	[1.73]		[0.91]	[0.86]	[2.41]
(1) Ivorian	-1.108	-0.121	-2.751	-1.767	-0.267
	[1.44]	[0.12]	[2.32]	[1.61]	[0.27]
(1) married	3.552	3.945	3.229	2.389	2.452
	[4.03]	[3.42]	[2.19]	[1.86]	[2.55]
(1) if Abidjan	-0.853	1.360	-2.035	-1.028	.
	[0.64]	[0.74]	[1.12]	[0.84]	
(1) if rural	-3.002	-1.836	-2.884	.	.
	[3.27]	[1.77]	[1.98]		
Constant	427.725	511.456	-15.281	133.582	-72.798
	[1.97]	[1.70]	[0.06]	[0.51]	[0.27]
Test statistics:					
F(all covariates)	16.48	6.35	13.62	8.31	5.85
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
χ^2 Wald tests: Prices	34.25	20.25	25.18	16.76	51.56
	[0.00]	[0.01]	[0.00]	[0.03]	[0.00]
ℓnPCE	26.94	4.24	20.54	28.19	15.72
	[0.00]	[0.12]	[0.00]	[0.00]	[0.00]
Education	9.70	3.87	7.65	6.37	1.44
	[0.01]	[0.14]	[0.02]	[0.04]	[0.49]
χ^2 LM(block effects)	29.62	3.10	41.35	0.26	38.81
χ^2 LM(heteroskedasticity)	34.44	28.29	35.25	21.99	23.21
Number of observations	3710	1678	2032	1836	1874

Notes:
See Table 2. Dependent variable is log(body mass index)*100 of all measured adults between 20 and 60 years of age. Covariates include 6 age dummies.

Table 5: Determinants of Adult (log) Body Mass Index by Sector and Gender

*ln(BMI)*100*	*Urban*		*Rural*	
	Male	*Female*	*Male*	*Female*
Community prices				
beef with bones	0.990	-6.109	-5.599	-12.181
	[0.13]	[0.89]	[1.63]	[2.88]
fresh fish	-3.664	3.716	-8.651	-5.817
	[0.58]	[0.78]	[3.77]	[2.21]
rice (imported)	27.194	0.853	-3.342	-11.285
	[1.69]	[0.10]	[0.70]	[1.70]
palm oil	-1.251	2.312	-3.482	-5.538
	[0.60]	[1.13]	[1.01]	[1.52]
eggs (chicken)	-11.886	-20.238	-4.003	-2.195
	[1.04]	[1.39]	[2.28]	[0.93]
sugar	-0.116	-1.583	0.375	-2.241
	[0.14]	[2.15]	[0.08]	[0.52]
plantains	-4.131	-13.470	-7.434	1.131
	[0.55]	[2.12]	[2.42]	[0.44]
manioc (unprocessed)	-26.746	2.296	-10.627	-12.996
	[1.58]	[0.32]	[1.48]	[1.63]
Household characteristics				
ℓn(per capita expenditure)	-93.479	88.330	132.180	-22.149
	[1.34]	[2.04]	[2.53]	[0.31]
ℓn(per capita expenditure)**2	4.089	-3.257	-5.477	1.302
	[1.45]	[1.86]	[2.47]	[0.43]
Education: years	0.359	1.352	0.343	-0.083
	[0.97]	[3.44]	[1.02]	[0.10]
years**2	-0.029	-0.094	-0.027	0.035
	[0.98]	[3.15]	[0.79]	[0.33]
(1) head of household	-3.650	5.133	-1.637	-1.721
	[1.57]	[2.25]	[1.09]	[0.55]
(1) spouse of head	.	1.861	.	-1.477
		[0.99]		[1.09]
(1) Ivorian	0.282	-3.831	-0.032	-1.278
	[0.20]	[2.42]	[0.03]	[0.85]
(1) married	5.513	2.954	2.668	0.616
	[2.37]	[1.44]	[2.18]	[0.41]
Test statistics:				
F(all covariates)	4.32	5.92	2.89	3.62
	[0.00]	[0.00]	[0.00]	[0.00]
χ^2 Wald tests: Prices	9.37	12.07	38.42	21.55
	[0.31]	[0.15]	[0.00]	[0.01]
ℓnPCE	12.36	20.60	9.81	9.93
	[0.00]	[0.00]	[0.01]	[0.01]
Education	0.99	11.97	1.21	0.53
	[0.61]	[0.00]	[0.55]	[0.77]
χ^2 LM(block effects)	3.78	4.14	6.16	14.02
	[0.00]	[0.04]	[0.01]	[0.00]
χ^2 LM(heteroskedasticity)	16.44	26.45	17.07	16.76
	[0.69]	[0.19]	[0.58]	[0.67]
Number of observations	884	952	794	1080

Notes:

See Table 2. Dependent variable is log(body mass index)*100 of all measured adults between 20 and 60 years of age. Covariates include 6 age dummies.

therefore, reflect reverse causality of health status on current earnings and income, at least to the extent that the instruments are uncorrelated with current productivity. Distinguishing urban from rural dwellers, the positive effect of PCE is also apparent although not at an increasing rate. The impact of PCE on adult BMI is, however, different for men and women. The relationship is positive for all women (although it is convex in urban areas and concave in rural areas) and the elasticity (at the mean) is around 0.10 (being 0.09 for rural women and 0.11 for urban dwellers): increasing household resources is likely to be associated with substantial improvements in the health of women (a result also noted in Alderman, 1989). For men in the bottom third of the PCE distribution, higher PCE is associated with *lower* BMI but this turns out to be a function of the specification: when rural and urban men are separated, the returns to PCE are positive for all (but 5%) of those in the urban sector and also for those in the bottom 8 deciles of PCE in the rural sector. The elasticity for men, however, is much smaller than it is for women (being 0.01 in the rural sector and 0.04 in the urban sector) suggesting that men's health would be less affected by declines in household income.

Over and above household resources, education has little impact on body mass index, except in the case of urban females.[23] For the approximately 25% of women with more than 7 years of education, BMI declines with schooling and increases for those with less schooling. Dropping household resources from the regressions, then education has a positive impact on the BMI of all urban males, all but about 15% of urban women, all rural women but still has no significant impact on the body mass index of rural men.

Conditional on household resources and human capital, men tend to be significantly lighter, given height, as do rural dwellers. Married people, on the other hand, tend to be heavier. Stratifying individuals into those who have no education and those who have been to school, we find no evidence that there are significant differences in the impact of prices and household resources on the BMI of these two groups.

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[23]Literacy is excluded from the regressions as it has no independent impact on bmis.

5. CONCLUSIONS

Examination of the determinants of individual anthropometric outcomes using the CILSS suggests an important role for public policy in affecting the health of Ivorians, especially children. Our results also indicate some of the dilemmas governments are likely to face as they design stabilization and price reform policies.

Increasing food prices to be in line with world prices may lead to more efficient resource allocation within the economy. Higher food prices should also be associated with higher incomes, at least among those rural households who are net food producers although these benefits may only be realized in the longer run. In the shorter run, then, higher food prices are likely to have a detrimental impact on the health of Ivorians as measured by weight for height among children (especially those aged 3 and older) and body mass index among adults. Higher income, on the other hand, is associated with better health of both adults and children although the magnitude of the income effects are small except for adult women. Thus, very large increases in income will be needed to offset the negative effects of higher food prices at least in the case of child health.

If reductions in social spending result in lower availability of health care services, then child health (particularly height for age) is likely to be adversely affected. The provision of basic services (such as immunizations) and ensuring facilities are equipped with simple materials (such as having basic drugs in stock) will probably yield high social returns in terms of improved child health.

Our analysis has relied heavily on the fact that we have had access to very detailed information on the characteristics of the local community, such as the level of health services *actually available*. Without this detail, some of our inferences would have been severely misleading. It would appear that amassing this kind of detailed information will substantially aid the design of good public policy.

APPENDIX

Appendix Table 1 reports the quasi t-statistics calculated using three estimators. The first is the usual 2sls estimate, ignoring intra-cluster correlations and heteroskedasticity. The second is [9], a generalization of the infinitesimal jackknife that permits equi-correlated disturbances within clusters. Although this estimator is consistent in the presence of heteroskedasticity, it is not robust to influential observations (Efron, 1982) and, in fact, it performs poorly in the presence of leverage observations. The third estimator is the jackknife which is a resampling type estimator of the leave-one-out form (Tukey, 1958). In a linear regression model, the jackknife estimate of variance is easy to calculate and involves simply re-defining ε in [8] as the residual divided by the diagonal element of the hat matrix together with adding another term in the middle bracket of [8] (MacKinnon and White, 1983).

The results in the Appendix Table correspond with the height for age and weight for height regressions for the whole country, reported in columns 1 and 4 of Table 2, respectively. The second and fifth columns in the Appendix Table are exactly the same numbers reported in Table 2.

The 2sls estimates differ from the other two estimates in several cases: failing to take account of either block effects or heteroskedasticity can result in misleading inferences. For example, in the weight for height regressions, according to the 2sls estimates, the impact of doctors is significant but that estimate of the quasi-t statistic is about 60% higher than the estimate using [9]. Based on the latter estimate, the number of doctors *does not* have a significant impact on child weight for height. The 2sls estimates are particularly poor for quasi-t statistics on the estimated age effects and are about 20-40% bigger than those based on [9].

In contrast, the jackknife and block effects/heteroskedasticity consistent estimates are remarkably similar, although not identical. This turns out to be generally true across all the models estimated in this paper. A similar result is reported in Thomas (1991) for a different model and data. It appears that the jackknife may be a rather good estimator of variance in a fairly broad range of regression models.

Appendix Table 1
Comparison of Estimators of Variance

		Height for age			Weight for height		
		2sls	Block/ Heterosk	Jack-knife	2sls	Block/ Heterosk	Jack-knife
Health services and facilities							
Personnel:	# doctors, surgeons etc	3.757	2.960	2.973	2.021	1.273	1.372
	# nurses, nursing staff	1.990	2.247	2.233	1.796	1.640	1.710
	# support staff	1.031	1.072	1.067	0.865	0.725	0.744
Infrastructure:	# useable beds	1.642	1.769	1.749	3.356	3.336	3.504
	# working vehicles	0.662	0.723	0.721	0.043	0.039	0.046
Drug availability:	(1) if anitbiotics in stock	3.074	3.227	3.208	1.753	1.716	1.834
	aspirin in stock	0.355	0.388	0.384	0.444	0.441	0.481
	quinine in stock	1.205	1.312	1.307	0.073	0.074	0.080
Services:	(1) if immunisations available	2.765	2.935	2.918	0.166	0.160	0.180
	child birth services	0.538	0.544	0.540	1.989	1.822	2.016
	growth monitoring program	1.555	1.666	1.653	0.148	0.141	0.157
Community prices:							
beef with bones		0.245	0.248	0.246	0.527	0.520	0.554
fresh fish		1.896	1.682	1.672	2.791	2.678	2.901
rice (imported)		0.268	0.295	0.291	2.508	2.751	2.871
palm oil		0.924	0.988	0.977	4.620	4.421	4.887
eggs (chicken)		2.130	1.853	1.832	1.975	2.035	2.022
sugar (granulated)		0.764	0.764	0.754	2.125	1.740	1.935
plantains		0.483	0.452	0.453	2.042	1.869	1.887
manioc (unprocessed)		1.792	1.935	1.906	2.666	2.535	2.747
Household characteristics:							
ℓn(per capita expenditure)		1.223	1.166	1.152	1.034	1.116	1.128
Standardised **height** of	senior female	4.193	4.193	4.169	1.543	1.574	1.609
	senior male	4.928	4.821	4.797	0.567	0.597	0.595
Education: senior female	(1) literate	1.072	1.137	1.124	0.075	0.066	0.066
	years educ	0.702	0.738	0.723	0.276	0.235	0.229
	years **2	0.295	0.303	0.293	0.520	0.402	0.382
senior male	(1) literate	1.943	1.981	1.952	1.746	1.857	1.833
	years educ	2.897	3.008	2.962	1.018	1.066	1.039
	years **2	3.366	3.510	3.445	1.153	1.134	1.100
Composition:	(1) senior female exists	0.505	0.615	0.600	0.165	0.222	0.220
	(1) senior male exists	2.077	2.262	2.235	0.125	0.131	0.131
	(1) head of hh Ivorian	1.338	1.268	1.262	3.004	2.789	2.885
Child chars:	(1) child of head	1.218	1.224	1.212	4.529	4.899	4.898
	(1) male	1.545	1.556	1.537	2.037	2.030	2.002
	(1) aged 6-11 months	5.414	4.277	4.219	5.112	3.709	3.695
	(1) aged 12-17 months	5.434	3.860	3.811	4.912	3.433	3.423
	(1) aged 18-23 months	10.523	7.870	7.792	7.758	5.485	5.475
	(1) aged 24-35 months	9.464	7.262	7.188	3.471	2.582	2.596
	(1) aged 36-47 months	10.302	7.987	7.885	2.604	1.995	1.996
	(1) aged 48-59 months	8.818	6.932	6.846	2.812	2.157	2.159
	(1) aged 60-83 months	8.562	6.593	6.519	4.293	3.125	3.129
	(1) aged 84-107 months	6.741	5.214	5.152	4.817	3.574	3.604
	(1) aged 108-143 months	7.922	6.042	5.966	4.123	3.099	3.121
Location:	(1) if Abidjan	0.022	0.024	0.023	1.455	1.333	1.413
	(1) if rural	0.331	0.338	0.335	1.177	1.257	1.325
Constant		1.429	1.377	1.360	0.163	0.184	0.186

Notes:

2sls is usual estimate of variance; block/heterosk is heteoskedasticity consistent estimate which permits equi-correlations within clusters (equation [8] in the text). Regressions are for the whole country; coefficient estimates are reported in columns 1 and 4 of Table 2.

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