ECONOMIC CRISES, HEALTH AND EDUCATION IN JAMAICA*

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Resumen: Estudiamos el impacto de fluctuaciones de crecimiento económico sobre indicadores de educación y salud en Jamaica. Instrumentamos las fluctuaciones de crecimiento con variaciones en las principales exportaciones del país, en regresiones cuasi-panel basadas en encuestas de hogar entre 1989 y 2007. El principal resultado es que las fluctuaciones en el PIB tienen diferentes efectos en la educación y la salud.

Abstract: We study the impact of growth fluctuation on education and health indicators in Jamaica. Using household surveys between 1989 and 2007, we study the impact by using pseudo-panel regressions at the parish level, instrumenting growth fluctuations with variations in major Jamaican export commodities, to account for the endogeneity of growth in its relationship with education and health indicators. The main finding of the instrumental variable regression is that GDP fluctuation has mixed impacts on education and health.

Clasificación JEL/JEL Classification: I32, O15, O54

Palabras clave/keywords: Jamaica, crisis económica, desarrollo humano, educación, salud, economic crisis, human development, education, health.

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1. Overview

The world economy observed a severe deterioration in 2008 and 2009. Although the speed of the deterioration decreased in late 2009, the impact and the legacy of this deterioration are still to be determined. Since less developed economies are often the last ones to recover from a crisis, low and middle-income countries might suffer from this crisis for a longer time. In this regard, the economic crisis that originated with the advanced economies draws deep concerns about low- and middle-income countries' achievement of the Millennium Development Goals (MDGs) set by United Nations member states (UN, 2009), especially in health and education of the poor.[1]

The literature on the relationship between health and education indicators and economic development is diverse. Many studies, such as Cutler, Deaton and Lleras (2006), Preston (2007), Jamison, Jamison and Hanushek (2007), show that economic development has a close positive link with human development indicators, including health and education attainment. On the other hand, Granados and Ionides (2008) and Ranis and Stewart (2005) suggest that the relation reverses in developed countries. Deaton (2006, 2007) concludes that the exact relationship is difficult to determine because of the interaction effect of institutions and human development stages.

Still, there are some projections on education indicators. Developing countries have made significant improvement in education outcomes, but the current global economic downturn threatens this progress by reducing the ability of both households and governments to invest in education (World Bank, 2009b: 1). Although empirical results are mixed, several studies indicate that the negative impact of a crisis is likely to be concentrated in poor countries and households (World Bank, 2009b: 9). The progress toward MDG 2, to achieve universal primary education, has happened too slowly and too unevenly (UN, 2009: 15).

Health outcomes and health financing are affected by economic crises in more complicated ways. In many countries health conditions deteriorate during crises, although the result is sensitive to policy measures applied to mitigate the effect of crises (World Bank, 2009b: 19). Responses from governments and international bodies will be important to protect the vulnerable from the economic downturn.

This paper aims to study the impact of past economic crises on the wellbeing of people in Jamaica. We study the Jamaican economy

[1] See MDG website for details. [http://www.undp.org/mdg/].

and its correlation with human development, to shed light on the feasibility and policy implications for the MDGs. We measure the impact of aggregate income fluctuations on human development indicators, in particular, child health and education indicators.

Previous studies on the impact of aggregate shocks on education and health reveal that the impact of an aggregate shock often depends on the level of development of an economy (see Ferreira and Schady 2008, for an overview). For high-income economies, income shocks often have positive effects on health, while they have negative ones for low-income economies (*e.g.* Arbache and Page, 2007). The impact on middle-income economies is ambiguous. The effects of aggregate shocks on education are less clear-cut.

Since Jamaica is an upper middle-income economy, previous studies provide little guidance as to what effect the current economic crisis will have on education and health outcomes. We provide some evidence on the relationship between aggregate income and education and health in Jamaica. These first estimates indicate that primary education enrollment suffers during a crisis, while attendance increases. The effects on health are ambiguous. Nevertheless, since the current crisis is different from those of the past, it is difficult to ascertain whether its impact will be similar to that of past crises.

This paper is organized as follows: Section 2 describes the Jamaican economy and section 3 illustrates the statistics of education and health in Jamaica. Section 4 describes our econometric model and section 5 shows the results of the econometric analysis. Section 6 concludes the paper.

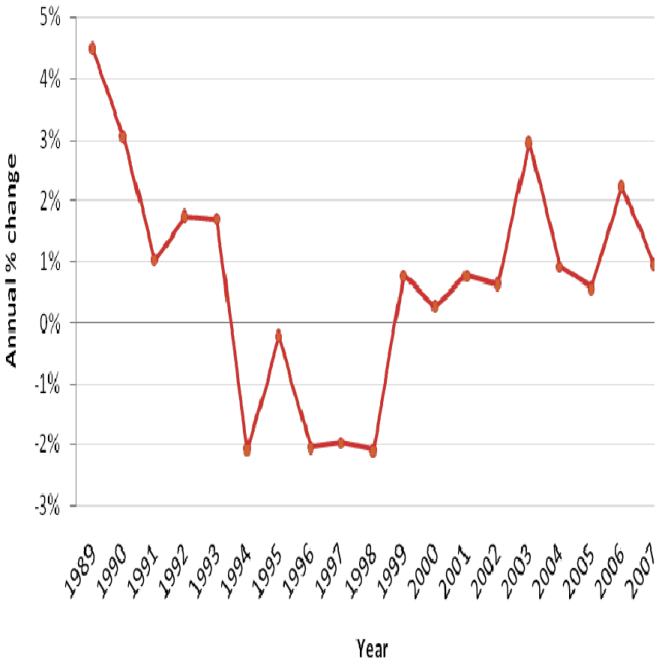
2. The Jamaican Economy

Jamaica has had a poor growth experience during the 1990s and the beginning of the 21st century. In figure 1, we plot the growth rates of GDP per capita in Jamaica (IMF, 2009).[2] The growth rate has been low and unstable throughout the period. Sustainable growth has been

[2] Calculations of GDP in Jamaica vary, due among other things to its large informal sector and services-oriented economy (World Bank, 2004). This leads to important discrepancies between the GDP data reported by the Central Bank of Jamaica, in its statistical digest; the IMF, in its *World Economic Outlook*; and the World Bank's *World Development Indicators* (WDI). We use IMF indicators throughout due to the availability of forecasts from this source. Major discrepancies with the WDI growth data arise for years 1991 and 1992, as well as 2007. In other years, values are similar.

the major topic in the research and policy dialogue in Jamaica (World Bank, 2004; Thomas, 2004).

Figure 1
GDP Per Capita Annual Growth in Jamaica
1989-2007



Source: IMF (2009).

Two crises can be identified in the recent history of Jamaica. The first one is 1991-1992, an inflation crisis. In those years, inflation was above 50% (see table 1). The Jamaican economy has experienced small but positive growth since 1985, through restructuring of the economy combined with substantial trade liberalization and deregulation. Sudden export increases and capital inflows led to a peak in inflation, which in turn increased poverty substantially.

The second crisis took place in the period of 1995-1997, a financial crisis. Jamaica was hit by one of the largest financial crises

(World Bank, 2004). The financial liberalization during the 1980s had been unaccompanied by adequate regulation, which turned into a spiral of debt caused by uncreditworthy parties. In response to the crisis, the Jamaican government bailed-out these credits at the cost of high government debt (150% of GDP by 2002/2003). It also improved its financial supervisory institutions substantially, creating bank and financial supervisory agencies (Kirkpatrick and Tennant, 2002).

Poverty (displayed in table 1 and defined as the percentage of individuals below the nationally defined poverty line) has decreased since 1992. It experienced a substantial increase in 1991 and 1992 during the inflation crisis. Thereafter, it has consistently declined, despite the financial crisis during the mid-1990s.

To support the poor Jamaica has a wide social safety net (Handa, 2004), with a variety of programs ranging from income support programs, such as food stamps, to employment programs, such as "Lift Up Jamaica". During the years from 1994 to 1998, 18% to 24% of government spending has been dedicated to social services, although the increasing costs of debt management are a potential danger for social spending.

Table 1
Overview of Indicators 1988-2007

Year	*GDP per capita growth*	*Inflation (year average)*	*Headcount Poverty Index (% of population)*	*Unemployment rate*
1988	-0.05	8.20		18.9
1989	0.04	16.12	30.4	16.8
1990	0.03	24.78	28.4	15.71
1991	0.01	68.60	44.6	15.37
1992	0.02	57.50	33.9	15.73
1993	0.02	24.31	24.4	16.31
1994	-0.02	35.10	22.8	15.34
1995	0.00	19.91	27.5	16.24
1996	-0.02	26.41	26.1	16.01
1997	-0.02	9.66	19.9	16.48
1998	-0.02	8.63	15.9	15.5
1999	0.01	5.98	16.9	15.66
2000	0.00	8.14	18.7	15.54

Table 1
(*continued)*

Year	*GDP per capita growth*	*Inflation (year average)*	*Headcount Poverty Index (% of population)*	*Unemployment rate*
2001	0.01	6.88	16.9	14.96
2002	0.01	6.99	19.7	15.12
2003	0.03	10.14	19.1	11.73
2004	0.01	13.52	16.9	11.44
2005	0.01	15.10	14.8	10.9
2006	0.02	8.52		9.6
2007	0.01	9.31		9.44

Sources: GDP per capita and inflation rate data are from the IMF (2009). Poverty rate data is from the World Bank (2004), PIOJ (2005). Unemployment data is from World Bank (2009a).

Unemployment rates have been persistently high during most of the 1990s. However, in the last few years there has been a decline to levels below 10%. One of the groups most vulnerable to unemployment is the out-of-school youth, aged between 14-19, and young adults, aged 20-24 (Handa, 2004). Their unemployment rate is substantially higher than the average unemployment rate. For example, in 2001, while the average unemployment rate was 17%, youth unemployment was 33% (World Bank, 2009a). The most recent estimate of youth unemployment, from 2004, stands at 28.1%.

The World Bank (2004) identified several key constraints on Jamaican growth and development:

• The large government debt, which reached 150% of GDP in 2002/2003. This debt is crowding out investment, as well as the productive expenses of the government;

• Pervasive and high crime, which deters business and tourism, and poses huge costs on society (at least of 4% of GDP);

• Education is still poor, due to the low quality of many schools and to the large drop out rate of poorer students during secondary education;

• Lack of access to credit for the private sector, in particular of affordable sources of capital for small businesses and entrepreneurs;

• The decrease in competitiveness, due to the appreciation of the exchange rate which decreases exports.

3. Trends in Education and Health in Jamaica

Jamaica has achieved full enrollment to primary education, reaching levels of 100% enrollment in 2007, calculated from *Jamaican Survey of Living Condition*, SLC, (2007). Enrollment in secondary education is almost as high for its first three years, grades seven to nine, reaching a level of 98% in 2007. Enrollment in grades 10 and 11 has traditionally been much lower, below 90% before 2007, when it reached a level of 93.5%.

Over time, we find that overall enrollment in primary and grades seven to nine is above 99% and 98%, respectively, for years 1998-2007, as shown in table 2. On the other hand, enrollment in grades 10 to 11 is substantially lower, at 86%. At this level of secondary schooling, the differences in enrollment between the highest and the lowest quintiles of the population become also larger. The enrollment rate for those in the lowest quintile is 81%, while that of those in the highest quintile is 92%. As noted in Davis (2004), the low level of enrollment in the second half of secondary education is one of the main weaknesses of the education system in Jamaica.

Several characteristics of the education system are worth noting. Public schools have no fees during primary education and low fees during secondary education. However, families face other costs to schooling, in particular food (which represent 40% of non-tuition costs) and transportation (Handa, 2004). The Jamaican government finances the School Feeding Program, which partly and, sometimes fully, subsidizes the cost of warm meals and snacks. One of the problems of this program is that there is a social stigma attached to participating in it.

The main problem of the Jamaican education system is the quality. World Bank (2004) reports important deficiencies in the achievements of students during primary and secondary education. Their performance in national tests is low and it is also lower than those of other Caribbean countries in the Caribbean Secondary Education Certification Examination (World Bank 2004, figure 5.7).

A simple observation in table 2 suggests mixed impacts of the crises on enrollment. We see that enrollment in primary school, while always above 98%, often decreases during an economic crisis. On the other hand, enrollment in secondary school, both for grades seven

to nine and 10 to 11, often increases during crisis periods. If we compare the reactions of the lowest and highest quintile to the two crisis periods, we find no substantial differences.

Impacts of the crises on attendance look similar. Attendance is measured as the ratio of days that a child was sent to school within a school week (5 days). In table 2 we see that attendance has gradually increased over time, often more so during crisis periods. Interestingly, the impact of crises on attendance is similar across the different levels of schooling considered and is significant for the 1991-1992 crisis, while it is not for the 1995-1997 one.

On our attendance variable, we note that questions on attendance are different in different years in the household survey, the *Jamaican Survey of Living Condition*.[3] At the beginning of the period, it asked how many days the child was sent to school in the last five days/week. Later on the question is rephrased to how many days the child was sent to school in the past four weeks. In order to make these values comparable, in those years in which the question was asked for the past four weeks, the answer is divided by four. Then a ratio has been calculated dividing all answers by five, assigning any with a value higher than one (in some cases the child went to school six days a week or 21 days out of the last four weeks), a value of one. Given the different formulations of the question and the nature of the question, based on the recollection of a parent or relative, the variable might be subject to substantial measurement error.

We conduct a simple test to check if the changes in enrollment and attendance are statistically meaningful. We use a *t*-test which tests the difference in averages of two samples, assuming that the samples have unequal variances. It is also known as Welch's *t*-test and is used in McKenzie (2003). One main assumption is that samples are independent. This is of course not the case, but given the impossibility of matching individuals across long periods of time, it is a straightforward first test, which gives us an indication of how the overall statistics change in crisis periods, without controlling for other characteristics of households.

The *t*-test result confirms that each crisis has a different effect on subgroups of students. Overall enrollment in primary school was negatively affected by the crises of 1991-1992 and 1995-1997. Enrollment in secondary school was positively affected by the crises. Crises seem to increase the attendance to primary or secondary schools.

[3] We provide a more detailed description of this survey in the next section.

Table 2
Selected Education Indicators in Jamaica, 1989-2007

	Year					*T-test*[a]	
	1989	*1991*	*1993*	*1995*	*1998*	*1991*	*1995*
	1990	*1992*	*1994*	*1997*	*2007*[b]	*1992*	*1997*
Enrollment							
Primary							
all	.99	.98	.99	.99	.99	-2.67***	-1.89*
lowest quintile	.98	.98	.98	.99	.99	.12	-1.07
highest quintile	.98	.99	.99	.99	.99	.33	-1.10
Grades 7-9							
all	.97	.96	.96	.97	.98	-.99	2.12**
lowest quintile	.95	.96	.96	.97	.98	.71	.72
highest quintile	.96	.98	.96	.97	.98	.96	.53
Grades 10-11							
all	.75	.80	.80	.82	.86	2.445*	1.18
lowest quintile	.75	.74	.78	.77	.81	-.45	-.22
highest quintile	.87	.86	.82	.89	.91	-.15	1.66*
Attendance[c]							
Primary							
all	.82	.86	.91	.92	.92	3.74***	1.11
lowest quintile	.83	.87	.90	.92	.91	1.41	1.07
highest quintile	.81	.89	.93	.92	.93	2.60***	-0.72
Grades 7-9							
all	.82	.88	.92	.92	.92	3.67***	.40
lowest quintile	.83	.87	.90	.92	.91	1.33	.96
highest quintile	.85	.92	.94	.92	.94	1.72*	.87
Grades 10-11							
all	.88	.91	.94	.94	.94	1.67*	.27
lowest quintile	.88	.94	.94	.96	.95	1.68*	.99
highest quintile	.86	.90	.95	.95	.95	.74	-.14

Notes: [a]Welch unpaired *t*-test; [b]Data 1998 to 2004 for quintiles; [c]Attendance information not available for 1990, 1992, 2003 and 2005.

Regarding health, Jamaica has been successful in dealing with most child diseases (Handa, 2000). Immunization rates of children

aged 0-5, for measles and Bacillus Calmette-Guérin (BCG) are high, above 80% in 2007 (calculated from SLC, 2007). The Pan American Health Organization (2007) reports that between 2001 and 2005 there were no cases of measles, polio, diphtheria, rubella or neonatal tetanus. The main health problems of Jamaica are closer to those of developed countries, like hypertension, heart disease, etc. But HIV/AIDS has been spreading throughout the country in recent years.

In our study of the impact of the crisis, we focus on two immunization variables, measles and BCG, the rate of child diarrhea and illness frequency for all age groups. The illness rate excludes injuries and accidents, focusing only on health problems. These questions were asked in the same way all years, except 2004 and 2007, where the question on measles was on how many doses were administered instead of whether the child had been immunized or not. The World Bank also calculated Body Mass Index values for 10 years out of the 20 year period and included them in the datasets. We have also examined these in our study.

In table 3, we see different impacts of the two crises on immunization. While measles immunization increased during the inflation crisis in 1991-1992, it decreased during the 1995-1997 crisis, especially for those in the lowest quintile. On the other hand, BCG immunization increased during both crises. Regarding child diarrhea, we observe an increase in both the lowest and highest quintiles, but not overall, during the inflation crisis in 1991-1992. This does not appear to be the case for the financial crisis in 1995-1997.

The impact of crises on illness seems to be larger and have opposite signs. We find a significant decrease in the illness rates of the overall population during both crises. Since health indicators are likely to be affected immediately by the households' and government's responses to the economic conditions, the simple comparison of averages might not be able to reveal the underlying correlations.

Table 3
Selected Health Indicators in Jamaica, 1989-2007

	Year					*T-test*[a]	
	1989	*1991*	*1993*	*1995*	*1998*	*1991*	*1995*
	1990	*1992*	*1994*	*1997*	*2007*[b]	*1992*	*1997*
Child health							
Measles							
all	.79	.86	.81	.79	.79	5.88***	-1.84*

Table 3
(*continued*)

	Year					*T-test*[a]	
	1989	*1991*	*1993*	*1995*	*1998*	*1991*	*1995*
	1990	*1992*	*1994*	*1997*	*2007*	*1992*	*1997*
lowest quint.	.81	.86	.84	.78	.82	2.25**	- 2.31**
highest quint.	.79	.90	.81	.79	.78	3.82***	-.78
BCG							
all	.94	.97	.93	.95	.97	4.26***	1.79*
lowest quint.	.95	.96	.93	.96	.96	.46	2.18**
highest quint.	.95	1.00	.93	.93	.97	2.53**	.15
Child diarrhea							
all	.06	.07	.06	.06	.05	1.47	.87
lowest quint.	0.06	0.10	0.05	0.05	0.04	2.20**	0.20
highest quint.	0.04	0.08	0.04	0.06	0.05	2.42**	1.52
Adult health							
Illness							
all	0.15	0.11	0.12	0.09	0.11	-13.10***	- 7.52***
lowest quint.	0.11	0.10	0.11	0.09	0.11	-2.25**	-3.69**
highest quint.	0.15	0.11	0.11	0.09	0.09	- 6.78***	-2.05*

Notes: [a]Welch unpaired *t*-test; [b]Data 1998 to 2004 for quintiles.

In sum, a simple comparison of the averages of the indicators suggests that economic crises do have impacts on health and education. In the next section, we present a simple model which examines the impact of the aggregate income changes on health and education and conduct more rigorous statistical analyses by using econometric techniques to investigate the fluctuation of growth rates and their impact on education and health.

4. Econometric Model and Data

Ferreira and Schady (2008) present a simple model regarding the effect of aggregate shocks on education and child health decisions. In the case of education, a negative income shock has two effects: an income and a substitution effect. Through the income effect, demand

for education within the household decreases as there is a higher need for income from labor. However, the relatively worse situation in the labor market makes education less costly and therefore can increase its demand. Which of these two effects dominates depends on several factors, the initial level of income, the degree of development of credit markets, the magnitude and expected duration of the shock, and public spending.

Regarding the demand for health, the effect of an aggregate income shock can have three channels: first, through expenditures on health, second, through the time dedicated to health-promoting activities and, third, through changes in public expenditures. A negative income shock might reduce expenditures on health and thus worsen health outcomes, but the lower opportunity cost of time and potential increases in government expenditures might compensate this.

For both cases, we can write a reduced form equation for health and education outcomes, which is a function of aggregate income, as well as other household characteristics.

$$E_{jt} = F(y_{jt},\ z_{jt})$$

$$H_{jt} = F(y_{jt},\ z_{jt})$$

E_{jt} and H_{jt} correspond to education and health indicators, y_{jt} is income and z_{jt} is a vector of other characteristics for household j. The reduced form represents behavioral decisions at the household level. However, because we do not have reliable household level panel data, the equation can be aggregated up to the level of analysis (see appendix A). In this paper, we use the parish level data to get pseudo-panel data, thus, j represents parish j.

Previous empirical studies have found different effects of aggregate shocks in middle income countries. While aggregate shocks had negative effects on education outcomes in Costa Rica, they had positive impacts in Mexico, Brazil, Peru and Nicaragua (Ferreira and Schady, 2008). Similarly, for health, other studies find positive impacts of a crisis in Colombia, but negative ones in Mexico and Russia. Thus, there is no clear prediction as to what the effect of an aggregate shock will be on health and education in Jamaica.

The indicators we will focus on are slightly different than those in previous studies. First, we study both enrollment and attendance of primary and secondary school children aged between six and 17, and not the adult population. The advantage of using these two indicators

is that we can assess immediate and more 'long-term' reactions to aggregate impact. While attendance can be varied at an ongoing basis, enrollment is decided once a year and, thus, might show a later reaction to shocks compared to attendance. We study enrollment in primary school, enrollment in secondary school, grades seven to nine, and enrollment in secondary school, grades 10 to 11. Similarly, for attendance, we focus on attendance to primary school, attendance to secondary school, grades seven to nine and attendance to secondary school, grades 10 to 11.

Also, regarding our health indicators we focus on immunization rates (for measles and tuberculosis), child diarrhea and Body Mass Index, as well as the overall rate of illness in the population.

Our main data sources are the *Jamaican Survey of Living Conditions* (SLC) for education and health indicators as well as household characteristics. We have data from many rounds of the SLC from the years 1988 to 2007. Regarding aggregate income, we use mainly IMF data from the *World Economic Outlook*, using the growth in real GDP per capita.

The SLC is conducted yearly by the Statistical Institute of Jamaica (STATIN) and comprises data on households' health, education, expenditures, etc. This survey has a representative sample of the Jamaican population. The households in the survey are interviewed during three to four years, after which another representative sample is drawn. From the available SLC data, however, one cannot track households for three to four years, due to the mismatch in identification numbers throughout different years. Thus, while we have a pseudo-panel, we do not use household level data but aggregate to the parish level, such that the same unit/region can be followed over time. For all our analyses, we use weights when aggregating to take into account any possible bias due to non-responding households. For more detailed information on this survey, see World Bank (2002), which includes a detailed report on the data collection process.

Among the several potential household characteristics, we focus on the household size (*HHSIZE*), the education of the household head (*HHEDUCATION*), his or her marital status (*HHMARRIED*) and age (*HHAGE*). We use these variables to control for the demographic factors of households and potentially control for differences in preferences reflected in these characteristics. On the one hand, the education of the household head is often highly correlated with that of the children and is thus an important determinant of education decisions. On the other hand, the situation of the household head, whether he/she is married or not and his or her age, also potentially influence the edu-

cation and health outcome of the children, who might be more or less needed at home (Schultz, 2004: 208).

In the education equation, we also include the rate of children attending public schools, as compared to private, in the parish (*PUBLICSCHOOL*). This can be of importance since the costs of both schools are substantially different, especially in terms of tuition fees. We will not include government spending as this has experienced a more or less constant increase over the 1990s (Handa, 2004). However, one could potentially investigate further the potential effects of different government programs.

Since most human development variables could be non-stationary and we aim to focus on the impact of changes in aggregate income, we specify our model in terms of first differences.[4] We use the aggregate income variable, which is the growth rate of GDP per capita (equivalent to the difference in log GDP), because there is no reliable parish level aggregate income data available. Therefore, our specification for primary school enrollment can be specified as follows,

$$\begin{aligned}\Delta ENROLLMENTPRIMARY_{jt} = {} & \beta_0 + \beta_1 \Delta y_t + \beta_2 HHSIZE_{jt} \\ & + \beta_3 \Delta HHAGE_{jt} + \beta_4 \Delta HHMARRIED_{jt} \\ & + \beta_5 \Delta HHEDUCATION_{jt} + \beta_6 \Delta PUBLICSHOOL_{jt} + \Delta \epsilon_{jt}\end{aligned} \tag{1}$$

The same equation can be specified for all other education and health indicators. We will consider these variables at the parish level, j, for periods 1988-2007, subindexed by t.

Note that we use the growth rate of GDP, although we could alternatively use dummy variables for the two crises periods, discussed in section 2. However, using the growth rate allows us to examine the impact of GDP movements, both positive and negative, and evaluate how the magnitude of these movements affects education and health.

One important problem is the potential endogeneity of aggregate income against child education and health. Although we are focusing on children and not adults, and thus the risk of endogeneity is lower, it is still relevant in this context. Thus, we will use an instrumental variable estimation, replacing GDP growth with exogenous instruments as suggested in Wooldridge (2002). We use as an instrument the international price variation of four main export commodities of Jamaica

[4] We ran unit root tests on the original variables and first difference of those, and found no evidence that the first order difference series are non-stationary.

(sugar, banana, bauxite and alumina), in real terms and in terms of Jamaican Dollar (J$) per metric ton (see appendix B for detailed data source).[5]

The validity of the instrumental variable (IV) estimation hinges on two main assumptions: *i*) exogeneity of instruments with respect to dependant variable; and *ii*) relevance of the instruments (correlation with the instrumented variable). We conduct the Hansen *J*-test, which tests the exogeneity of the instrument, and the Stock and Yogo (2002) weak instruments test, which tests the relevance of instruments.

Potentially, changes in income affect different population groups differently. For example, one can hypothesize that poorer households suffer more from income shocks due to their limited access to credit.[6] Thus, equation (1) could be limited to the lowest and highest consumption quintiles, or we could add interaction terms of the growth rates and area dummy variables, the results of which can be compared for rural and urban ones.[7]

5. Results of the Econometric Analysis

We display two tables, table 4 and table 5 for the education indicators, and two tables, table 6 and table 7, for the health indicators. Note that some years drop out of the regression if there is data missing for one or more variables. For the education indicators, several years are missing for the variable indicating the proportion of children attending public schools (*PUBLICSCHOOL*). This implies that the first years 1989, 1990 and 1991 drop out of the regression. We do not include 1988 as the questions regarding education were asked only for individuals aged three to 14.

In each table there are two different regressions. The first regression is a simple panel regression with fixed region effect. This method does not take into account the endogeneity of growth. The

[5] We used tourism travel receipts as another instrument, but the instrument failed to pass the validity tests. The results can be obtained from the authors.

[6] Ferreira and Schady (2008) point out that limited access to credit is a relevant determinant of the extent of the impact of economic shocks on educational choices. They argue that access to credit is less extensive in developing countries compared to developed ones and, therefore, the former might suffer more strongly from aggregate economic shocks.

[7] Regression results by income quintiles are not reported in this paper, but can be obtained from the authors.

second regression is a fixed-effect panel estimation with an instrumental variable (IV), using commodity prices as the instrumental variable for growth. We instrument growth with the growth rates of banana, sugar, bauxite and alumina prices in the world markets in J$ per metric ton and in real terms (see appendix B for details). All our IV regressions take into account the potential existence of heteroskedasticity in the error term.

There are several tests which are conducted to determine the validity and adequacy of the instruments we used. We report three tests.

First, the Hansen *J*-test, which is equivalent to the Sargan test for overidentifying restrictions, but is adjusted for our estimation with robust standard errors. The null hypothesis of these tests is that instruments are valid (the moment conditions of Generalized Method of Moments (GMM) are close to 0). A rejection of the null hypothesis indicates some problems with the instruments, although it is not clear which ones.

Second, the weak instrument test, which tests whether the instruments are correlated with the instrumented variables. This *F* statistic is to be compared to a set of critical values provided by Stock and Yogo (2002). The null hypothesis is that the instruments are weak, and this null is rejected if the critical value is larger than the *F*-statistic. Thus, the lower the *F*-statistic, the higher the probability that the test is rejected. There are two kinds of weak instrument tests performed and thus two critical values one can use. One test, called the relative bias test, has a critical value of 11.04 at a 5% maximal bias of the IV estimator relative to the OLS one. The other test, the IV size test, has a critical value of 16.87, at a 10% maximal size of a 5% Wald test of the estimated coefficient for the instrumented variable.

Third, the underidentification test indicates whether the instruments are correlated with the instrumented variables. The null hypothesis in this test is that the equation is not identified. In table 4, the results suggest that primary enrollment rates decrease after economic downturns. We find a small but significant effect of lagged growth (*lgrowthpc*) on current primary school enrollment. In the simple panel fixed-effect regression, the coefficient estimate for the lagged growth rate (.17) is positive and significant at 10% confidence level. In the IV estimation, the coefficient estimate (.26) is positive and significant when we use commodity prices as the instrument for growth. As we found earlier in the simple comparison of averages of enrollment rates, this is an indication that some households might postpone children's entry to primary school if affected by a macroeconomic shock.

Secondary school enrollment is negatively affected by the lagged growth rates, that is, when the growth rate in the previous period is low, then the enrollment in secondary school increases. The coefficient estimate for the lagged growth rate is -.42 and is significant in the simple panel regression. But it is not affected by growth rates once the growth rate is instrumented. The coefficient estimates for the lagged growth rate are not statistically significant in the IV estimation (.07). The effect is not significant for higher grades (10-11) in secondary schools.

Control variables do not seem to play a great role in determining enrollment rates. The coefficient estimates are not statistically significant in general. It is partly because, as we have seen in table 2, the enrollment is fairly high in Jamaica, and we are analyzing the changes of the variables in the regressions. Since the annual changes in the variables are small, the limited number of observations contributes to the low precision of the estimates. However, we find that the marital status of the household head (*dhhmarried*) and the rate of children attending public school (*dwpublicschool*) marginally affect enrollment during the 2nd phase of secondary school, grades 10-11. When the average share of two parent households increases, the enrollment in higher grades in secondary school decreases (coefficient estimates are -.35 in simple panel regression, and -.37 in IV regression). More students are enrolled in higher grades in secondary school when the percentage of public schools in the parish increases (.47 in simple panel, and .50 in IV).

Regarding the validity of our instrument, we find that the Hansen *J*-test overall cannot be rejected, which means that instruments are valid. For primary school enrollment, the test statistic (7.32) is rejected at a 5% confidence level, but is accepted at 1%. This seems to be caused by the price of alumina: if this price is excluded from the regression the Hansen *J*-test is not rejected at 1%. For the weak identification test, we use the IV size test that has a Stock and Yogo's critical value of 16.87. The instrument test statistics are lower than the critical value which means we have strong instruments. The underidentification test gives a similar result with a very low p value.

A lower growth rate is strongly associated with higher attendance. Table 5 suggests that attendance in primary school increases when the growth rate is low and the growth rate in the previous period is high. The coefficient estimate is -1.45 for current period growth and 1.40 for the lagged growth rate in the simple panel regression with fixed effect. They are both statistically significant at a 1% confidence level. The result is quite robust for different grades. The magnitude

of the effect of growth rates does not change much for grades seven to nine or grades 10 to 11.

Table 4

Panel Data Fixed Effects Regression Results for Enrollment Rates in Jamaica, 1992-2007

	Primary		*Secondary (7-9)*		*Secondary (10-11)*	
	Simple panel regression	*IV*	*Simple panel regression*	*IV*	*Simple panel regression*	*IV*
growthpc	-.12	-.058	.45	-1.26	-.31	.48
	(.112)	(.317)	(.281)	(.780)	(.910)	(2.596)
lgrowthpc	.17*	.26*	-.42*	.07	.47	1.89
	(.102)	(.159)	(.256)	(.438)	(.830)	(1.540)
dhhage	-.00	-.00	.00	-.00	-.00	-.00
	(.001)	(.001)	(.002)	(.002)	(.007)	(.008)
dwhhsize	-.00	-.00	-.00	.00	-.02	-.02
	(.003)	(.003)	(.007)	(.008)	(.022)	(.025)
dhhsex	.00	.00	-.00	-.02	.32	.31
	(.028)	(.031)	(.070)	(.091)	(.226)	(.285)
dhhmarried	-.00	-.00	-.09	-.06	-.35*	-.37**
	(.025)	(.023)	(.063)	(.081)	(.202)	(.190)
dhhyearsedu-cation	-.00	-.00	.00	.00	.02	.02
	(.002)	(.002)	(.006)	(.006)	(.020)	(.020)
dwpublic school	-.01	-.01	.08	.11	.47*	.50*
	(.031)	(.025)	(.079)	(.103)	(.254)	(.284)
Constant	.00		.00		.00	
	(.001)		(.004)		(.012)	
Observations	168	168	168	168	168	168
R-squared	.038	.027	.052	.19	.10	.066
Number of parish	14	14	14	14	14	14
Hansen J-statistic		7.32		1.26		1.30

Table 4
(*continued*)

	Primary		*Secondary (7-9)*		*Secondary (10-11)*	
	Simple panel regress.	*IV*	*Simple panel regress.*	*IV*	*Simple panel regress.*	*IV*
Hansen p-value		.02		.53		.52
Weak identification F-statistic		8.04		8.04		8.04
p-value underidentification test		6.65e-06		6.65e-06		6.65e-06

Note: Robust standard errors in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$; 1992 to 2007 excluding years 2003 and 2005.

However, the negative impact of the current growth rate disappears when the growth rate is instrumented by commodity prices. For primary school attendance, the coefficient estimate for the growth rate is 1.59 but it is not statistically different from zero. The same result applies for other grades. On the other hand, the positive impact of the lagged growth rate is still significant in IV estimations.

Note that the coefficient estimates for the share of public schools is negatively correlated with attendance rates in many cases. That is, the share of public schools has a different impact on the enrollment and attendance rates.

In short, the regression analysis reveals heterogeneous impacts of growth fluctuation on education indicators. Slow growth seems to lower the enrollment rate with a time lag in primary school, and this impact stays significant even when the endogeneity of the growth rate is controlled for by instrumental variables. On the other hand, the secondary school enrollment rate increases with low growth in the previous period, but this impact becomes not significant when the growth rate is instrumented. The attendance rate is strongly affected by the growth rate. In particular, current recession increases the attendance rate. But this correlation becomes insignificant when the growth rate is instrumented. The positive impact of a lagged growth

rate is significant, whether the endogeneity of growth is controlled for or not.

Table 5
Panel Data Fixed Effects Regression Results for Attendance Rates in Jamaica, 1992-2007

	Primary		*Secondary (7-9)*		*Secondary (10-11)*	
	Simple panel regression	*IV*	*Simple panel regression*	*IV*	*Simple panel regression*	*IV*
growthpc	-1.45***	1.59	-1.48***	-.21	-1.93***	.55
	(.506)	(1.933)	(.514)	(1.914)	(.574)	(2.071)
lgrowthpc	1.40***	1.66***	1.44***	1.83***	1.77***	2.32***
	(.412)	(.553)	(.419)	(.566)	(.467)	(.592)
dhhage	.00**	.01***	.01**	.01**	.01*	.01**
	(.004)	(.004)	(.004)	(.004)	(.004)	(.004)
dwhhsize	-.01	-.02*	-.01	-.02*	-.01	-.02
	(.013)	(.015)	(.013)	(.013)	(.014)	(.016)
dhhsex	.33***	.34*	.18	.18	.18	.18
	(.120)	(.199)	(.122)	(.124)	(.136)	(.197)
dhhmar-ried	-.09	-.12	-.03	-.04	.08	.05
	(.106)	(.090)	(.108)	(.113)	(.121)	(.109)
dhhyears education	.00	.01	.01	.02*	.00	.01
	(.011)	(.014)	(.011)	(.011)	(.012)	(.015)
dwpublic school	-.25*	-.25*	-.31**	-.30**	-.32**	-.32**
	(.137)	(.147)	(.140)	(.128)	(.156)	(.151)
Constant	-.00		-.00		-.00	
	(.007)		(.007)		(.008)	
Obser.	140	140	140	140	140	140
R-squar.	.023	.03	.22	.16	.23	.07
Num. of parish	14	14	14	14	14	14
Hansen J-statis.		13.45		13.61		9.92
Hansen p-value		.00120		.00111		.00701

Table 5
(*continued*)

	Primary		*Secondary (7-9)*		*Secondary (10-11)*	
	Simple panel regress.	*IV*	*Simple panel regress.*	*IV*	*Simple panel regress.*	*IV*
Weak identification F-statistic		4.05		4.05		4.05
p-value underidentification test		.0144		.0144		.0144

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; 1992 to 2007 excluding years 2003 and 2005.

The evidence on the impact of the growth fluctuation on immunization is also mixed. We use all the health and disease related indicators available in our data sets at the individual level.[8] Table 6 suggests that measles immunization is not affected by the growth rate. On BCG immunization, the growth rate in the current period has a negative impact on the share of children with immunization, while the lagged growth rate has a positive impact on the immunization. However, these impacts become statistically equal to zero when the growth rates are instrumented by commodity prices.

Among health indicators, the illness rate is weakly affected by the growth rates, as shown in table 7. In the simple panel regression with fixed effect, the coefficient estimate for growth rate (*growthpc*) is negative and the one for lagged growth (*lgrowthpc*) is positive. The result is almost the same for the IV estimation with the coefficient estimate for the current growth rate being -1.51 and statistically significant.

Child diarrhea is affected only by the lagged growth rate. The coefficient estimate for the growth rate is significant only for the lagged

[8] Since our data sets are derived from the Living Standard Measurement Surveys, the information on disease and illness is more limited than the information available in the Demographic and Health Surveys.

growth in the IV estimation (1.24). There is no evidence that BMI is affected by growth rates.

Table 6
Panel Data Fixed Effects Regression Results for Immunization in Jamaica, 1992-2007

	Measles immunization		*BCG immunization*	
	Simple panel regression	*IV*	*Simple panel regression*	*IV*
growthpc	-.39	3.47	-.98***	-.03
	(.691)	(2.159)	(.331)	(1.018)
lgrowthpc	.12	-.22	.55**	.76
	(.559)	(1.086)	(.268)	(.539)
dhhage	.00	.00	-.00	-.00
	(.005)	(.005)	(.002)	(.002)
dwhhsize	-.01	-.01	.00	.00
	(.017)	(.017)	(.008)	(.007)
dhhsex	.19	.18	-.03	-.04
	(.170)	(.185)	(.081)	(.088)
dhhmarried	-.22	-.13	.05	.09
	(.142)	(.162)	(.068)	(.065)
dhhyears education	-.01	-.01	-.01	-.00
	(.015)	(.018)	(.007)	(.008)
Constant	-.00		.00	
	(.009)		(.004)	
Observations	196	196	196	196
R-squared	.034	.211	.065	.035
Number of parish	14	14	14	14
Hansen J-statist.		1.613		4.24
Hansen p-value		.446		.120
Weak Identifica. F-statistic		11.74		11.74
p-value under identifica. test		8.04e-05		8.04e-05

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 7

Panel Data Fixed Effects Regression Results for Health Indicators in Jamaica, 1992-2007

	Illness rate		*Child diarrhea*		*Body Mass Index (BMI)*	
	Simple panel regres.	*IV*	*Simple panel regres.*	*IV*	*Simple panel regres.*	*IV*
growthpc	-.28	-1.51*	-.41	-1.10	9.82	-42.70
	(.300)	(.896)	(.441)	(1.357)	(25.834)	47.764
lgrowthpc	-.41*	-.41	.44	1.24**	-24.97	21.35
	(.243)	(.551)	(.357)	(.587)	(23.289)	31.849
dhhage	.00	.00	.00	.00	-.16	-.19
	(.002)	(.002)	(.003)	(.004)	(.200)	(.259)
dwhhsize	-.00	-.00	-.01	-.00	-.13	.18
	(.007)	(.008)	(.011)	(.013)	(.599)	(.524)
dhhsex	.13*	.14**	-.07	-.08	14.60**	12.29
	(.074)	(.068)	(.108)	(.113)	(6.980)	(10.790)
dhhmar-	-.01	-.05	.07	.09	-19.60***	-17.42**
ried	(.062)	(.080)	(.091)	(.111)	(6.596)	(8.861)
dhhyears	-.01**	-.01**	-.00	-.00	-.58	-.27
education	(.006)	(.006)	(.010)	(.011)	(.640)	(.961)
Constant	-.00		-.00		.59	
	(.004)		(.006)		(.382)	
Obser.	196	196	196	196	112	112
R-squar.	.06	.08	.02	.003	.14	.09
Num. of parish	14	14	14	14	14	14
Hansen J-statistic		16.59		.90		1.10
Hansen p-value		.00		.063		.057
Weak identifi. F-statistic		11.74		11.74		8.70

Table 7
(*continued*)

	Illness rate		*Child diarrhea*		*Body Mass Index (BMI)*	
	Simple panel regres.	*IV*	*Simple panel regres.*	*IV*	*Simple panel regres.*	*IV*
p-value under identifi. test		8.04e-05		8.04e-05		.000369

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; years 1992 to 2007, except BMI which runs from 1990 to 2000, excluding 1998 and 1999.

The results on health indicators suggest that it is very challenging to find the immediate link between economic growth and the health condition in statistical analyses. It is likely to be driven by the institutional factors in the health service industry, and the policy responses to reduce growth fluctuation. With this limitation, child diarrhea and illness rates, two of the health indicators which are less likely to be policy-sensitive, are weakly affected by growth rates.

6. Conclusion

The main finding of the statistical analysis is that GDP fluctuation has mixed impacts on education and health in Jamaica. Economic slowdowns tend to decrease enrollment in primary schools, but increase attendance for all grades, when the endogeneity of the growth rate is controlled for. Impacts on health indicators are also mixed, especially for the indicators that are affected by government responses, such as vaccination. However, we found that illness rates and child diarrhea rates increase during economic downturns.

Since the impact is not in one direction or of the same magnitude, policy responses to economic downturns should be carefully designed and packaged. For example, education policies should sustain both enrollment and attendance. In order to achieve this, not only must the incentive to keep children in school increase by providing government transfers, such as conditional cash transfer, but

the counter-incentive to send children to labor market must also decrease by, for instance, regulation on child labor and minimum wage for adults. Government policies on health service and programs will be effective in the aggregate when the policies are targeted to specific health condition and packaged together.

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Appendix A. Derivation of the Reduced Estimation Form

In this appendix, we describe the model and econometric approach aimed at estimating the effect of income and income shocks on human development indicators, in particular, health and education indicators. These indicators will be denoted throughout as h_{jt} and e_{jt}, where j is the subindex for a group (region or parish) and t is the subindex for time.

We start with a simplified model of decision-making at the household level, which relates health and education decisions to income. We then aggregate it to the group level and specify a reduced-form equation, which can be estimated.

In every moment t, the population is divided into J groups, indexed by j. Each of these groups contains N households, indexed by i. Each household maximizes utility, U_{it}, subject to its budget constraint. This implies,

$$\text{Max}(x_{it})U_{it} \text{ subject to } y_{it} \leq c_{it}$$

where x_{it} are the decision variables of the household, y_{it} the current income of the household and c_{it} the household's current expenditure. Among its several decision variables (x_{it}), we study education and health choices for the children in the household. Thus, we can write e_{it} and h_{it} as follows

$$e_{it} = f(y_{it}, z_{it})$$

$$h_{it} = g(y_{it}, z_{it})$$

where z_{it} is a vector of individual characteristics (for example, household size, age of the household head, etc.). We construct mean education indicators at the group level, that is:

$$e_{jt} = F(y_{it}, z_{it})$$

The aggregate function F can depend in many ways on income and other individual characteristics. In order to estimate such a relationship, we need to make strong simplifying assumptions. In this study, we will assume that mean income and the mean of other individual characteristics characterize the relationship with mean education (or health) indicators fully.[9] Thus, we can write mean education as

[9] One could also add their standard deviations. This is left for future analyses.

$$e_{jt} = F(y_{jt}, z_{jt})$$

Using a first order Taylor expansion we obtain,

$$e_{jt} - e_{jt-1} \cong \beta_1(y_{jt} - y_{jt-1}) + \beta_2(z_{jt} - z_{jt-1})$$

where β_1 corresponds to the partial derivative of F with respect to y, and all other β_2 are defined analogously.

The equation to be estimated can therefore be written as follows,

$$e_{jt} - e_{jt-1} = \beta_0 + \beta_1(y_{jt} - y_{jt-1}) + \beta_2(z_{jt} - z_{jt-1}) + \varepsilon_{jt} - \varepsilon_{jt-1}$$

Or equivalently,

$$\Delta e_{jt} = \beta_0 + \beta_1 \Delta y_{jt} + \beta_2 \Delta z_{jt} + \Delta \varepsilon_{jt} \tag{1}$$

This specification allows us to estimate the impact of income changes on education changes.

Since we have the same group j over a period of T years, we can exploit this feature of the data and use panel data methods. In our study, groups will refer to regions of Jamaica. In particular, we will consider two levels of aggregation: First, the sampling region, which is a group measure created by Statistical Institute of Jamaica (STATIN) to create groups of the sample which have approximately equal numbers of dwellings and are composed of homogeneous units (World Bank, 2002); Second, the parish level (there are 14 parishes).[10]

The group of individual characteristics contains both observable characteristics, collected in the SLC, and unobservable characteristics (such as child's ability). Due to the fact that we are taking first differences, if the unobservable characteristics are time-invariant, the omitted variable bias would not be of much concern.

Further, since the groups were not randomly sampled, but correspond to different areas of Jamaica, the most appropriate approach is potentially to use fixed effects estimators, taking individual characteristics of each region as fixed (Wooldridge, 2002). To estimate fixed effects consistently we need to assume that the idiosyncratic error terms, $\Delta\varepsilon_{jt}$ are uncorrelated to the regressors.

[10] A third level of aggregation could be the three main areas of Jamaica: Kingston Metropolitan Area (KMA), other urban areas and rural areas. However, this makes N small, and the asymptotic properties of the panel data estimators cannot hold (Wooldridge, 2002: 250).

This implies,

$$E(\Delta\varepsilon_{jt}|\Delta y_{jt}) = 0 \quad \text{for} \quad t = 1, ..., T$$

$$E(\Delta\varepsilon_{jt}|\Delta z_{jt}) = 0 \quad \text{for} \quad t = 1, ..., T$$

Another important assumption is that there is no measurement error in the variables used for the econometric analysis. This assumption is very difficult to satisfy given the quality of the data available.

Appendix B. Data Source of Export Commodity Prices

Bananas

- Definition: Bananas, average of Chiquita, Del Monte, Dole, and US Gulf delivery,
- Unit: US dollars per metric ton,
- Deflated: No,
- Nature: Data in monthly prices. Simple average is constructed for each year,
- Source: IMF commodity prices online data, http://www.imf.org /external/np/res/commod/index.asp.

Sugar

- Definition: Sugar, US, import price contract number 14 cif,
- Unit: US cents per pound,
- Deflated: No,
- Nature: Data in monthly prices. Simple average is constructed for each year,
- Source: IMF commodity prices online data, http://www.imf.org /external/np/res/commod/index.asp.

Bauxite

- Definition: Bauxite unit value data in dollars per metric ton (t) are the average US import price of bauxite, port of shipment, free alongside ship (FAS),
- Unit: US dollars per metric ton,
- Deflated: Yes, 98US$,
- Nature: data are in yearly prices,
- Source: US Geological Survey. In particular, data are from the Minerals Yearbook and the Mineral Resources of the United States.

Alumina

- Definition: Alumina unit value data are the average US import price of calcined alumina, port of shipment, FAS,
- Unit: US dollars per metric ton,
- Deflated: Yes, 98US$,
- Nature: data are in yearly prices,
- Source: US Geological Survey, in particular, data are from the Minerals Yearbook and the Mineral Resources of the United States.

For our analysis, two transformations are done:

- All US$ are deflated, with the same base year, 2000 (base year for Jamaica CPI as well) and the same units US$ per metric ton.
- All US$ are converted to J$.