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IS MOTHER NATURE A CURSE FOR SOCIAL DEVELOPMENT?

Desire Avom
Universite' de Yaounde' II

Fabrizio Carmignani*
School of Economics
The University of Queensland

Abstract

On the question of whether natural resources kill growth, the jury is still out. While waiting for a decision, we provide evidence that Mother Nature is responsible for slowing down social development over and above any effect it might have on income or growth. We define social development by a combination of health and education outcomes. We find that, after controlling for per-capita income and a bunch of other macroeconomic and institutional factors, a higher dependence on (point and diffuse) natural resources causes social underdevelopment. The estimation of a system of equations indicates two possible transmission mechanisms. One operates via income inequality, the other via macroeconomic volatility.

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* Corresponding author: School of Economics, The University of Queensland, St Lucia, Brisbane, QLD 4072, Australia. Tel. +61 (0)733656619. E-mail: f.carmignani@uq.edu.au.

1. Introduction

A heavy incidence of primary commodity exports on total merchandise exports is a typical feature of many developing countries. The conventional wisdom is that this dependence on Mother Nature has detrimental effects on long-term economic growth (see, inter alia, Sachs and Warner, 2001; Isham et al. 2005). While this wisdom has been challenged by new empirical findings (i.e. Stijns, 2005; Brunnschweiler, 2008; Brunnschweiler and Bulte, 2008)[1], little attention has been devoted to the effect that Mother Nature might have on other dimensions of development, such as for instance education and health outcomes. There are indeed very few exceptions. Gylfason (2001a) argues that natural capital intensity crowds out human capital (as well as social and physical capital), thus implying an adverse effect of primary commodities on education. More recently, Costantini and Monni (2008) have explored the link between natural resources degradation, growth, and human development. In their model, however, natural resources are allowed to affect the UNDP (United Nations Development Programme) human development index only indirectly through their effect on education and institutions. All in all, very little is known about the broader development effects of primary commodities.

The purpose of our paper is to fill in the void in the literature. More specifically we ask whether the effect of Mother Nature on development goes beyond its effect on income

[1] The recent empirical research shows that the sign of the effect of primary commodities on growth is conditional on the quality of institutions: in countries where institutions are producer friendly, then primary commodities are a driver of growth. On the contrary, in countries where institutions are grabber friendly, Mother Nature is a curse (see, Mehlum et al. 2006, Snyder, 2006, Boschini et al., 2007).

and growth. We argue that this is an important issue as it is now widely acknowledged that development is not only about income and growth. While it is clear that a strong rate of income growth is a necessary condition for poverty reduction, it has also become clear that high poverty levels can persist in spite of a relatively good growth performance (Bourguignon, 2003). In a similar vein, higher levels of per-capita GDP are generally associated with better development outcomes, but the correlation is not perfect and per-capita GDP alone is unable to capture the multifaceted non-monetary dimensions of development.

Intuitively, there are good reasons to believe that primary commodities might affect development over and above their effect on per-capita income. Health, education, and other development outcomes critically depend on the supply of public goods and on the extent to which people can access these public goods. At a macro level, the supply of and access to public goods are likely to be function of factors like the size and scope of government, the degree of openness to international trade, the intensity of cyclical volatility, and the inequality of income distribution. In turn, all of these factors are potentially linked to country's dependence on primary commodities. As a matter of fact, our results indicate that: (i) primary commodities hamper "social" development (whereby social refer to an empirical definition of development that does not necessarily include per-capita income) and (ii) distributional inequalities and cyclical volatility are the relevant transmission channels of this negative effect.

The rest of the paper is organised as follows. In Section 2 we use a non parametric procedure to derive some preliminary stylised facts on the correlation between social

development and primary commodities. In Section 3 we estimate a reduced form model of social development and find that the negative effect of primary commodities is quite robust. We then estimate in Section 4 a system of equations to uncover the transmission mechanisms of this effect. Section 5 provides some policy discussion and concludes the paper. The Appendix contains a detailed presentation of econometric diagnostics, the description of the variables used in the empirical analysis, and the list of the countries included in the empirical analysis.

2. A preliminary look at the data

For our empirical analysis we will identify Mother Nature with the sum of exports of (i) agricultural raw materials, (ii) food and beverages, (iii) fuels, and (iv) metals and ores in percent of total merchandise exports (*prim_comm*).[2] We therefore do not limit our attention to point natural resources (oil, ores, and metals), but also look at the effect of diffuse natural resources (agriculture and food) that effectively bear considerable importance in the economy of many developing countries. The empirical definition of social development is instead a more controversial issue that deserves some lengthier considerations before we can start looking at what the data say.

2.1 *An empirical definition of social development*

We are interested in studying the effect of primary resources on non-monetary dimensions of development. In this respect, we face the problem of choosing one

[2] In the rest of the paper we will often refer to this measure as to "dependence on primary commodities" or, in short, "primary commodities".

indicator of development (which will become the dependent variable in our empirical model) out of a myriad that are today currently available. For instance, the World Development Indicators (World Bank, 2008) include more than 200 variables that capture relevant aspects of social and human development. The MDG (Millennium Development Goals) framework (IAEG, 2008) makes use of a "parsimonious" selection of 60 indicators, almost any of which could work well as a proxy for the notion of development we have in mind. UNDP (1990) deals with the multidimensionality of the concept of development by constructing an index of human development that is defined as the weighted average of five indicators representing population health, education, and standard of living. This index is now produced annually and has become a rather popular reference in the practice of development economics.

Our approach to the empirical measurement of development is similar to that adopted by the UNDP for its human development index: we summarise the information from various indicators into a single aggregate measure to which we refer as *socdev*. However, differently from the UNDP index, we do not rely on an arbitrary and ad-hoc selection of weights to compute the aggregate measure. Instead, we determine these weights from principal components analysis. In a nutshell, the procedure involves an orthogonal linear transformation of n (possibly) correlated development indicators into m (where $m < n$) uncorrelated variables called principal components. The first principal component accounts for as much of the variability in the original data as possible, and each succeeding component accounts for as much of the remaining variability as possible. We take the following disaggregate indicators: life expectancy at birth (*life_exp*), rate of immunization against diphtheria, pertussis and tetanus (*immunization*),

and average years of education in the population (*schooling*). Our variable *socdev* is then the first principal component of these three indicators. Higher values of *socdev* denote *worse* development outcomes, so that in fact *socdev* is a measure of social underdevelopment.

We are aware of the limitations of our choice of disaggregate indicators. First of all, we do not include any measure of institutional development and/or environmental sustainability. As a matter of fact, we are primarily concerned with social outcomes, namely health and education, and this is the reason why we prefer not to add indicators of institutional quality or environmental degradation. Moreover, institutions might be one of the channels through which primary commodities affect social development and hence institutional measures will enter the empirical model as regressors. Second, among the many possible indicators of health and education, we restrict attention to only three and neglect others that might capture important outcomes. Our defence in this case is that the principal components obtained from richer datasets are very strongly correlated with *socdev*. The three indicators that we have chosen are available for a long period of time and a large cross-section of countries, so that the number of observations for empirical estimation is maximised. Finally, we exclude per-capita income from our definition of development. Once again, our choice is motivated by the focus on the health and education dimensions of development. Per-capita income is likely to be an important determinant of health and education outcomes and hence we thought thatits inclusion in the definition of the dependent variable might make the interpretation of the results of the empirical model more difficult. However, we also constructed a principal component that includes per-capita GDP (*socdev_2*) and a principal component that

includes the log of per-capita GDP (*socdev_3*). Both of them display very high correlations with our preferred measure *socdev*, as it can be seen from Table 1. This suggests that after all, our main findings on the role of primary commodities would not change if the definition of social development included per-capita income.

INSERT TABLE 1 ABOUT HERE

2.2. A non-parametric scatter plot of social development and primary commodities

The simple bilateral correlation coefficient between *socdev* and *prim_comm* is 0.499, significant at the 1% confidence level. Therefore there appears to be a positive association between social underdevelopment and dependence on primary commodities. We explore this association in more details by using a non-parametric methodology to obtain a robust locally weighted scatter plot smoothing. The methodology, known as *lowess*, is described by Cleveland (1993 and 1994) and it has been recently used by Imbs and Wacziarg (2003) to characterise the patter of sectoral diversification along the development path. With this methodology we impose as little structure on the function form of the relationship as possible and we can therefore better account for possible non-linearities.

In brief, denote the index of social underdevelopment by y and the degree of dependence on primary commodities by x. Let then (y_n, x_n) be a generic observation on the two variables, with $n = 1 \ldots N$. We fit a locally weighted polynomial regression of y on x using only a subset of observations that lie around x_n, with smaller weights being

given to the observations that are more distant from x_n.[3] The fitted value of this local regression evaluated at x_n is used as the smoothed value in constructing the nonparametric scatter plot linking *y* and *x*. The procedure is repeated for each observation (y_n, x_n) in the sample, so that the smoothed curve is traced out from *N* fitted values. In implementing this procedure we choose a bandwidth equal to 0.3; that is, 30% of the total data in the sample are included in each local regression. We also specify a degree 1 of polynomial to fit in each regression. In fact, different choices of bandwidth and polynomial degree do not substantially affect our findings.

The scatter plot and fitted line obtained from the non-parametric procedure are reported in Figure 1. It is clear from the figure that there is a positive association between social underdevelopment and dependence on primary commodities. This relationship may not be linear, but the curve is unambiguously upward sloping and sharply steeper at high level of *prim_comm*. In other words, a heavier dependence on primary commodities is quite systematically associated with worse social development outcomes. While this does not say much about the direction of causality, we take it as a first stylised fact and move from there to provide more robust empirical evidence.

INSERT FIGURE 1 ABOUT HERE

3. Mother Nature, per-capita income, and social development

[3] Local weighting implies that the shape of the curve linking *y* and *x* at high levels of *x* is not affected by the observations at low levels of *x*.

Recent empirical evidence shows that income and growth are the key drivers of social outcomes (see, for instance, Gupta et al. 2002 and Carmignani, 2008). The stylised fact detected in the previous section could therefore be the simple consequence of the conventional natural resources curse: if natural resources reduce income and income is a key determinant of social outcomes, then natural resources worsen social outcomes. However, instead of engaging in a new study of the empirical relevance of the conventional curse hypothesis, we address a different question: to what extent primary commodities cause social underdevelopment after excluding any income effect? In other words, we want to see whether primary commodities affect social underdevelopment independently from any possible effect they might have on income (or growth). To this purpose, we use a standard parametric methodology to estimate the impact of primary commodities on social underdevelopment while keeping per-capita income constant.

3.1 *The empirical specification*

We initially fit a very simple regression model:

$$(1) \quad s_{it} = \alpha_0 + \alpha_1 y_{it} + \alpha_2 p_{it} + \varepsilon_{it}$$

where *s* is the variable *socdev*, *y* is the log of per-capita income (*gdp_pc*), *p* is the indicator *prim_comm* (or alternatively *agric_food* or *fuels_metals*), *i* denotes a generic country, *t* is time, ε is random disturbance, and the αs are the parameters to be estimated. Data are averaged over 5 year periods in order to focus on longer term effects. The

period of estimation goes from 1975 to 2005 and the sample includes 87 countries. Missing observations at the beginning of the sample period make the panel unbalanced.

In equation (1), the estimated coefficient on p (α_2) captures the effect of primary commodities on social underdevelopment after controlling for any effect arising from per-capita income. If $\alpha_2 > 0$, then there is evidence that primary commodities affect social underdevelopment over and above any indirect effect that might operate through income.

3.2 *Baseline estimates*

Baseline estimates of equation (1) are reported in Table 2.

INSERT TABLE 2 ABOUT HERE

We begin with basic least squares estimates in column I. The estimated coefficients are strongly significant: social underdevelopment increases when per-capita income decreases and when dependence on primary commodities increases. Thus, primary commodities appear to affect social underdevelopment directly and not just indirectly through income. However, the marginal effect of primary commodities is weaker than the marginal effect of per-capita income: a reduction of 16 percentage points in *prim_comm* (equivalent to 27% of the standard deviation of *prim_comm* in the sample) generates the same decrease in social development that is determined by an increase in per-capita income from US$ 6000 to US$ 6600.

In column II we extend the model specification to include the square of *prim_comm*. It might be argued that primary commodities become a liability only if dependence grows above a certain threshold. In this sense, the relationship between *prim_comm* and *socdev* might be non linear: negative at low values of *prim_comm* and positive at higher values of *prim_comm*. The estimates however seem to reject this hypothesis.[4] We will therefore employ a linear specification in the rest of our analysis.

In column III we allow for cross-sectional fixed effects in the panel set-up. The marginal effects of both per-capita income and primary commodities on social underdevelopment are now larger. However, there are no major qualitatively changes relative to column I. We have also tried period fixed effects and random effects, but again results do not change much: the coefficient on *prim_comm* remains positive and statistically significant.

Finally in column IV we try to account for the potential endogeneity of the two regressors. Education and health outcomes are likely to be important derivers of economic growth and therefore determine the level of per-capita income. One might also argue that the stock of human capital in the economy affects the path and speed of the industrialization process. In this respect, the degree of dependence on primary commodities would be endogenous to the level of social underdevelopment of the country. We therefore adopt an instrumental variables approach to control for possible reverse causality. Our list of instruments includes lagged values of per-capita income

[4] We also tried to fit a polynomial of degree three, but only the estimated coefficient of the linear terms was statistically significant (and positive).

and dependence on primary commodities plus a measure of country's distance from the equator (*lat_abst*) and an index of country's legal origins (*legor_uk*).[5] We run a few diagnostics to check the validity and relevance of our instruments. The Appendix provides a detailed discussion of these diagnostics. In a nutshell, our instruments turn out to be both relevant and valid. The coefficients estimated by instrumental variables appear not to be qualitatively different from those estimated using least squares. The conclusion that primary commodities affect social underdevelopment over and above any effect due to per-capita income therefore holds.

3.3 Sensitivity analysis and extensions

We perform a number of robustness checks on our baseline estimates. These robustness checks are reported in Table 3. Unless otherwise indicated, all coefficients are obtained from instrumental variables estimation.[6] The set of instruments always include the lagged value of the regressors plus *legor_uk* and *lat_abst*. Again, we discuss in the Appendix the diagnostics concerning the validity and relevance of our choice of instruments.

INSERT TABLE 3 ABOUT HERE

[5] Geographical and climatic conditions make it more likely for countries closer to the equator to rely more on diffuse natural resources. Moreover, the latitude variable is strongly significant in a regression of *prim_comm*. We therefore believe it is a relevant instrument for our indicator of dependence. Similarly, there are good theoretical reasons to believe that legal origins are correlated to per-capita income, most likely through their effect on economic and financial institutions. These theoretical considerations suggest using *legor_uk* as an instrument for per-capita income.

[6] The Hausman test of endogeneity (see Davidson and MacKinnon, 1993) effectively confirms that our measures of primary commodities tend to be endogenous to social underdevelopment.

First of all, we split the aggregate indicator *prim_comm* in (i) an indicator of dependence on point resources, *fuels_metals*, defined as the exports of fuels and metals in percent of total merchandise exports and (ii) an indicator of dependence on diffuse resources, *agric_food*, defined as exports of raw agricultural materials and food in percent of total merchandise exports. We do so as we want to see whether the adverse effect of primary commodities on social outcomes is in fact driven by any particular category of natural resources. Column I reports the results of the regression with *fuels_metals* and Column II the results of the regression with *agric_food*. It turns out that the coefficient on both *fuels_metals* and *agric_food* is positive and statistically significant, meaning that both categories of natural resources have some detrimental social development impact.

In column III we restrict the sample to countries that are not very heavily dependent on primary commodities. The non-parametric evidence discussed in Section 3 suggests that the relationship between primary commodities and social underdevelopment becomes particularly steep at high levels of dependence (i.e. *prim_comm* above 60%). In this respect, the estimated positive coefficient on *prim_comm* might be driven by a subgroup of observations at very high levels of dependence. We therefore exclude from the regression all observations with *prim_comm* above 60%. The coefficient on *prim_comm* remains positive and statistically significant, thus confirming that the relationship holds even for countries that are not extremely dependent on primary commodities.

In column IV we extend the simple model (1) to include a number of other potential determinants of social underdevelopment:

$$(2) \quad s_{it} = \alpha_0 + \alpha_1 y_{it} + \alpha_2 p_{it} + \mathbf{bW}_{it} + \varepsilon_{it}$$

where **W** is a set of additional controls, **b** a vector of coefficients (to be estimated) on these controls, and all of the other variables and parameters are the same as in model (1). **W** includes: country's openness to international trade (*trade*), the quality of institutions (*inst_quality*), and the size of the government (*gov_cons*). Openness to trade is measured by the exports plus imports share of GDP and it is meant to capture the effect of globalization on social outcomes. Our working hypothesis is that globalization puts a premium on human capital formation, thus contributing to better health and education outcomes. Institutional quality is measured by the quality of the legal environment. In general efficient institutions and good governance should make policymakers more accountable to the people. This in turn is expected to improve the delivery of public services and public goods, therefore reducing social underdevelopment. Finally, the size of the government is proxied by government consumption in percent of GDP. Ideally, we would like to use public expenditure on health and education instead of government consumption, but data limitations prevent us from doing that. We therefore rely on government consumption to capture the effect of public expenditure on development. Previous empirical work on the macroeconomic determinants of health and education outcomes has recognised the important of institutions and government size, while the role of trade openness has been somewhat neglected (see again Gupta et al. 2002 and Carmignani, 2008). Both *gov_cons* and *trade* are instrumented by their lagged values.

However, lagged values of *inst_quality* do not seem to perform equally well as instruments. In particular, lagged institutional quality is not entirely exogenous to the dependent variable. The theory and empirical evidence reported by La Porta et al. (1999) suggest that institutional quality might be instrumented by the legal origins of a country. Because the dummy *legor_uk* is already supposed to instrument for per-capita income, we add another legal origin dummy (*legor_sc*) to instrument for *inst_quality*. Again, the diagnostics reported in the Appendix indicate that these instruments perform quite well.

Of the new variables, only *trade* displays a significant coefficient. The negative sign suggests that indeed greater openness reduces social underdevelopment. In fact, one should not be too surprised by the lack of significance of the coefficients on *inst_qual* and *gov_cons*. Institutional quality is very strongly correlated with per-capita income and hence much of its effect on *socdev* is probably already accounted for by *gdp_pc*. The lack of effect of government expenditure on development outcomes might instead be due to inefficiencies in spending. What is really important in column IV however is the finding that the coefficient on *prim_comm* is still positive and strongly significant at usual confidence levels. This means that primary commodities cause social underdevelopment even after controlling for an extended group of other possible determinants of health and education outcomes.

Finally, we checked whether the lagged values of *prim_comm* have any effect on *socdev*. Results are not reported here in order to save space, but they are available upon request. The one period lagged value of *prim_comm* turns out to be largely insignificant when added to the specification of column IV. At the same time, not much changes with

respect to the other variables, even though we observe a decrease in the statistical significance of the contemporaneous value of *prim_comm*. This is not surprising as lagged and contemporaneous values are strongly correlated (in fact, this strong correlation is one of the reasons why the lagged value is a useful instrument for the contemporaneous value) and therefore a problem of multicollinearity arises.

4. Transmission channels

The evidence reported in Section 3 corroborates the stylised fact discussed in Section 3: a higher dependence on primary commodities is bad for social development. Because they are already controlled for in the regression model, per-capita income, international trade openness, government consumption, and institutional quality cannot fully account for the transmission from primary commodities to social outcomes. That is, there must be some other variables that explain why primary commodities are bad for social development. It is to this question that we now turn our attention[7].

4.1 Some hypothesis on possible transmission channels

We propose two possible, and not mutually exclusive, channels of transmissions for the effect of primary commodities on social development.[8] The first channel is through income inequality; the second is through macroeconomic volatility.

[7] For the sake of brevity, we focus in this section only on the aggregate measure of primary commodities, *prim_comm*. In general, the results we report for *prim_comm* extends to the disaggregated measures *fuels_metals* and *agric_food*.

[8] We just want to stress that here we are talking about any effect of primary commodities beyond the effect that might be transmitted through per-capita income.

Consider income inequality first. Together with average per-capita income, income inequality determines the incidence of monetary poverty in the economy. At the same, time, there is likely to be a positive association between monetary and non-monetary poverty: those who are “monetary poor” lack the resources to invest in education and health and therefore they will also become “socially poor”. Thus, for any given level of per-capita income in the economy, we suspect that higher inequalities will increase social underdevelopment. There is also evidence that inequalities increase with the degree of dependence on primary commodities (see Gylfason, 2001b). Intuitively, the rents generated by natural resources tend to be appropriated by small groups and elites. Few countries appear to have developed the institutions that guarantee an equitable distribution of the benefits produced by natural resources among the population at large. In fact, the association between natural resources and institutional quality is often negative, in the sense that a heavy dependence on primary commodities generally goes together with the type of extractive institutions that foster inequalities. The bottom line is that primary commodities might increase inequality, which in turn should cause more social underdevelopment.

Let us now turn to macroeconomic volatility. Households with lower income might find it more difficult to cope with output fluctuations as they are likely to be liquidity constrained. Volatility might therefore prevent (ore reduce) investment in health and education for a large proportion of total population, thus contributing to higher social underdevelopment. This effect should be stronger in less developed economies where

government are unable to provide adequate social safety networks.[9] At the same time, a larger exposure to external shocks (i.e. price fluctuations on international commodity markets) will cause higher volatility. Poelhekke and Van der Ploeg (2007) for instance claim that the reason why natural resources reduce economic growth is because they increase output volatility. In the end, a country that heavily relies on exports of primary commodities experiences greater macroeconomic volatility because it is more vulnerable to external shocks; greater volatility in turn worsens social outcomes.

Our hypotheses can be summarised as follows:

(i) Inequality channel: Higher dependence on primary commodities increases inequality and higher inequality causes social underdevelopment

(ii) Volatility channel: Higher dependence on primary commodities increases macroeconomic volatility and greater volatility causes social underdevelopment.

These two hypotheses yield two types of testable implications. First, in a single equation (reduced form) model where *socdev* is regressed on (i) *prim_comm*, (ii) an indicator of inequality and/or a measure of volatility, and (iii) a set of controls, the coefficient on *prim_comm* should lose statistical significance, while the coefficients on inequality and/or volatility should be positive and statistically significant. This is because, if our hypotheses are correct, then any effect of *prim_comm* on the dependent variable would

[9] Evidence in support of this conjecture is provided by Carmignani (2008). He finds that social security expenditure in a sample of transition and emerging economies has a significant positive effect on social outcomes.

be accounted for by the estimated coefficient of inequality and/or volatility. Second, in a structural model of two equations, *prim_comm* should have a positive coefficient in a regression of inequality and/or volatility and inequality and/or volatility should have a positive coefficient in a regression of *socdev*. The rest of this section is devoted to testing those implications.

4.2 Evidence from reduced forms

The first testable implication can be nested within the regression model (2). The vector of regressors **W** now includes the Gini coefficient (*inequality*, as a measure of income inequality) and the standard deviation of per-capita income growth over a five year window (*volatility*, as a measure of macroeconomic volatility). Results are reported in Table 4, columns I and II. In column I, the Gini coefficient is treated as exogenous, based on the results of the Hausman test of endogeneity (Davidson and MacKinnon, 1993). In column II macroeconomic volatility is instrumented by Chin and Ito's index of financial openness, *kopen* (Chinn and Ito, 2008). The relevant theoretical argument here is that greater financial openness increases the risk of financial instability, which in turn is a key source of output instability. Empirically, *kopen* appears to outperform lagged *volatility* as an instrument, probably because this latter is only weakly exogenous. In both columns I and II all of the other regressors are instrumented as in Column IV of Table 3. Our choice of instruments is once again supported by diagnostics tests that we discuss in the Appendix

It can be readily seen from the table that the implications corresponding to our hypotheses on the transmission channels are empirically valid. In both columns, the coefficient on *prim_comm* looses significance, while *inequality* (column I) and *volatility* (column II) display a positive and significant coefficient. Intuitively, if primary commodities influence social underdevelopment via inequality and/or volatility, then the estimated coefficients on *inequality* and/or *volatility* already capture the effect statistical relationship between *prim_comm* and *socdev* and hence the estimated coefficient on *prim_comm* is no longer different from zero.

INSERT TABLE 4 ABOUT HERE

4.3 Evidence from system estimation

To verify the empirical validity of the second type of testable implications, we have to set-up a system of two equations as follows:

(3) $s_{it} = \alpha_0 + \alpha_1 y_{it} + \alpha_2 z_{it} + \mathbf{b}\mathbf{W}_{it} + \varepsilon_{it}$

(4) $z_{it} = \beta_0 + \beta_1 p_{it} + \mathbf{c}\mathbf{M}_{it} + \upsilon_{it}$

where z is either the Gini coefficient or the standard deviation of output growth, **M** is a vector of other determinants of z, υ is a random disturbance, **c** is a vector of parameters to be estimated along with the βs and the αs, and all of the other symbols are the same as in equations (1) and (2).

The central feature of the system of equations (3)-(4) is that the degree of dependence on primary commodities (*p*) affects social underdevelopment (*s*) through its effect on either the Gini coefficient or the volatility of output (*z*). The implication to be tested is that $\alpha_2 > 0$ and $\beta_2 > 0$. We allow for non-zero correlation between the error terms of the two equations and employ a Generalized Method of Moments (GMM) system estimator that accounts for both heteroskedasticity and autocorrelation in the covariance matrix. It can be shown that many other popular estimators, such as the three and two stages least squares, can be obtained as special cases of the GMM estimator (see Wooldridge, 2002). Results are reported in columns III (*z* = *inequality*) and IV (*z* = volatility) of table 4.

In column III, vector **W** includes the only two controls that were statistically significant in the single equation estimates of Table 3 and columns I and II of Table 4: log of per-capita GDP and openness to international trade. Vector **M** is instead specified based on the evidence on the determinants of inequality provided by Carmignani (2009). He shows that most of the variation in inequality across countries and over time is accounted for by institutional quality and international trade openness, while log per-capita GDP and other factors (such as for instance a country's degree of democracy) are relatively less important. The set of instruments for the first equation includes the lagged value of per-capita income and international trade openness plus latitude and legal origin. In the second equation instead only primary commodities and institutional quality are treated as endogenous and instrumented by the lagged value of *prim_comm*, latitude and legal origins, while international trade openness is taken to be exogenous based on the result of the Hausman test.

In column IV, **W** and the instruments for the first equation are specified as in column III. Vector **M** is instead designed to account for the impact of globalization and economic development on volatility. It therefore includes Chinn and Ito's measure of financial openness *kopen*, the volatility of the terms of trade (*tot_vol*)[10], and the log of per-capita GDP. Both financial openness and terms of trade volatility appear to be exogenous to output volatility. In addition to these two exogenous variables, the list of instruments includes the lagged value of primary commodities and per-capita income plus legal origins and latitude, as usual.

The estimated coefficients shown in columns III and IV of Table 4 provide empirical support to our hypotheses. In column III, the estimated coefficient on *inequality* in the *socdev* equation is effectively positive, meaning that larger inequalities increase social underdevelopment. At the same time, primary commodities are a significant determinant of inequalities, thus implying that *prim_comm* affects *socdev* via its effect on *inequality*. In column IV, the positive and statistically significant coefficient on *volatility* in the first equation means that in more volatile economies social outcomes tend to be worse. The estimates of the second equation then indicate that primary commodities are among the key drivers of volatility, so that in the end *prim_comm* affects *socdev* via its effect on *volatility*.

[10] Globalization consists of two main pillars: financial openness and trade openness. Financial openness is captured by Chinn and Ito's measure of capital account liberalization. Trade openness should be captured by the indicator *trade*. However, as it can be easily verified, if *trade* is added to the set of regressors of the second equation, then the system is not properly identified. Therefore, we replace *trade* with the standard deviation of terms of trade over a five year window. The underlying assumption is that most of the effect of trade openness on output volatility can be traced back to international price shocks.

We tried various sensitivity tests to check the robustness of our system estimates. First of all, we re-estimated the system by using a standard two stages least square equation-by-equation estimator. Results are substantially similar to those obtained from the GMM system estimator. These equation-by-equation estimates allow us to compute the first stage diagnostics on the relevance of instruments, which are commented upon in the Appendix. We then tried to include *prim_comm* as a regressor in the *socdev* equation. As expected from the results of the reduced form model in columns I and II of Table 4, the coefficient of *prim_comm* is never significant, while all of the other coefficients retain both their sign and level of statistical significance. Finally, we allowed *inequality* and *volatility* to be jointly endogenous with *socdev*. This means that we added *socdev* to the set of regressors of the second equation of our system. It turns out that *socdev* is not statistically significant in the inequality regression, thus confirming that *inequality* is exogenous to *socdev*. In the *volatility* equation, *socdev* is significant at the 10% level, with a negative sign. More importantly, the estimated coefficient on *prim_comm* remains practically unaltered. Overall, we conclude that results from system estimation are sufficiently robust.

5. Conclusions

There is no consensus in the literature on whether Mother Nature is a curse for income growth or not. In this paper we show that, independently from its effect on income, Mother Nature is a curse for social development. Our empirical analysis indicates that after controlling for various other determinants of social outcomes (including per-capita income), a country's dependence on primary commodities negatively affects social

development. We provide evidence of two channels, other than income or growth, through which primary commodities can influence social development. The first channel operates through the inequality of income distribution: a heavier dependence on primary commodities causes larger inequalities, which in turn worsen health and education outcomes. The second channel works via macroeconomic volatility: a heavier dependence on primary commodities makes a country more vulnerable to external shocks, thus causing larger economic fluctuations that negatively affect social development.

From a policymaking perspective, the evidence on the transmission channels is important to design policies that help mitigate the negative effects of natural resources on social development. More specifically, countries that heavily depend on primary commodities ought to (i) strengthen the redistributive content of their fiscal policy and (ii) adopt a counter-cyclical macroeconomic policy stance. Fiscal redistribution will counter the effect of abundant natural resources on the Gini coefficient. Countries might chose among different fiscal tools. For instance, Carmignani (2009) finds that narrow redistribution (transfers and subsidies) is effective in reducing income inequality. A progressive shift of the tax structure from regressive or neutral taxes (such as indirect domestic taxes and international trade taxes) towards progressive domestic income and profit taxes might also help. Outside the fiscal domain, the results of our regressions also point to the importance of institutional development as a way to curb inequalities.

A countercyclical macroeconomic policy will instead help dampen volatility. It is however often observed that in many developing countries macroeconomic policies

(especially fiscal policy) are run pro-cyclically (Kaminsky et al. 2004, Iltzezki and Veigh, 2008). One of the key factors explaining this pro-cyclicality is that aid tends to be pro-cyclical, and therefore spending is also pro-cyclical. In this respect, the key challenge for policymakers is to adequately manage revenues from the export of primary commodities. Public savings ought to be accumulated at times of buoyant international commodity prices, so that expenditure can be financed out of these savings at times of recession. Another important factor limiting the degree of counter-cyclicality of macroeconomic policy in several developing countries is the lack of policy space. This lack of policy space can in turn arise from the adoption of rather rigid macroeconomic policy frameworks within the context of Poverty Reduction Strategy Papers (see, for instance, Gottschalk, 2005) and/or from the use of tight fiscal and monetary rules (as it is for instance the case of many African countries participating into regional integration agreements). These causes of rigidity have to be removed to provide policymakers with enough space to adjust macroeconomic policy in the short-term to respond to shocks, thus strengthening the contribution of macroeconomic policy to the achievement of social development objectives.

Appendix

A1. Diagnostics on the validity and relevance of instruments[11]

In producing Instrumental Variables estimates (column IV of Table 2 and all columns of Tables 3 and 4) we are particularly concerned with the relevance and validity of our choice of instruments. Relevance refers to the existence of a sufficiently strong correlation between the chosen instruments and the endogenous variables. Validity instead refers to the orthogonality of the instruments to the error process; that is, to be valid, instruments must be exogenous to the dependent variable of the original regression model.

In order to assess the relevance and validity of our choice of instruments, table 5 reports – for all the models that make use of instruments – the following diagnostics: the partial R^2, the Shea's (partial) R^2, and the Sargan-statistic of the test of overidenfying restrictions. In what follows we provide a brief and non-technical description of their meaning and interpretation within the context of our paper.

Consider the generalised regression model:

(A1) $s_{ijt} = \mathbf{X}_{jt}$ (+ θ_{ijt}

[11] See Baum et al. (2003 and 2007) and references therein for a detailed treatment of the econometric theory underlying the issues discussed in this appendix.

where *s* is the dependent variable, **X** is the set of regressors, β are the parameters to be estimated, ε is the disturbance term, *i* denotes a generic country and *t* is time. In our paper *s* is the variable *socdev*, **X** includes *gdp_pc*, *prim_comm* and, eventually, the other controls (*trade*, *gov-cons*, *inst_quality*, *inequality*, and *volatility*).

Some of the regressors in **X** are endogenous in the sense that they are not orthogonal to the disturbance. Let $\mathbf{Z}_1$ be the set of instruments for these endogenous regressors. The regressors in **X** that are orthogonal to the disturbance (exogenous regressors) are instrumented by themselves and denoted by $\mathbf{Z}_2$**.** Therefore, $\mathbf{Z} = [\mathbf{Z}_1\, \mathbf{Z}_2]$ is the set of all exogenous variables, with $\mathbf{Z}_1$ being the set of "excluded" instruments (that is, exogenous variables that are only used as instruments and do not appear on the r.h.s. of the original model A1) and $\mathbf{Z}_2$ being the set of "included" instruments (that is, exogenous variables that appear on the r.h.s. of A1 and instrument themselves). Note that in the case of our paper, the set $\mathbf{Z}_2$ is empty and $\mathbf{Z} = \mathbf{Z}_1$ for the following models: column IV of Table 2, all columns of Table 3, and column II of Table 4. In column I of Table IV instead, $\mathbf{Z}_2$ only includes the variable *inequality*. Finally, when the system in columns III and IV of Table 4 is estimated equation-by-equation (as it is necessary to generate some of the diagnostics), the set $\mathbf{Z}_2$ is again empty for the *socdev* equations, it includes instead *trade* for the *inequality* equation and *kopen* and *tot_vol* for the *volatility* equation.

The relevance of instruments can be formally tested by examining the fit of the first stage regressions. For each endogenous regressor *x* in each model we therefore run a regression of *x* on $\mathbf{Z}_1$ and compute the squared partial correlation between $\mathbf{Z}_1$ and *x*.

This is normally known as "partial R^2" and it is the first diagnostic we report in Table 5. Higher values of the partial R^2 indicate that the chosen instruments are relevant. Formal statistical inference can then be obtained by running an F-test of the joint significance of the $\mathbf{Z}_1$ instruments in the first-stage regression. We actually compute the F-statistic associated with each of the partial R^2 reported in Table 5 and the null hypothesis of the F-test iss always rejected at the 1% confidence level (the full set of F-statistics is available upon request).

However, the partial R^2 might not be sufficiently informative if the model includes more than two endogenous regressors. We therefore compute and report a second statistics, known as Shea's (partial) R^2. This is a partial R^2 that takes the intercorrelations among the instruments into account. The only problem with Shea's R^2 is that its distribution has not been derived and therefore no formal test of significance can be implemented. A useful rule of thumb is that Shea's R^2 should not be too small relative to the partial R^2. In other words, if the null hypothesis of the F-test associated with the partial R^2 is rejected and Shea's R^2 is not too small relative to the partial R^2 one can then conclude that the instruments are relevant.

As it can be seen from table 5, the partial R^2 are generally very high and, as already indicated, the null hypothesis of the F-test is always rejected at the highest confidence level. The Shea's R^2 are somewhat smaller than the partial R^2, but still quite high. The difference between partial R^2 and Shea's R^2 is never too large, even though we recognise that some degree of subjectivity is involved in this evaluation. Overall, we believe that the instruments we have used are relevant. In fact, this should not come as a

surprise. In many cases we have used lagged values of the endogenous regressors as instruments. Lagged values are generally correlated with contemporaneous values and therefore they tend to be relevant almost by construction.

INSERT TABLE 5 ABOUT HERE

We provide evidence of the validity of our instruments through the Sargan test of overidentifying restrictions. This test can in fact be performed only if the number of instruments (included and excluded) is larger than the number of regressors. In this case the equation is overidentified and it is possible to test whether the moment conditions implying exogeneity of the instruments are satisfied. The Sargan test is run for each model (and not for each endogenous variable in each model). The last column of Table 5 then reports the Sargan test-statistic and the p-value associated with the null hypothesis that the overidentfying restrictions are valid. Therefore a p-value above 0.1 implies that the null cannot be rejected and hence that the choice of instruments is valid. It can be seen from the table that the value of the test-statistic and the p-value considerably change across models. However, our overidentifying restrictions are never rejected. We conclude that the instruments we have chosen are generally valid.

A final note is in order for the diagnostics tests on the instruments used in the system of equations (columns III and IV of Table 4). These systems are estimated using a GMM procedure. In the context of GMM, the relevant test-statistic for the test of overidentfying restrictions is computed as the value of the GMM objective function evaluated at the efficient GMM estimator. The interpretation of the test is analogous to

the single equation case and under the null hypothesis the overidentfying restrictions are valid. We never reject the null, meaning once again that our instruments are exogenous to the error process. The first-stage ststistics (partial R^2 and Shea's R^2) instead can be computed only if the system is estimated equation-by-equation. As we commented in the text of the paper, equation-by-equation estimates of the system are very similar to the GMM system estimates. At the same time, the diagnostics reported in Table 5 confirm that, when the equations are individually estimated, the instruments are relevant.

All in all, we believe that the diagnostics we presented support our choice of instruments for each model.

A2. Variables description and data sources

Abbreviation	Full name	Description	Source
gdp_pc	Per-capita GDP	Per-capita GDP at constant US dollars (base year = 2000)	WDI
Volatility	Output volatility	Standard deviation of annual growth rate of per-capita GDP over a five year period.	Own computation from WDI data
Inequality	Income inequality	Gini index of income distribution	UNU-WIDER
Trade	Trade openness	Exports plus imports in percent of GDP	WDI
gov_cons	Government consumption	Government expenditure for goods and services, including compensation of employees, in percent of GDP	WDI
tot_vol	Terms of trade volatility	Standard deviation of annual levels of terms of trade over a five year period	Own computation from WDI data
inst_qual	Institutional quality	Index of quality of the legal environment	EFW
prim_comm	Primary commodities	Exports of primary commodities in percent of total merchandise exports. Primary commodities are: (i) agricultural raw materials, (ii) food and beverages, (iii) fuels, and (iv) metals and ores….	Own computation from WDI data
agric_food	Agricultural raw materials and food	Exports of agricultural raw materials and food and beverages in percent of total merchandise exports	Own computation from WDI data
fuels_metals	Fuels and metals and ores	Exports of fuels and ores and metals in percent of total merchandise exports	Own computation from WDI data
Socdev_1	Social underdevelopment 1	First principal component of: immunization rate, life expectancy and education	Own computation from WDI data
Socdev_2	Social underdevelopment 2	First principal component of: immunization rate, life expectancy, education, and per-capita GDP	Own computation from WDI data
Socdev_3	Social underdevelopment 3	First principal component of: immunization rate, life expectancy, education, and log per-capita GDP	Own computation from WDI data
Imm	Immunization rate	Percent of children immunized against…	WDI
Life_exp	Life expectancy	Average years of life expectancy at birth	WDI
Tyr	Education	Average years of schooling in the population.	Barro and Lee (2001) and subsequent updates
Legor_uk	Legal origin UK	Dummy variable taking value 1 if legal origin of a country is UK commercial code	La Porta et al. (1999)
Legor_sc	Legor origin Scandinavian	Dummy variable taking value 1 if legal origin is the Scandinavian code	La Porta et al. (1999)
Lat_abst	Latitude	Distance from the equator	La Porta et al. (1999)
K_open	Capital account liberalization	Index of liberalization of capital account transactions and international capital movements.	Chinn and Ito (2008)

Notes: WDI stands for the World Development Indicators of the World Bank, EFW for the Economic Freedom of the World database of Freedom House, UNU-WIDER is the database on inequality of the United Nations University.

A3. List of countries included in the econometric analysis

Algeria
Argentina
Armenia
Azerbaijan
Bahamas
Bangladesh
Barbados
Belarus
Bolivia
Botswana
Brazil
Bulgaria
Burkina Fasu
Burundi
Cambodia
Cameroon
Chad
Chile
China
Colombia
Costa Rica
Czech Republic
Ecuador
Egypt
Estonia
Ethiopia
Fiji
Gabon
Gambia
Georgia
Ghana
Guinea
Honduras
Hong Kong
Hungary
Indonesia
Israel
Ivory Coast
Jamaica
Jordan
Kazakhstan
Kenya
Kyrgyzstan
Korea, South
Lao
Latvia
Lebanon
Lesotho
Lithuania
Madagascar
Malawi
Malaysia
Mali
Mauritania
Mauritius
Mexico
Morocco
Mozambique
Niger
Nigeria
Pakistan
Panama
Peru
Philippines
Poland
Paraguay
Romania
Russia
Rwanda
Salvador
Senegal
Singapore
Slovakia
South Africa
Sri Lanka
Taiwan
Tanzania
Thailand
Tunisia
Turkey
Uganda
Ukraine
Uruguay
Venezuela
Vietnam
Zambia
Zimbabwe

Table 1: Bilateral correlations between indicators of social underdevelopment

	Socdev	socdev_2	socdev_3	schooling	immunization	gdp_pc	life_exp
socdev	1	0.978	0.987	-0.907	-0.810	-0.712	-0.903
socdev_2	0.978	1	0.988	-0.922	-0.746	-0.843	-0.888
socdev_3	0.987	0.988	1	-0.916	-0.743	-0.779	-0.918
schooling	-0.907	-0.922	-0.916	1	0.584	0.729	0.823
immunization	-0.810	-0.746	-0.743	0.584	1	0.358	0.642
gdp_pc	-0.712	-0.843	-0.779	0.729	0.358	1	0.614
life_exp	-0.903	-0.888	-0.918	0.823	0.642	0.614	1

Note: All correlation coefficients are significant at the 1% confidence level. The only exception is the correlation between the immunization rate (imm) and per-capita gdp (gdp_pc), which is only significant at the 10% confidence level.

Table 2: Evidence on the effect of primary commodities on social underdevelopment

	I	II	III	IV
constant	5.880 ***	6.118 ***	8.711 ***	5.678 ***
log(gdp_pc)	-0.782 ***	-0.782 ***	-1.261 ***	-0.762 ***
prim_comm	0.005 ***	-0.009	0.022 ***	0.005 ***
Prim_comm^2		0.0001 **		
R2	0.74	0.75	0.92	0.72
Observations	413	413	413	384

Note: OLS estimates in column I, II. GLS estimates in column III. Instrumental variables estimation in column IV. The set of instruments includes lagged values of log(gdp_pc) and prim_comm plus lat_abst and legor_uk (see Appendix for variables description). *, **, *** denote statistical significance at the usual confidence levels.

Table 3: Sensitivity analysis

	I	II	III	IV
Constant	6.177 ***	6.296 ***	4.978 ***	5.711 ***
log(gdp_pc)	-0.802 ***	-0.808 ***	-0.689 ***	-0.661 ***
prim_comm			0.010 **	0.004 **
fuels_metals	0.005 ***			
agric_food		0.002 ***		
inst_quality				-0.128
trade				-0.004 ***
gov_cons				0.016
R2	0.7	0.92	0.71	0.81
Observations	384	384	201	362

Notes: Instrumental variables estimation in all columns. The set of instruments includes lagged values of the regressors plus lat_abst and legor_uk in columns I, II, and III. In column III the variables legor_sc and legor_ge are also added to the list of instruments. In column IV, the list of instruments includes lagged values of log(gdp_pc), prim_comm, trade, and gov_cons plus lat_abst, legor_uk and legor_sc (see Appendix for variables description). *, **, *** denote statistical significance at the usual confidence levels.

Table 4: Transmission channels

Equation-by-equation estimation			System estimation		
	I	II	III	IV	
			Dep variable is	***socdev***	***socdev***
Constant	4.992***	5.574***	constant	5.179***	5.169***
log(gdp_pc)	-0.779***	-0.784***	log(gdp_pc)	-0.745***	-0.722***
prim_comm	0.003	-0.003	inequality	0.020*	..
trade	-0.007***	-0.006***	volatility	..	0.282**
inst_qual	0.119	0.001	trade	-0.007***	-0.005***
gov_cons	-0.013	0.014	***Dep variable is***	***inequality***	***volatility***
inequality	0.017**	..	constant	54.143***	1.564***
volatility	..	0.312***	prim_comm	0.098***	0.015***
			inst_qual	-3.800***	
			trade	0.036*	
			log(gdp_pc)		0.095***
			tot_vol		0.020
			K_open		-0.129***
R2	0.74	0.65	Total system obs	412	759
Obse	181	362	J-stat	5.52	7.84
J-stat	3.93	0.52			

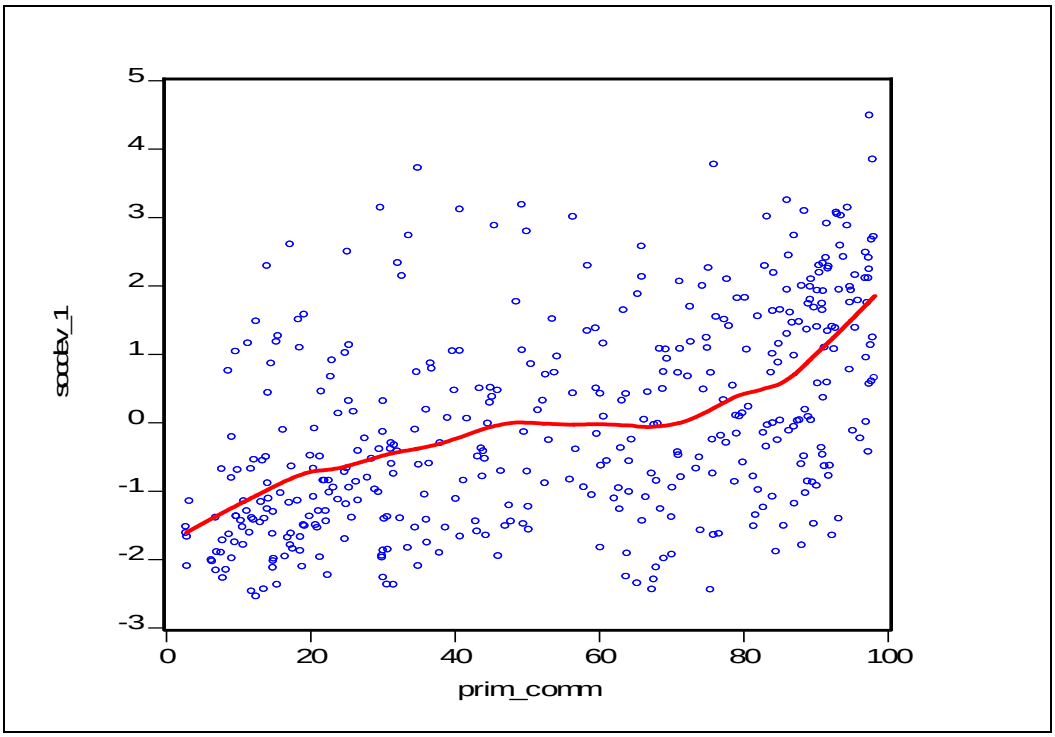
Notes: The left panel of the table reports equation-by-equation instrumental variables estimates. The set of instruments includes lagged values of all regressors, expect for Inequality in column I and Volatility in column II, plus lat_abst, legor_uk, and legor_sc (this latter only in column II). The Hausman test suggests treating inequality as exogenous in column I. Instead, volatility in equation II is instrumented by k_open (see Appendix for variables description). The right panel of the table reports system estimations based on GMM. Instruments are as follows. Equation 1 (dependent variable is soc_dev_1): lagged log(gdp_pc) and trade, lat_abst and legor_uk. Equation 2 (dependent variable is inequality in column III and volatility in column IV), column III: lagged prim_comm, legor_uk, legor_sc, trade, column IV: lagged log(gdp_pc) and prim_comm, legor_uk, legor_sc, lat_abst, tot_vol, and k_open.

Table 5: Diagnostics on the validity of instruments

Regression model		Endogenous variables	Partial R^2	Shea partial R^2	Sargan-statistic (p value)
Table 2 Column IV		Log(gdp_pc)	0.9584	0.9069	1.67 (0.43)
		Prim_comm	0.8594	0.8133	
Table 3 Column I		Log(gdp_pc)	0.9792	0.9784	0.7 (0.53)
		Fuels_metals	0.8127	0.8121	
Table 3 Column II		Log(gdp_pc)	0.9792	0.9738	6.66 (0.15)
		Agric_food	0.7071	0.7111	
Table 3 Column III		Log(gdp_pc)	0.9584	0.9069	0.59 (0.74)
		Prim_comm	0.8594	0.8133	
Table 3 Column IV		Log(gdp_pc)	0.9751	0.6342	0.1 (0.95)
		Prim_comm	0.8788	0.6454	
		Inst_quality	0.6686	0.4028	
		Trade	0.8116	0.7146	
		Gov_cons	0.7844	0.6123	
Table 4 Column I		Log(gdp_pc)	0.9927	0.7123	3.93 (0.14)
		Prim_comm	0.8889	0.8845	
		Inst_quality	0.5323	0.3927	
		Trade	0.8662	0.8311	
		Gov_cons	0.7863	0.6147	
Table 4 Column II		Log(gdp_pc)	0.9754	0.6893	0.52 (0.77)
		Prim_comm	0.8789	0.8241	
		Inst_quality	0.6824	0.4464	
		Trade	0.8138	0.7355	
		Gov_cons	0.7872	0.5001	
		volatility	0.1761	0.1567	
Table 4 Column IIII	Socdev equation	Log (gdp_pc)	0.9733	0.9602	5.52 (0.14)
		Trade	0.8620	0.8554	
		Inequality	0.3646	0.3611	
	Inequality equation	Prim_comm	0.8510	0.6022	
		Inst_quality	0.3358	0.2376	
Table 4 Column IV	Socdev equation	Log (gdp_pc)	0.9575	0.7702	7.531 (0.15)
		Trade	0.7856	0.6594	
		Volatility	0.1899	0.1596	
	Volatility equation	Log(gdp_pc)	0.9480	0.9257	
		Prim_comm	0.8925	0.8716	

See Appendix for a description of the test statistics.

Figure 1: Non-parametric scatter plots of social underdevelopment and dependence on primary commodities



Note: Scatters with nearest neighbour fit. For each data-point, the local regression includes 30% of total sample observations. In each local regression, a polynomial of degree 1 is fitted. The observations of each local regression are weighted using tricube weights that decrease as the observation gets more distant from the data-point. See Appendix for variables definition.

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