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1 • Trends and cycles in primary commodities: state space modelling and the Kalman filter

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Abstract

Decomposing economic time series into their temporary and permanent components have followed two broad paths: trend versus difference stationary models and detrending versus filtering. Whereas the former breaks down due to their inability to capture the underlying data generation process (dgp), the latter are either one sided filters or are based on ad hoc procedures in achieving parsimony. In this paper, we propose structural time series models in which trends, cycles, seasonal components are treated as stochastic, and which contains the traditional approach as a special case. Cast in state space form, and estimated using maximum likelihood via the Kalman filter, these models accurately predict the behaviour of commodity prices through time. Using data on agricultural raw materials and metal price indices for the 1957(1) to 2008(4) period we document the frequency and duration of commodity prices, key elements for designing policies aimed at smoothing terms of trade shocks and the resulting macroeconomic effects associated with price disruptions. We found that the individual dgp have varied over time and are best captured as stochastic rather than deterministic trends. Moreover, we uncover multiple structural breaks and outliers, far beyond what extant results would like us to believe. Finally, the models remain robust in an out of sample forecast.

Key Words: commodity prices, terms of trade shocks, trends, cycles and state space models.
JEL classification: C51, Q11, E32

Introduction

All primary commodities exhibit certain stylized facts: they have grown above average over the past 60 years, and have fallen much less so during the same period; slowing more with recessions, and rising faster with upturns. The short-run fluctuations in primary commodity prices are noted to be demand driven, and sometimes display evidence of lagged supply response, while the long-run trend is supply driven and tend to follow advances in technology in primary, relative to manufactured industries (see Cashin and McDermott, 2002; Deaton and Laroque, 1992). Whereas a lot has been written about the behaviour of commodity markets, there are still many gaps in our knowledge concerning the short-run cyclical fluctuations and long-term trends.

Extant knowledge have followed two broad paths: trend and difference stationary models and their various extensions that account for structural breaks and, detrending procedures based on Beveridge and Nelson (1981), type decomposition and Hodrick and Prescott (1980), for short, style of detrending. While the former suffer from low power, imposes a restrictive deterministic time trend plus a stationary component which is sometimes misleading and indeed unnecessary (see Harvey, 1997), the latter, notably, techniques are based on ad hoc procedures in their model selection, while the Hodrick and Prescott filters employ mechanical means to separate the long-run from the short term components. In this paper, we propose unobserved components to overcome the intractable difficulties encountered in extant literature.

First, estimating the change in the secular terms of trade inevitably faces serious statistical difficulties. For example, results are very sensitive to which years are taken as the beginning and end of the data series and the

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way the price indices of exports and imports are calculated. We favour this model based as opposed to the model free procedures found in the literature as they capture the salient features of the data that are useful in analysing and predicting the short run and long run behaviour of commodity terms of trade. Moreover, it is easy to incorporate changing patterns and to introduce additional features such as interventions.

Second, in contrast with previous studies that rely on cross-country evidence, we concentrate on individual commodity prices. With cross-country studies, a movement in the commodity prices, and hence the overall terms of trade of all developing countries does not have much relevance for individual countries in the context of policy prescriptions. For example, a developing country exporting mainly beverages would have found its terms of trade rising very little between 1972 and 2001, while developing countries exporting primarily raw materials, metals and especially petroleum experienced a large increase in their terms of trade. Thus, what is important is the type of product in a nations exports and the change in the price of those products over time. We account for this by focusing on specific commodity indices for which movements in global demand and supply conditions would have implications for the terms of trade of exporting nations. Our results indicate that nearly all recessions since the 1960s have been preceded by some kind of commodity price shock. Metal prices tend to track the economic cycle while agricultural raw materials fluctuate anywhere from every 2.5 to 8 years. These fluctuations are persistent in both boom and burst phases and can lessen as well as exacerbate recessions.

Section 2 outlines the structural time series models applied in decomposing our set of commodity prices.

Section 3 briefly reviews the trends in primary commodity prices. We decompose the cycles in section 4 and discuss policies aimed at smoothing short run shocks to commodity terms of trade for exporting countries.

Section 5 discusses interventions beyond the short run.

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Model set up: unobserved components

We propose structural time series models that typically consist of interpretable components such as trend, cycle, seasonal and irregular components. Each component is set up in such a way that the dynamic stochastic process depends on normally distributed disturbances. With regards to the terms of trade series, this seems to be the most plausible way of decomposing trends and cycles as opposed to the alternative analysis based on Hodrick-Prescott filter and Beveridge-Nelson decomposition. The deterministic trend is a limiting case in which the hyperparameters which allow the level and slope to change are equal to zero. This allows us to investigate the long-run and shortrun dynamics of commodity prices, while modelling the observed and unobserved components associated with them. Following Harvey (1989), Harvey and Koopman (2000), the logarithm of the terms of trade index x can be represented with stochastic unobservable components as follows

$$\chi_t = \mu_t + \psi_t + \varepsilon_t \qquad t = 1, \ldots, T \tag{1}$$

where μ_t is a trend component, ψ_t is a cycle component and ε_t is an irregular component. We assume that the ψ_t is a stationary white noise process, ε_t is a white noise disturbance with variance σ^2 and the components are mutually uncorrelated. The linear trend can be written as

$$\mu_t = \mu_{t-1} + \beta_{t-1} + \eta_t \qquad t = 1, \ldots, T \tag{2}$$

$$\beta_t = \beta_{t-1} + \zeta \qquad t = 1, \ldots, T \tag{3}$$

Where η_t and ζ_t are independent white noise processes with variances σ^2_η and σ^2_ζ respectively. The cyclical component can be modelled as

$$\begin{bmatrix}\psi_t \\ \psi_t^*\end{bmatrix} = \rho \begin{bmatrix}\cos\lambda & \sin\lambda \\ -\sin\lambda & \sin\lambda\end{bmatrix} \begin{bmatrix}\psi_{t-1} \\ \psi^*_{t-1}\end{bmatrix} + \begin{bmatrix}\omega_t \\ \psi^*_t\end{bmatrix} \ldots 0 \le \lambda \le, 0 \le \rho \le 1 \tag{4}$$

where ω_t and ω^*_t are uncorrelated white noise processes with variances σ^2_ω and $\sigma^2_{\omega*}$ respectively (ψ^*_t appears by construction). Here λ can be thought of as the frequency of the cycle and ρ as a damping factor of the amplitude. Although this formulation appears rather peculiar, it allows for a great variety of processes. The cycle can be written as

$$(1 - 2\rho\cos\lambda L + \rho^2 L^2)\,\psi_t = (1 - \rho\cos\lambda L)\,\omega_t + (\rho\sin\lambda L)\omega^*_t \tag{5}$$

which is an ARMA (2, 1) (L is the lag operator).

If $\sigma_\omega^2 = \sigma^2_{\omega*}$, it reduces to an AR(2) with complex roots, whereas if either $\lambda = 0$ or $\lambda = \eta$, then the cycle is AR(1).

We assume $\sigma_\omega^2 = \sigma^2_{\omega*}$

Equations (1), (2), (4) and (5) can be cast in state space form. The parameters λ, ρ, σ^2_ω and σ^2_η are estimated by maximizing the likelihood of the observed sample with respect to these parameters through the Kalman filter. A

comparison of different non-tested models can be made either using the maximized likelihood function (L) or the prediction error variance (PEV), which is the steady-state variance of the one-step ahead prediction error.

Equations (1), (2), (4) and (5) also imply an ARMA representation of

$$\chi_t = \frac{1}{\Delta^2}(\xi_{t-1} + \Delta\eta_t) + \frac{(1 - \rho\cos\lambda L + \rho\sin\lambda L)\,\omega_t}{(1 - \Phi_1 L - \Phi_2 L^2)} + \varepsilon_t \quad (6)$$

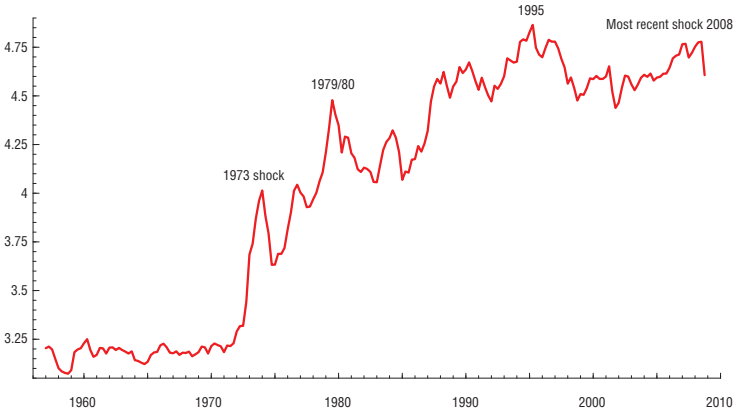
where $\Delta = (1 - L)$ is the first difference operator. Equation (5) shows that a structural time series model can be thought of as an unobserved component ARMA (2, 2, 4) with at most two unit roots. Thus, if $\sigma^2_\xi = 0$, i.e the slope is constant, and $\sigma^2_\eta > 0$, then $\aleph_t$ is stationary in first differences, whereas if $\sigma^2_\xi = \sigma_\omega^2 = \sigma^2$ then $\aleph_t$ is difference stationary. Conversely, if $\sigma^2_\eta = \sigma^2_\xi = \sigma_\omega^2 = 0$, then $\aleph_t$ is trend stationary and all the variance is attributed to the irregular component. Here the trend is linear and deterministic and has a non-zero constant drift. If $\sigma_\omega^2 > 0$, $\aleph_t$ is still trend stationary with richer dynamics (it is an ARMA(2,2)) and all the variance is attributed to the cyclical and residual components. The most general model has stochastic trend, stochastic slope and a stationary ARMA cycle. Among the restricted versions of the basic structural model are the deterministic trend model with constant slope and the stochastic trend model with AR (1) cycle. In the former restrictions are $\sigma^2_\eta = \sigma^2_\xi = 0$ while in the latter $\lambda = 0$ or $\lambda = \pi$.

What has been happening to commodity prices?

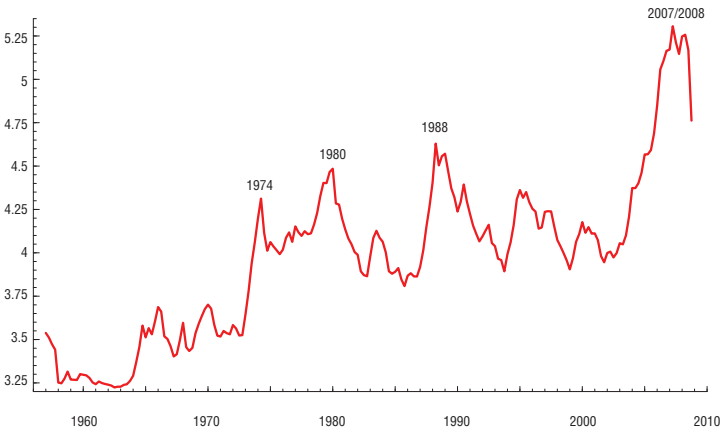
Prior to the 2007/2008 asset price bubble the world economy was hit by two shocks: a tsunami of energy and food price rises. At the end of 2006, the price of crude oil was about $60/barrel and, about $90/barrel at the end of 2007. It leapt from around $100/barrel and reached an all time peak of $145/barrel in 2008 before receding with the recession. Along side the rising energy costs was another shock, described as the 'silent tsunami' by the director general of the World Food Programme: explosion in world food prices. A worldwide commodity price boom picked up pace in 2007, with the IMF commodity price index indicating a 45% hike since the end of 2006, mirroring earlier price run-ups in other commodities such as tin, nickel, soybeans, corn, wheat, and rice. In 2007 wheat prices rose 77% and, rice 16%. Record prices for fuel and food gave a vicious twist to inflation, pushing up the cost of living for workers, cut backs on air travel due to high surcharges and arguably, are partly to blame for propelling industrial and emerging economies closer to a recession even before the explosion in the sub prime mortgage sector[1]. Figure 1 shows the plot of the two commodities analysed: agricultural raw material and metals. The data set is data is quarterly from 1957(1) to 2008(4). The two indices track important commodities traded internationally. The components of the agricultural raw materials index and their respective weights in the International Financial Statistics (IFS) calculations are; cotton (1.1%), hides (3.1%), rubber (1.1%), timber (5%) and wool (1.1%). The metals index has aluminium (6.1%), copper (5.1%), iron ore (1.8%), lead (0.3%), nickel (1.2%), tin (0.3%), uranium (0.7%) and zinc (0.9%).

Figure 1: Logarithms of commodity prices

Agricultural raw materials



Metals



A cursory look at the graphs depicts that booms and bursts in commodity prices have mimicked upturns and downturns in the global economy since the 1960s, indicating that vagaries in real commodity prices either

[1] *Admittedly, however, in real terms, prices of many commodities, particularly food, remained well below their highs in the 1970s and early 1980s, with the main exceptions of crude oil, lead, and nickel. In addition, the inflationary pressure such high prices induced is nowhere near earlier decades.*

precede or lead recessions. We can infer from the graph that before 1973 commodity prices have been relatively stable, with metal prices depicting more variability than agricultural raw materials. The entry of the cartel OPEC in the 1970s and the subsequent 1973 oil price shock drove all commodity prices upward (this is true for all non-fuel primary commodities after the 1973 oil shock). In a space of just one year, metal prices went up by 18.6% from 3.5% in 1972 to 4.3% in 1973. Agricultural raw materials also rose by 20% during the same period. Commodity prices have continued their upward trend since then, punctuated by slumps. However, the recession that followed this boom, sent commodity prices trending downwards in real terms from the mid 1970s to most of the 1980s. Metal prices went down by 5.4% in 1975, 25% in the 1980s recession and all time drop of 34.7% in 1993. Agricultural raw materials followed similar patterns with 19.2% drop in 1975, 12.9% in 1980 and 14% in 1990. The early 1990 recession, coupled with the 2000s recessions depressed prices until the recent boom from 2004 onwards. The end of the sample in Figure 1 shows that the rate of growth of metal prices has been faster than agricultural raw materials, and the price build up that started in 2004 ended with the 2007/2008 recession. Importantly, Figure 1 shows that commodity prices begun to weaken by the end of 2008, even faster for metals. The slump in global growth from the first quarter of 2008, subdued demand from industrialized economies and the lackluster performance of emerging markets, notably India and China, account for the recent weakness. The trends of commodity prices is of particular importance since they capture the permanent component of prices, and are likely to be driven by production and technology advances in primary industries, while the cyclical patterns capture the temporary components, reflecting demand conditions and/or lagged supply response. Thus from the point of view of policy when assessing the near-to-medium term outlook for commodity prices, it is important to have an idea to what extent the cycles persists, and how they inform the trend.

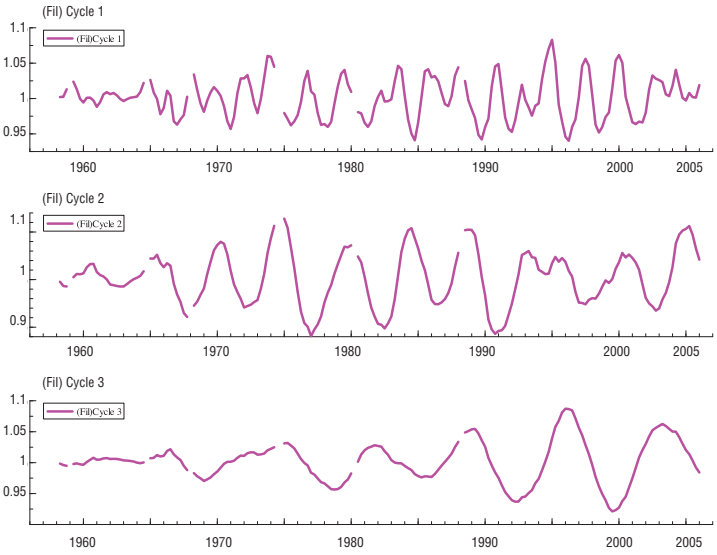
These swings in commodity prices calls for a critical look at the trends and cycles imbedded in real time movement in commodity prices. Such an exercise is crucial because more than half the developing world dwells on the export of some one or two primary commodities for export earnings. The Food and Agricultural Organisation (FAO) estimates that over 2.5 billion people in the developing world depend on the soil for their livelihoods. Thus the long-term trends, short-term shocks and price spikes in commodity markets aren't just arcane macro-economic phenomena – they have very real impacts on the day to day lives of people everywhere i.e. whether they are cotton farmers in Mali, oil workers in Nigeria or copper miners in Zambia. It equally affects the price we all pay for food and clothing and manufactured goods, and most importantly, the global economy as we see in the current recession

Decomposing the cycles

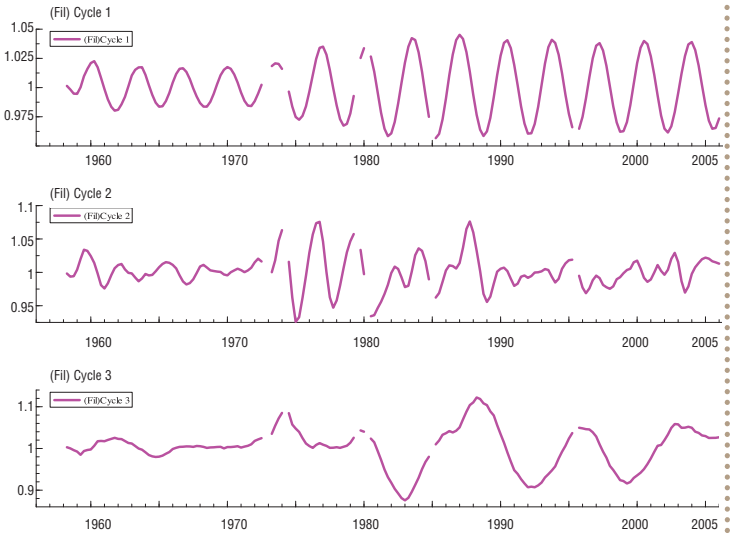
A common misunderstood behaviour of commodity prices is the cyclical fluctuations around the trend. Figure two plots 3 filtered cycles estimated using state-space methods for two the two commodities. For metals, the time span for the first cycle shows periodicity of 9.6 quarters, approximately 2 years. This is similar to the second cycle for agricultural raw materials, where the cycle is about 2.5 years. For metals, we document that the second cycle approximate that of a normal business cycle, estimated to be about 5 years in length. The third cycle for both commodities is longer, 7 years for metals and 8 years for agricultural raw materials. The speed with which commodity price cycles die are quite persistent, estimated to average 0.9 for the three cycles in both commodities. The existence and persistence of these cycles raises important policy questions about the stabilization and, consumption and income smoothing of both producing and consuming nations alike, given that these short-run fluctuations impact on the macroeconomic and balance of payments positions of commodity exporters. A traditional argument to lessen the effects of the short-run fluctuations is for governments of raw material nations to intervene.

Figure 2: Cycles in Commodity Prices

Metals



Agricultural raw materials



This argument is in turn informed by microeconomic considerations. If private agents bear all the downside risk of commodity price (and supply is inelastic in the short-run), they will face variable and unpredictable incomes streams over time, with possibly very limited opportunity to smooth income. Thus, it may be optimal for the government to intervene to stabilize prices received by private agents and thus enhance the welfare of risk averse individuals by permitting smoother income and consumption streams. Implicit in this explanation however, is the assumption that individual agents are myopic, and /or they may lack information to form reasonable expectations about the nature of price shocks. The evidence to date suggests that this is not observed in reality. Micro surveys indicate that rice farmers in Thailand for example smooth their consumption quite successfully both within and between harvest years. Evidence from Ghana shows that small holders are capable of making intertemporary choices between consumption and savings. This is particularly evident in the cocoa boom in 2002/2003. Cocoa producers found that the boom was largely due to the political problems in Ivory Coast. A lot has also been written about the Kenyan coffee boom of 1976–79 where as much as 60% of boom income went into private savings, simply because farmers were aware that the boom was due to frost damage in Brazil and that their income gains were largely transitory. In contrast, the Kenyan government went on a spending spree following the coffee boom, far in excess of revenues. Although the evidence goes contrary to what theory predicts, there is a big role for governments in commodity price fluctuations, other than direct interference with the price signals. This could be achieved through social safety nets measures, such as government taking stakes in raw material based industries, so that in return for holding equity in such concerns may also levy export and income taxes. Export revenue taxes (whether in the form of specific and ad valorem taxes and adjustable levies) have been popular with commodity exporting countries in generating revenues to stabilize the price disruptions that result from commodity price fluctuations. The establishment of marketing boards is yet another measure to smooth the path of price fluctuations. These boards set producer prices below international prices with the view to stabilizing incomes of private agents while the fluctuation in international commodity prices are transmitted directly to the budget via export taxes or surpluses generated by the marketing boards. One difficult problem in these interventions is the potential backlash they have by creating all manner of rent seeking behaviour, which in the long-run defeats the very purpose for which they have been established. Thus not only does strong institutional backing and monitoring needed but also a rethink of the incentive structure that keeps rent seeking behaviour alive and profitable is required for successful operation.

Raw material based developing countries have also designed stabilization funds to deal with the impact of the temporary fluctuations in commodity prices, particularly managing export receipts to serve as a buffer in stormy times. The existence of stabilization funds, it is argued, impose a rule on governments, designed to use resources more optimally from a long term perspective and lessen the risk that governments may be tempted to increase spending excessively during temporary booms. However, there is no evidence to suggest that a third world a government facing elections may remain disciplined with regards to spending.

Further, their design imposes the same rent seeking behaviour that boards present. That said, it may be important that countries time investments in new projects to take advantage of the cyclical upturns and thus improve project profitability. Moreover, hedging the downside risk associated with slumps in commodity prices that typically occur anywhere between 2 to 7 years provide a better way out of the boom-burst behaviour of commodities. This is particularly crucial and more tractable, given that, knowledge on the timing and duration of price slumps has improved dramatically.

Beyond the cyclical fluctuations

In the long-run, policies needed to deal with the commodity price debacle are different. Our evidence suggests that the long-run trend of commodities has

been characterized by huge shocks and structural changes, providing a kind of feedback loop, namely that, whereas the short-run cycles persist and inform the long-run trend, the structural changes and breaks in the long-run trend feed into the short-run cycles. Most developing countries embarked on import substitution in the 1950s/60s as a way of reallocating resources away from primary production into heavy industry and manufactures directed to the local market. For most African and Latin American countries, the results have been largely disastrous, partly because investments were undertaken in industries where the countries did not enjoy comparative advantage, and/or lacked technical know-how, but most importantly because the state took centre stage in the import substitution business thus undermining the profit motive that innovation and competition brings to the market place. Attempts have also been made by developing countries to adopt more outward oriented trade regimes from the 1980s onwards, but the terms of engagement here have been skewed against developing nations, with the same composition of raw material exports and manufactured imports. For Latin America and Asia, progress has been made since the 1980s with greater diversification and robust exports in semi-processed and manufactured exports. Africa's performance has lagged far behind other regions in this respect. The evidence from commodity exporting OECD countries such as Australia, Norway and Canada indicates that sound management of export receipts, robust political and economic institutions, determined approach to diversification, proper investment in commodity producing infrastructure and sound corporate performance are sine qua non to successful raw material based economies. The suggestion of international commodity agreements, albeit works well for OPEC, has not been successful in other commodity classes. Again the experience of OECD commodity exporters suggests that such cartels are neither necessary nor sufficient conditions for a successful home grown commodity economy. Looking ahead, commodity exporting developing countries by requiring a substantial proportion of the raw materials to be processed domestically for export. In contrast to the prevailing logic of import substitution in the earlier decades, such industries should be driven mainly by economic imperatives rather than political whims. Private-public, private-private partnerships may hold an important lesson in this respect, with state driving infrastructure development and attending to the institutional bottlenecks that more often kick against private initiative, while the private sector concentrate on the wealth creating business. Implicit here is that the state of technology and capital (most notably financial capital and machines) is given. The industries thus established retains the bulk of the employment that is exported with the commodities and the attendant outlook for the balance of payments and budget position. The technology transfer that ensues also transmits to the local economy. Very recently, Botswana has been successful in negotiating a contract with DeBeers, the world's largest dealer in diamonds to open a processing factory in Botswana. With 25% of the worlds diamond coming from this source such a venture, across commodity exporting countries such as Zambia (copper), Ghana (cocoa and gold), hold the single most important promise for dealing with the long term weaknesses evident in commodity prices. However, the opening factories in raw material sources is not enough if sufficient demand cannot be generated for the products thus produced. Thus, commodity producing developing countries endeavour to reduce dependence on external markets by encouraging local demand. Admittedly, this is itself a function of incomes, and hence requires robust economic and sustainable growth to alter the current dynamics.

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2 • Does political stability improve the aid-growth relationship? A panel evidence on selected Sub-Saharan African countries

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Abstract

Significant ambiguity still surrounds the aid-growth relationship despite fifty years of research on the subject. For the case of Sub-Saharan Africa (SSA), a possible reason for the lack of consensus is that until recently the influence of political stability on the aid-growth relationship had been largely ignored despite its relevance for the region. Further, although overlooked by the literature, the Instrumental Variable (IV) technique, the preferred treatment method of endogeneity in aid-growth relationships, may be ineffective in eliminating endogeneity bias because typical instruments for aid are neither sufficiently exogenous nor strong. Using a dataset of 31 SSA countries from 1984-2007, we re-visit the question of whether aid can spur growth in SSA using first-differencing (FD) to eliminate unobserved effect endogeneity while focusing on the role of political stability on the aid-growth relationship in SSA. Results suggest aid promotes growth conditional on political stability in SSA and that First Differencing (FD) eliminates a substantial amount of the endogeneity bias. Our results demonstrate the pertinence of a stable political environment to attaining the UN's Millennium Development Goals (MDGs) for SSA countries since these goals inherently assume that aid can promote growth.

Key Words: Growth, Aid, Political Stability, Endogeneity, SSA, and IV.
JEL classification: 011

Introduction

Despite repeated warnings by economists of its futility, the developed world still provides lots of aid to Sub-Saharan Africa (SSA) to spur economic growth (Leeson, 2008 and Arndt, Jones and Tarp, 2010). SSA has absorbed almost one trillion nominal aid dollars over the last fifty years but the growth record has been unimpressive (Mayo, 2009 and Easterly, 2006). The insistence of developed countries to bestow aid on SSA is not so confounding if one considers that ambiguity still surrounds the effect of foreign aid on growth (Naito, 2010 and Bruckner, 2011). In particular, estimation of the aid-growth relationship is fraught with different kinds of endogeneity problems (Rajan and Subramanian, 2008 and Deaton, 2008). Further, since SSA has been racked by political instability, a question emerges about the effect of political stability on the aid-growth relationship in the region.

Given the uncertainty about the effect of aid on growth, and the possible consequences of political stability on the aid-growth relationship, this paper seeks to: (1) empirically determine if aid and growth are related using recent SSA data, and (2) identify the effects of political stability on the aid-growth relationship in SSA after accounting for possible endogeneity bias.

The article contributes to the literature in three main ways. First, it focuses on the SSA region and employs recent data in estimating the effect of political stability on the aid-growth relationship. Second, it uses a dependable measure of political stability constructed with Political Risk Service (PRS)'s International Country Risk Guide (ICRG) dataset to identify the effect of political stability on the aid-growth relationship in SSA. Finally the possibility of endogeneity bias is addressed: The current literature treatment of endogeneity with IV is criticized while FD is justified and employed in estimating the aid-growth

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regression. Aid is found to be positively and significantly related to growth in SSA conditional on political stability after minimizing endogeneity bias. This result confirms Islam's (2005) finding that aid promotes growth in stable but not in unstable LDCs.

Literature review

There are valid theoretical arguments as to why the effect of aid on growth might be positive, negative, linear, nonlinear or even ambiguous (Minoiua, and Reddyb, 2010; Easterly, 2006 and Hansen and Tarp, 2001). On one hand, "Gap theory" contends that aid promotes growth by augmenting the investment and foreign exchange needed for production and growth (Chenery and Strout, 1966).

On the other hand, countries that receive aid might consume it, leading to aid-dependence (Bauer, 1984, 1991and 2000; Mayo, 2009; Rajan, and Subramanian, 2011 and Arndt, Jones and Tarp, 2010). Clearly, aid might hurt or promote growth, so the effect of aid on growth remains an empirical question (Rajan and Subramanian, 2008 and Bruckner, 2011). Comprehending the exact relationship between aid and growth is, however, crucial to SSA countries and donors as they seek to realize the UN's MDGs because the MDGs inherently posit that aid is growth-promoting (see Appendix 1 for details of the eight MDGs). The stated aim of the MDGs is to halve severe $1/day poverty between 1990 and 2015 using aid as one strategy (Sachs, 2005 and Collier, 2007) so it's vital to ascertain with a reasonable degree of confidence how aid affects growth in SSA.

Entangled in the debate on how aid affects growth are differences in the structure of the economic model, the context under which aid is effective, the econometric procedures employed and the data used. In particular, the effect of aid on growth is likely to be context-specific therefore identifying the salient features of the context received a lot of attention in the literature. Burnside and Dollar (2000) (henceforth BD (2000)) identified good macroeconomic policy as the salient contextual condition for aid to promote growth. They found that the aid-growth relation is positive for countries that maintain sound economic policies but negative for countries with inappropriate policies, basing their result on a positive and significant interaction term involving aid and policy. BD (2000) included a dummy for SSA which proved negative and significant in aid-growth regressions, indicating that the aid-growth effect may be different for SSA. This point is noteworthy as effective policy might be insufficient to guarantee the efficacy of aid in promoting growth in SSA. Not surprisingly, the contention that aid promotes growth given good policy has been successfully challenged in the literature. For example, Easterly, Levine and Roodman (2004) showed that the positive aid effect given good policy disappears when either more time series data or different countries are used in the data set. In contrast, Islam (2005) finds that the aid-growth relationship must be conditioned on political stability, not macroeconomic policy as political stability is the more pertinent determinant of the efficacy of aid in stimulating growth.

Like Islam (2005), our objective is to investigate whether political stability influences the aid-growth relationship. However, we limit our dataset to SSA because this is our region of interest and because SSA appears to experience relatively high levels of instability. We investigate the effect of political stability on the aid-growth relationship and address two types of endogeneity also identified by Hansen and Tarp (2001): (i) simultaneity (caused by feedback from growth to aid) and (ii) unobserved effects endogeneity caused by correlation between latent, time-invariant (and or time-varying) country-specific effects in the error matrix and the matrix of right hand side variables. Both types of endogeneity can cause bias in OLS estimation of aid-growth relationships so their deleterious effects need to be properly mitigated. While the aid-growth literature only now focuses on reducing bias due to unobserved effect endogeneity, it abounds with attempts to control simultaneity bias using IV. There is however limited literature that focuses on evaluating whether the typical instruments for aid used in IV estimation of aid-growth regressions such as population satisfy the exogeneity and strength criteria defined for valid instrumental variables analysis (Deaton, 2008). This research will help close that literature gap. For example, population may be endogenous in the growth equation for SSA countries. Therefore, in contrast to the IV treatment of the endogeneity of aid by Islam (2005), Burnside and Dollar (2000), and majority of the aid literature, typical instruments for aid may actually be invalid instruments for aid. Colonial legacy (Islam 2005) and rainfall (Bruckner, 2001), however, may be argued to be exogenous instruments for aid since they are not determined by contemporaneous economic performance. However, they are not excludable; that is, they belong to the true model and should enter the growth equation as explanatory variables and should not be used as instruments. Finally, except for Deaton (2008) the literature has not focused on evaluating the "strenght" of instrument for aid in aid-growth regressions.

Empirical model

The model used in this paper is a modified version of Islam's (2005) empirical aid-growth model which was derived from Solow's (1956) theoretical growth model and is standard in the aid-growth literature. Following Islam (2005), aid is hypothesized to affect growth through its effect on savings and investment. Political stability affects the aid-growth link through its effect on the ability of a nation's citizens to accumulate capital, save, invest and innovate (Hansen and Tarp, 2011). In particular a stable political environment can lead to effective economic policies and correct investment decisions both of which can spur growth. In a stable political environment, aid is then just new capital and should logically contribute to growth (Hansen and Tarp, 2001). The effects of political stability on the aid-growth relationship can thus be captured in the empirical model by the interaction between political stability and aid. The empirical growth model employed is presented in (1)–(3) and used to investigate the relationship between economic growth and foreign aid, as well as the effects of political stability on the aid-growth relationship in SSA.

$$(1)\ \boldsymbol{GROWTH}_{it} = \gamma_0 + \gamma_{AID}\,\boldsymbol{AID}_{t-1} + \gamma_{AIDSQ}\,\boldsymbol{AID}^2_{t-1} + \gamma_{AIDPS}\,\boldsymbol{AIDPS}_{t-1} + \gamma_{PS}\,\boldsymbol{PS}_{t-1} + \gamma_{SQPS}\,\boldsymbol{PS}^2_{t-1} + \boldsymbol{Z}_{it}'\gamma_Z + \varepsilon_{it}$$

$$(2)\ \varepsilon_{it} = \varepsilon_i + \nu_{it}$$

$$(3)\ \nu_{it} \sim N(0, \sigma^2)$$

GROWTH is GDP per capita growth, *AID*, is foreign aid or Official Development Assistance (ODA), AID^2 is the square of *AID*, *PS* is political stability, PS^2 is the square of political stability, *AIDPS* is the interactions of *PS* with *AID*, and $\gamma 0$ is the overall constant. The vector *Z* includes variables that control for initial conditions affecting growth, and recent literature provides guidance for their selection (Islam, 2005). Z contains variables such as initial level of income (represented by initial GDP or IGDP), standard deviation of aid (STAID), level of education (PRIM), quality of institutions (represented by international country risk guide (ICRG)'s quality of bureaucracy and democratic accountability variables, BQUAL and DACC), government consumption as a portion of GDP (GCONS), and the money supply as proportion of GDP or (M2). Different from Islam (2005) but consistent with Rajan, and Subramanian (2011), Arndt, Jones and Tarp (2010) and Minoiua and Reddyb (2010), we explicitly specify the unobserved effects which are likely correlated with the explanatory variables in the error term. Thus, ε_{it} is a composite error consisting of a country-specific component, ε_{it} and an iid error term, ν_{it} which has variance σ.[2] We include a set of time dummies, one for each four-year period, to account for potential cyclical effects such as downturns in the world economy that may affect the aid-growth relationship.

The sign of the relationship between aid and growth remains an empirical question and may depend on the countries examined (Easterly, 2003). Political stability is expected to positively promote growth. While quality of institutions, level of education and the money supply variables are expected to be positively related to growth, government consumption and the standard deviation of aid are expected to be negatively correlated with growth. Initial GDP will also likely reduce growth as dictated by conditional convergence (Barro, 1996). Following Easterly, Levine, and Dollar (2004) the square of aid is also included as a regressor in the growth equation to account for other possible types of non-linearity.

Data description and summary statistics

The aid data are from SourceOECD while the political stability data are from the Political Risk Service (PRS) and are described in detail later in the paper. Aid as used here refers to Oversees Development Assistance (ODA) typically given to poorer countries by richer donors and is exclusive of non-ODA aid. According to the development Assistance Committee (DAC) of the OECD, there are two main types of ODA aid; multilateral and bilateral aid. About 30% of ODA aid is multi-lateral aid and the remaining 70% is bilateral aid. Total ODA is used in this research. ODA donor countries belong to the Organization of Economic Cooperation and Development (OECD) and together donate about 80% of total worldwide aid. China and India have recently become significant donors together accounting for more than 10% of total current aid but such aid is not ODA aid and is not considered in this research. Private organizations provide 10% of worldwide aid (OECD).

The growth data and the remainder of the data are from the World Development Indicators (WDI) of the World Bank, the Penn World Tables, and the World Banks' Africa Database CD. The data come from 31 SSA countries for which data were available, range from 1984 to 2007 and cover six four-year periods (i.e. 1984–1987 to 2004–2007). Apart from possible sample selection bias that may emerge since not all SSA countries are included in the dataset, there are also missing observations leading to an unbalanced panel.

It is also plausible that countries with worse institutions

(or more likely to be afflicted by war) are less likely to have good quality data so they are not part of the sample. Such countries are perhaps also more likely to have a zero aid-growth relationship; so their absence would bias OLS results upward. Note, however, that the included SSA countries are spread within the SSA region and there is no evidence of a well-defined data generating process by which the SSA countries were picked therefore sample selection bias is unlikely to be too severe. With regards to missing data, of the 186 observations, 90 % of the data have complete sets of observations so the missing data problem will have limited consequence in OLS estimation even if more data is lost through lagging or first differencing.

Table 1 Descriptive statistics of key variables

Variable	*Description*	*Mean (SD)*	*Min (Max)*
Growth in per cap GDP (GROWTH)	Based on real GDP per capita in constant US dollars.[a]	0.400 (4.760)	-14.08 (32.13)
Initial GDP (IGDP) * $ 100 000 000	Real GDP per capita in the last year preceding the period for which the growth rate is calculated.[a]	688.929 (937.94)	56.52 (4599)
Aid (AID)	Net Official Development Assistance (ODA) disburse-ments as a percentage of GDP.[b&c]	0.1914 (0.2520)	0.001 (1.70)
Primary Schooling (PRIM)	Years of primary education.[a]	6.1621 (0.7100)	4.00 (8.00)
Financial Depth (M^2)	Money and quasi-money (M2) as a percentage of GDP. [a]	25.0366 (35.04)	-8.10 (368.4)
Life Expectancy (LE)	Life expectancy at birth, total (years).[a]	46.2442 (12.491)	10.00 (63. 06)
Political Stabilty (PS)	This is an assessment both	6.8130	1.70
Government (GCONS)	of the government"s ability to carry out its declared program(s), and its ability to stay in office. [f]	(2.4091)	(10.700)
	Gov consumption expenditure as a % of GDP. [a]	15.3340 (6.454)	5.9 (50.1)
Time Dummies	Each Dummy takes a value of 1 for particular period and 0 otherwise. The six 4-year time periods starts from 1984–1987 and end with 2004–2007. [e]		0.00000 (1.000)

Table 1 continued

Variable	*Description*	*Mean (SD)*	*Min (Max)*
Standard Deviation of Aid	Square root of the variance of Aid	1.52 (0.0002)	0.17 (0.2)
Investment profile (INVPROF)	Assessment of factors affecting risk to investment not covered by other political risk components. Ranges from 0–12. 12 is very low risk and 0 is high risk. [f]	5.7790 (2.0743)	0.500 (10.80)
Democratic Accountability	This is a measure of how responsive government is to its people. The minimum is 0 and represents the highest highest risk. The maxmum is 6 and represents lowest risk.[f]	2.605 (1.1236)	0.200 (5.60)
Bureaucratic Quality (BQUAL)	This is a measure of the quality of the bureaucracy. Ranges from 0–4 with 4 being the lowest risk.[f]	1.4130 (1.025)	0.000 (4.00)

Sources: [a]World Development Indicators; [b]OECD-DAC's online SourceOECD database; [c]World Bank's Africa Database C; [d]Sachs and Warner (1995); [e]Constructed variable; [f]International Country Risk Guide (ICRG) of Political Risk Services (PRS) and [g]Defined in detail in text.

Table 1 contains definitions and descriptive statistics of variables based on six four-year observations and provides detailed information about data sources and transformations of key variables used in the growth regressions in (1–3). The conversion of the annual data into four year periods is consistent with the time it takes for aid to manifest into growth (Moreira, 2005 and Clemens, Radelet and Bhavnani, 2004). Correlations between the main explanatory variables used in the analysis are presented in Table 2 on the next page. The correlations between the variables are low, typically less than 0.4, indicating that multicollinearity is not severe and should not distort statistical inference. Aid is negatively correlated to political stability and initial GDP, respectively (-0.19) and (-0.24), implying aid is not systematically allocated to politically stable countries.

Table 2 Correlation matrix of selected explanatory variables

	IGDP	Aid	POL	PS	PRIM	M2	BQUAL	DACC	LE	GCONS	INVPROF
IGDP	1										
AID	-0.1972	1									
POL	-0.0643	0.3644	1								
PS	-0.0096	-0.2487	0.083	1							
PRIM	0.0323	0.2071	-0.03	0.0906	1						
M2	0.3038	0.1295	0.199	-0.1076	0.422	1					
BQUAL	0.3684	-0.2402	0.003	0.0044	-0.098	0.1415	1				
DACC	0.1163	-0.1725	-0.02	0.3078 -	0.026 -	0.1911	0.2047	1			
LE	-0.055	0.132	-0.09	-0.2365	0.2141	0.1048	0.328	-0.0638	1		
GCONS	0.0609	0.1105	0.229	-0.319	-0.305	0.1675	-0.0262	-0.0868	-0.136	1	
INVPROF	0.0527	-0.1642	0.179	0.696	0.0915	-0.0562	0.1042	0.4819	-0.288 -	0.2083	1

Note: The SAA countries in the analysis include: Angola, Burkina Faso, Cameroon, Congo, Congo DR, Cote d'Ivoire, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Madagascar, Malawi, Mali, Namibia, Niger, Nigeria, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia and Zimbabwe.

Figure 1 provides a plot of the measure of political stability (PS) against growth rates. The PS measure is an assessment of the quality of governance, the government's ability to carry out its declared program (s) and its ability to stay in office. The rating is the sum of three subcomponents, each with a maximum score of four points and a minimum score of zero points. The subcomponents of the PS measure are government unity, legislative strength and popular support. For each subcomponent, a score of four points equates to very low risk and a score of zero points to very high risk. As a consequence of how its subcomponents are defined, a PS score of twelve points equates to very low risk (stable) and zero points to very high risk (unstable).

The PS measure was constructed using data from PRS's International Country Risk Guide (ICRG) dataset which covers 182 countries from 1980–2008 and is widely considered by political science researchers as the most reliable and comprehensive data on political stability available. The PS measure makes sense for the principal argument of this paper since good governance, and a lack of conflict reflected in government unity, legislative strength and popular support contributes to growth by making aid more effective. The sub-components of the PS capture the milder forms of political stability which likely affect the aid-growth relationship even in the absence of catastrophic events such as wars making the PS measure the best one for our purposes. Further, note that although the ICRG data has been widely used in the literature on corruption and governance, (see La Porta, Lopez-de-Silanes and Shleifer, (1997)) its use is not as widespread in the aid and growth literature. The popularity of the ICRG data has, however, increased recently as Knack and Keefer (2001) and Brautigam and Knack (2004) both employed PRS's ICRG data to study the impacts of aid on institutions and governance in SSA while Rajan and Subramanian (2008), Arnd et al (2010), and Minoiu and Reddy, (2010) employ the measure in aid-growth regressions. These authors reported that the political stability measures provided meaningful and intuitive findings. It is also noteworthy that the PRS data accurately captures changes in historical political stability among countries and over time as will be explained. Further, other more "recent" governance indicators e.g. Mo Ibrahim's index of governance provide rankings of countries which are consistent with the political stability measure used in this study providing some comfort that our measure is accurate. A final attribute of the PRS's ICRG dataset is that it provides the widest range of stability data both in terms of the number of SSA countries available and years covered and uses a well documented and reliable method where country experts rate countries over time and is thus a perfect fit for our purposes. It is possible to have slight differences in PS scores for particular countries say for Liberia relative to Ghana and South Africa in terms of ex post accuracy of forecast which may reflect the bias of the experts measuring the stability conditions. However such biases are likely to be time-invariant and will disappear when FD estimation is employed as was done in this paper.

Figure 1 Growth vs political stability, all SSA countries, 1984–2007

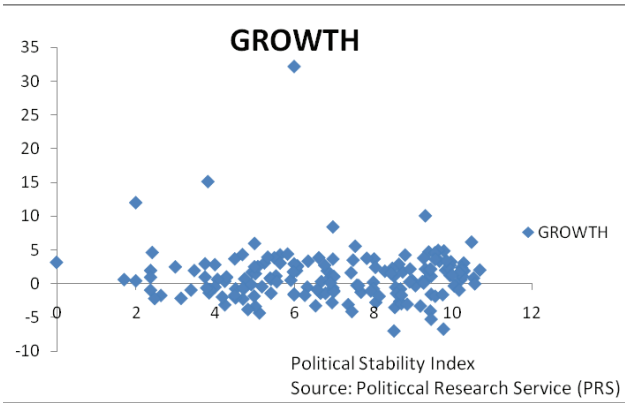


Figure 2 Political stability for the most stable SSA countries, 1984–2007

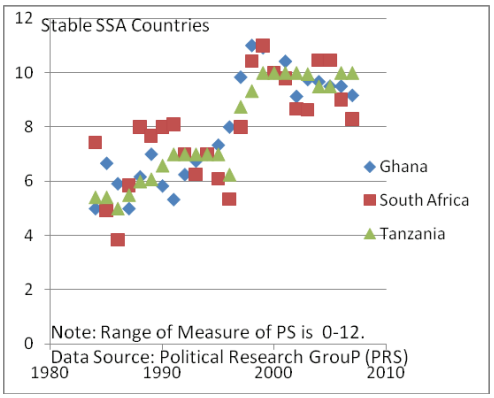


Figure 3 Political stability for the least stable SSA countries, 1984–2007

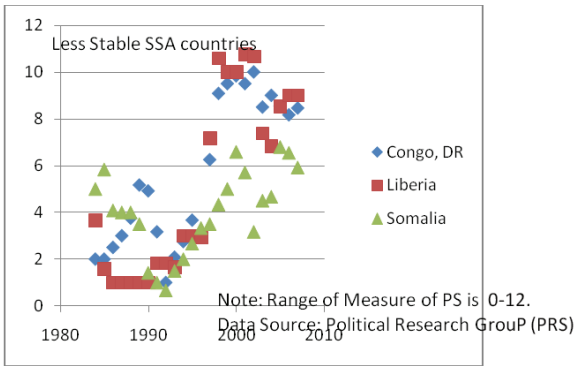


Figure 4 Political stability for SSA countries, 2004–2007

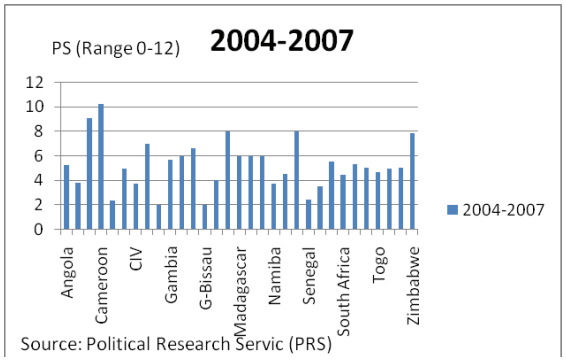
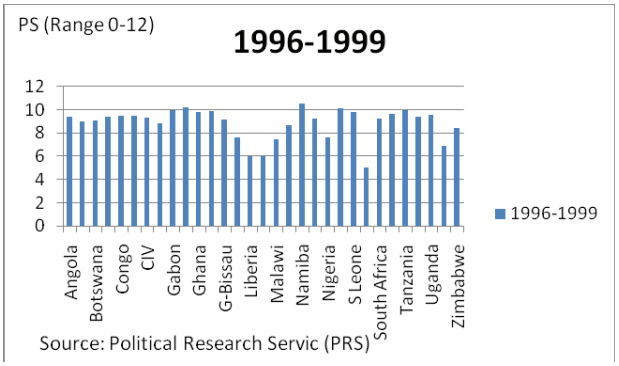


Figure 5 political stability for SSA countries, 1996–1999



Figures 2 to 5 shows that the measure of PS is a credible measure of political conditions. For each country, there is variation in the PS measure over time, and for each period, there is variation across countries in the PS measure. Figures 2 and 3 demonstrate that there is variation over time in the measure of PS not only for the most stable SSA countries like Ghana, South Africa and Tanzania, who have average PS values greater then 6.8 (the mean PS), but also for the least stable SSA countries like Congo (DRC), Somalia and Liberia for which average PS is less than 6.8 or the mean PS. For both the least stable and the most stable set of countries (Figure 2 and 3), the bulk of the high PS numbers is concentrated at the end of the data range, while the opposite holds true for the low PS numbers. This indicates a general rise in political stability of the SSA region more recently for the least stable countries and is consistent with observation. Further, the PS index values appear to correspond to perceptions of the political situation for the SSA countries over time. For example, Liberia has higher PS score for 2003–2007 than for 1996–1999, when it was still plagued by conflict and uncertainty. Figures 4 and 5 illustrate that for each year there is heterogeneity in the score of PS for SSA countries. Visual inspection of Figures 4 and 5 reveals that for the countries that are neither the least stable nor the most unstable, political stability has declined from 1999–2007, but only very slightly. The appendix contains the list of the SSA countries used in the research.

Methods

The empirical growth model in (1) is applied to thirty-one SSA countries from 1984–2007. Before estimating (1), the annual data were converted to four-year averages, because one-year intervals are too short to capture growth rates (Deaton, 2008).

The possibility that endogeneity bias may arise from

different sources (simultaneity or unobserved effects), the small size of our sample, and the lack of valid instruments for the potentially endogenous aid and political stability variables posed peculiar econometric challenges for the estimation of the growth equation. A small sample size typically causes problems in estimation of the aid-growth relation because the traditional IV estimation techniques used to correct for endogeneity bias such as two-stage least square (2SLS) produces inconsistent estimates when the sample size is small (Woolridge, 2002). Further, Durbin-Wu-Hausman tests of endogeneity have low power in finite samples and may not detect endogeneity bias even when it is present. Even when the number of observations is sufficient, which would normally make traditional IV estimates consistent, traditional IV-type regressions are of little use in correcting endogeneity bias specifically in aid-growth regressions (Deaton, 2008). This is because in the context of SSA, none of the "standard" instruments for aid in the literature such as population (see BD, 2000 and Islam, 2005), and primary exports (see Bruckner, 2011) satisfies a major requirement for instrument validity: zero correlation between the instrument and the error term (exogeneity).

The aid-literature has paid even less attention to evaluating whether the "standard" set of instruments for aid is sufficiently strong. This may be because most of the significant contributions to the aid literature occurred in the twentieth century while the literature on weak instrument (see Stock and Yogo (2005)) emerged more recently. Further, when instruments are weak, IV estimation is inconsistent (Bound, Jaegger and Baker, 1993). We therefore drop instrumental variable (IV) analysis as a strategy for mitigating simultaneity bias.

Unobserved effects can be either time-varying or time invariant. Latent and time-invariant variables such as cultural norms and historical tensions that affect growth also affect aid, political stability and policy, so that unobserved effects may account for a considerable portion of the total endogeneity bias. Time-invariant unobserved effects can be removed by first differencing (FD). If such a strategy eliminates endogeneity bias we should notice corrected signs and stronger statistical significance of coefficients and better fit of the FD model relative to OLS. Further, we lag the endogenous variables so that they are predetermined in the aid equation to reduce the possibility of simultaneity.

The structure of the first difference (FD) formulation of the OLS regressions in (1)–(3) are shown in (4)–(6).

4 $$\Delta \boldsymbol{GROWTH}_{it} = \gamma_0 + \gamma_{AID}\,\Delta \boldsymbol{AID}_{it-1} + \gamma_{SAID}\Delta \boldsymbol{AID}_{it-1}^{2} + \gamma \boldsymbol{PS}_{it-1} + \gamma_{AIDPS}\,\Delta \boldsymbol{AIDPS}_{it-1} + \Delta \boldsymbol{Z}'_{it}\,\gamma_Z + \Delta \upsilon^{it}$$

5 $$\beta_{FD} = (\Delta X'\,\Delta X)^{-1}\,\Delta X'\,\Delta X$$

6 $$E\,(\varepsilon_{it}\,\varepsilon^{it\prime}) = \sigma^2$$

The observant reader will notice that as it stand the structure of (4)–(6) does provide detailed information about the time relationships in the data and makes the point that FD removes latent time invariant country-specific effects. However these equations (4–6) do not automatically account for violations of strict exogeneity due to feed forward effects or due to unobserved but time-varying country-specific effects. We therefore test for strict exogeneity before carrying out estimations.

Given sufficient data, however, GMM is the optimal estimation method because it treats both unobserved endogeneity and simultaneity endogeneity (Hansen and Tarp, 2001). However, although we did perform such GMM estimations in previous versions of this paper we do not rely on results of the GMM dynamic panel model because it is likely fraught with finite sample bias since our dataset is small. Our current strategy of lagging AID, PS and AIDPS and estimating by FD eliminates all the unobserved endogeneity and is the correct estimation method. Fixed-Effects (FE) is not applicable here, because the data is not strictly exogenous. Residual simultaneity may persist however despite lagging PS, AID and AIDPS.

Islam (2005) and Burnside and Dollar (2000) treat simultaneity with IV and find no significant simultaneity bias since estimates of aid are the same as OLS in magnitude but Aguir (2011) using rainfall and primary exports as instruments for aid concludes that simultaneity biases his estimates upwards in IV estimation. In comparison, Hansen and Tarp (2001) and Dalgard and Hansen (2003) both use GMM and find contrasting results. While the former notes differences between GMM and OLS estimates, the latter does not find any differences so the controversy about the effect of endogeneity (direction and size) persists in the literature.

Discussion of results

The empirical strategy was executed to (i) identify and quantify the effect of foreign aid on growth in SSA (ii) to determine if political stability influences the aid-growth relationship, and (iii) to address any endogeneity problems that emerge. The main results of estimation of the growth equation (1) are presented in Table (3) on the next page. Columns 1 and 2 of Table 3 display results of estimation of equation (1) respectively by OLS, and FD. In contrast, columns 3 and 4 of Table 3 contain the same regressions in columns 1 and 2 but with PS dropped to evaluate how important the influence of political stability is to the aid-growth relationship. Finally note that AID_{t-1}, PS_{t-1} and $AIDPS_{t-1}$ are lagged in the FD estimations (columns 2 and 4) but not in the OLS regressions (columns 1 and 3). This means for the FD estimations (but not the OLS regressions), AID_{t-1}, PS_{t-1} and $AIDPS_{t-1}$ are pre-determined in the growth regression so there is little simultaneity bias. OLS estimation was performed with both lagged and contemporaneous aid, political stability and their interactions (AID_t, PS_t and $AIDPS_t$) but results of only the contemporaneous variables are reported (as there is little difference between the two) to facilitate comparison of our OLS results with estimated coefficients of the aid-growth relationship in the literature. All regressions in Table 3 (right) are corrected for serial correlation and heteroskedasticity using FGLS.

The FD estimations appear to fit the data better than the OLS because their coherence measures such as t-values of individual coefficients are higher than the OLS values irrespective of whether political stability is in the equation or not. The major results of the research as presented in the different Columns of Table 3 are that aid and political stability both positively impact growth in SSA and that political stability enhances the growth-stimulating powers of aid. This is because from Columns 1 and 2 of Table 3, aid, political stability and their interactions are positively related to growth at five percent significance level, respectively, by OLS and FD although the magnitude of the aid coefficient in the FD equation is smaller than in the OLS equation. Most importantly, since AIDPS, the interaction of aid and political stability is also significant, we conclude that conditional on stability aid promotes growth.

The reduction in magnitude of the coefficient on aid for the FD estimate may be explained by the difference in the level of endogeneity treatment that OLS and FD respectively provide. Omitted variable bias, which cannot be reduced by OLS, went down with FD, indicating that unobserved country-specific effects constitute the majority of any possible omitted variable bias. Any remaining bias has to be time-varying as FD removes all time-invariant sources of bias. Although we are able to remove the time-invariant unobserved effects by FD, endogeneity bias, albeit very limited, may still exist due to simultaneity despite lagging AID, AIDPS and PS.

We evaluated the possibility of endogeneity arising from simultaneity in earlier versions of the paper. In particular, we estimated the aid-growth equations by IV after re-specifying the model as a system of 4-simultaneous equations. Although first stage regression

Table 3 Growth regression results

	(1)	*(2)*	*(3)*	*(4)*
	OLS	FD	OLS	FD
IGDP	-0.0001	-0.003	0.009	-0.001
	(-1.15)	(2.04)*	(-0.39)	(0.97)
AID	12.05	8.066	0.232	5.775
	(2.19)*	(2.62)*	(0.15)	(1.95)
PS	1.084	1.593		
	(4.12)***	(4.94)***		
PRIM	0.098	0.744	0.043	1.299
	(0.22)	(0.25)	(0.09)	(0.45)
M2	0.049	0.106	0.049	0.108
	(1.64)	(2.51)*	(1.39)	(1.92)
BQUAL	0.727	1.303	0.583	0.99
	(1.61)	(1.98)*	(1.37)	(1.41)
DACC	0.253	1.535	0.363	1.102
	(0.77)	(2.13)*	(1.1)	(1.51)
GCONS	-0.007	-0.095	-0.004	-0.198
	(-0.18)	(-0.84)	(-0.1)	(1.44)
LE	0.013	0.184	0.024	0.157
	(0.46)	(2.00)*	(0.76)	(1.69)
INVPROF	0.078	0.946	0.483	0.025
	(0.3)	(1.5)	(2.56)*	(0.06)
AIDPS	0.872	0.332	(1.69)	(1.98)*
STD_AID	-1.861	-6.214	2.415	-2.416
	(-0.57)	(-1.63)	(0.84)	(-0.76)
Constant	-8.48		-4.643	
	(2.29)*		(-1.32)	
Observations	167	102	167	102
Adjusted R-squared	0.33	0.55	0.19	0.4

Note: Each regression included a set of time dummies. Errors are corrected for serial correlation and heteroskedasticity. The AID, PS and AIDPS variables are all lagged one period in the FD estimations. Three outliers identified in the text, were deleted in each regression. The square of AID and the time dummies are never significant and are not reported. Student t-statistics in parentheses. Significant at 10%; ** significant at 5%*** significant at 1%****

F-statistics and the Stock and Yogo (2005) test suggested the instruments were not very strong, we got very similar results in terms of the signs and magnitudes of the coefficients on (AID_{t-1}, PS_{t-1} and $AIDPS_{t-1}$) to the OLS so simultaneity does not appear to be an issue but unobserved effect endogeneity is an issue. The absence of potentially important time-varying factors from the list of regressors could also undermine the robustness of regression results but previous iterations of the paper using such time-varying factors as inflation or Burnside and Dollars' (2000) policy variable did not significantly influence the results.

Given sufficient number of observations, a dynamic system GMM will be the best estimator to treat simultaneity concurrently with unobserved, time-invariant endogeneity if in fact simultaneity and unobserved effects endogeneity were really issues. Contrary to our, fears, however, simultaneity is not the issue here so FD suffices. We performed system GMM but the results in terms of the magnitude and signs of AID, PS and AIDPS are similar to FD.

For completeness, note that there may still be an endogeneity problem if there are unobserved time-varying country-specific characteristics that influence aid and growth. For example, some SSA countries may have different technologies of production, endowment, or institutions which can vary with time rendering FD estimation impotent at treating endogeneity. Angrist and Pischke (2009) (hence forth AP (2009) point out that the notion that "the important omitted variables are time-constant is implausible." Simple first-differencing may not be effective in this case so the estimation method should also address the endogeneity caused by time-varying variables. To account for this issue, in earlier versions of the paper, we used the "random growth" specification (Papke, 1994) that allows for endogeneity to be based on country-specific growth rates. We interacted a trend variable with the country dummies in a LSDV specification to accomplish this. This did not change the OLS results much so it seems that the bias is mainly based on time-invariant variables. Finally, given that the sample size is small which compromised the strength of the instruments for aid in GMM and IV these estimation strategies offer no improvement over FD.

In comparison to results in columns 1 and 2, aid and political stability are insignificant in Columns 3 and 4 where political stability is omitted indicating political stability is an important pre-condition for aid. The majority of the coefficients of the other variables in our model have the expected sign in both OLS and FD estimations, where PS is included, although not many have statistically significant coefficients.

To determine the economic relevance of the aid-growth relationship in SSA, we compute the marginal effects (MEs) of growth with respect to aid. The MEs were calculated for the OLS and FD estimations in columns 1 and 2 of Table 3. We obtained a value of 0.12 for the ME of growth with respect to aid using OLS where aid is not lagged so that a one percent increase in aid will lead to a 0.12 percent increase in growth. In other words since AID is scaled by GDP, a $1 increase in aid will lead to a $0.12 increase in GDP. Further, we obtain a value of 0.084 for the same ME using FD where aid is lagged after taking the significant AIDPS in the FD regression into account. In comparison, Islam (2005) finds using OLS (and data from all LDCs not just SSA) that a unit increase in aid as a fraction of GDP, increases growth by 0.12 percent for LDCs. This agrees with our results.

A potential concern about the robustness of the primary conclusions of the research that aid is more effective in more stable countries concerns the limitation of PS measure because it does not explicitly reflect corruption which can often been an overriding problem. However we did replace the PS measure with the corruption perception index (CPI) in previous estimations and arrived at the same conclusion because more corruption was associated with less growth. In any case INVPROF also captures corruption effects. The result of the analysis should, however, be interpreted with care because about 30% of ODA aid is multi-lateral aid and the remaining 70% is bilateral aid although we used total ODA aid in the research. It is also worth noting, that the strategy of the new players in aid donation China and India (former recipients of aid) of providing aid to improve or build vital infrastructure in SSA (National Public Radio) may in the end yield better results than ODA which often does not focus on improving infrastructure in the recipient country.

Decomposition of the effect of political stability on the Aid-Growth Regression: marginal effects and elasticities at different points (0–12) of PS

To further decompose the effect of PS on the aid-growth relationship, we compute the aid-growth effect at different values of PS. From Figure 6, the marginal effect (ME) of aid on growth computed at the median of growth and aid is positive and rises very gradually at low levels of PS. Keeping in mind that the PS scale is from 0–12 with 12 being most stable, it can be seen that at very high levels of PS (higher than the mean and median of PS), ME rises

precipitously. In fact, AID, AIDPS and PS are all weakly significant below a PS value of 6 at 5% significance level. At PS values greater than 6 (the median of PS), these variables are strongly significant at 5% significance level.

Figure 6 Partial effects at different levels of political stability

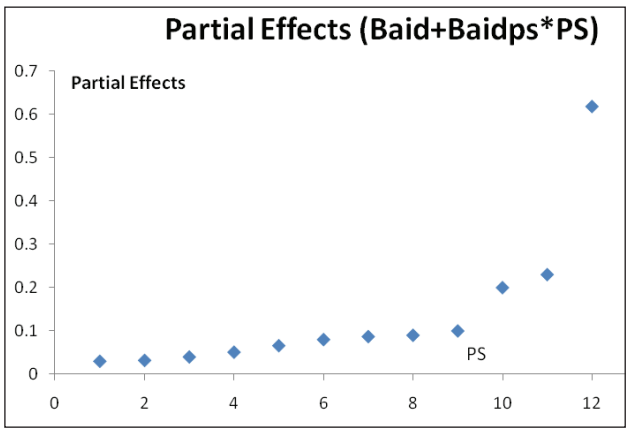


Figure 7 Elasticity at different levels of political stability

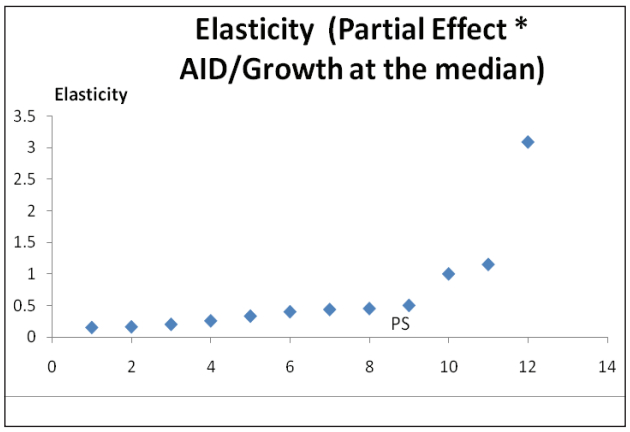


Figure 7, which plots the elasticity of growth with respect to aid against PS, substantiates the point made in figure 6 because it shows that growth is inelastic at low levels of PS but elastic at very high levels of PS. Beyond the relatively high PS value of 10, a one percent increase in aid leads to a greater than one percent increase in growth. However, the majority of poor SSA countries have PS values lower than 10 which might explain of why the effect of aid on growth is sometimes difficult to discern in SSA.

Conclusion

The research objective was to determine the sign and economic relevance of the relationship between aid and growth in SSA and further to investigate the consequence of political stability and economic policies on the aid-growth relationship. The evidence suggests that aid and growth are positively related at the five percent significance level, that political stability has a strong influence on the aid-growth relationship in SSA and that the aid-growth relationship suffers from endogeneity bias caused primarily by unobserved effects. Our results help to clarify why so much aid has done so little good in SSA. Aid is currently given independent of country stability. Based on our findings, aid is more effective at higher levels of stability so reaching the millennium development goals is more likely when aid is provided to stable SSA countries. Aid can prevent starvation in poor unstable SSA countries, but cannot be expected to spur growth there. A policy recommendation of this paper is that the pursuit of political stability and good governance in SSA is not only a worthy objective in itself, but also because stability promotes growth and augments the growth-promoting power of aid. To make the principal results of this research that political stability makes aid more efficient at promoting growth-more meaningful, the determinants of political stability specifically in SSA are good candidates for further research. In particular it will be interesting to investigate how big a role a free press plays in the attainment of political stability. Preliminary evidence (Armah and Amoah, 2010) seem to suggest that in SSA, political stability is fragile in one direction and stable and restrictive in the other direction when the press is restrained. However little empirical evidence is available in the literature to refute or back this claim so more careful research into the problem is needed. Further research is also needed to find out if growth is linked with media freedom in SSA.

Finally the literature could benefit from more detailed investigation in the issue of time-varying observed endogeneity. AP (2009) suggest a way to check the robustness of estimation when there is the possibility of residual bias due to latent but time-varying country-specific effects. Their suggestion involves first performing an Arrelano and Bond (1991) or AB-type dynamic panel estimation. However, they note that this estimate may be inconsistent if the lagged dependent variables are not uncorrelated with the error term and thus are not appropriate instruments. To check robustness, they suggest performing two separate regressions (a) with the lagged dependent variable but no country-specific dummies and (b) without time dummies but with country-specific dummies. AP (2009) point out that if estimates of the slopes using AB-type estimation is statistically significant and is value is bracketed by the estimates from the regressions a and b, the time-varying endogeneity is not a significant issue. Despite Angrist and Pischke (2009) suggestions effective methods of treating endogeneity caused by latent time-varying country-specific effects remain elusive.

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Appendix 1

The United Nation's Millennium Development Goals (MDGs)

Millennium Development Goals	*Targets*
1 Eradicate extreme poverty and hunger	i. Reduce by half the number of people living on less than $1/day. ii. Reduce by half the proportion of people who suffer from hunger.
2 Achieve universal primary education	i. Ensure that all boys and girls complete a full course of primary schooling.
3 Promote gender equality & empower women	i. Eliminate gender disparity in primary and secondary school education, preferably by 2005, and at all levels by 2015.
4 Reduce child mortality	i. Reduce by two thirds the mortality rate among children under 5.
5 Improve maternal health	i. Reduce by three-quarters the maternal mortality ratio.
6 Combat HIV/AIDS malaria and other major diseases	i. Halt and begin to reverse the spread of HIV/AIDS. ii. Halt and begin to reverse the incidence of malaria and other major diseases.
7 Ensure Environmental sustainability	i. Integrate the principles of sustainable development into country policies & programs, reverse loss of environmental resources. ii. Reduce by 1/2 the number of people w/o sustainable access to safe drinking water. iii. Achieve significant improvement in the lives of at least 100 million slum dwellers by 2020.
8 Develop a global partnership for development	i. Develop further an open rule based, predictable, non-discriminatory trading and financial system; Includes a commitment to good governance, poverty reduction both nationally and internationally. Address the special needs of the least developed countries; includes tariffs and quota free access for LDC exports; enhanced debt relief for the heavily indebted poor countries (HIPC) and cancellation of official bilateral debt; and more generous development assistance (ODA) for countries committed to poverty reduction. ii. Address the special needs of landlocked countries and small Island developing States. iii. In cooperation with developing countries, develop, and implement strategies that with generate employment for the youth. iv. In cooperation with pharmaceutical companies provide access to affordable and essential drugs in developing countries. v. In cooperation with the private sector, make available new technology especially in IT &communication.

3 • Free-riding and incidence of poverty in Ghana

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Abstract

Poverty levels in Ghana have largely been high among rural dwellers. The study assess the ex ante risk that if an individual is not currently below the poverty line, will slip past it, and the ex post possibility that those who are already in poverty will remain in it with increased severity.

The FGT poverty class of index was first used. This showed that a proportion of 0.77 of the entire population under investigation was poor. Also, the poor trade hugely among themselves at 0.74 redistribution rate.

Furthermore, to investigate the major determinants of poverty in Ghana resulting from free-riding, a dichotomous logit model was used. Most importantly, female household heads were found to be more vulnerable to poverty relative to their male counterparts. It was also observed that there has been a 'poverty-switching' phenomenon from the savannah zone to the coastal and forest zones of Ghana with deplorable consequences.

Key words: Incidence of Poverty, Free-riding, Logit, FGT Poverty class of index, Ghana
JEL: D030, D190, I320, I380, J160, J170, R290

Introduction

Poverty in Ghana has over the years been a major militating factor to economic development. In 2006, the poverty headcount ratio showed that about 53.7% of the total population was living on at most $2 a day (ADI, 2010). Thus, in the spirit of poverty measures, majority of the total population could be considered as poor at the time. However, the source of these levels of poverty cannot be attributed to the individuals' own characteristics alone. As noted by Rice (2001), studies by Cozzarelli, Wilkinson, and Tagler confirm what most attribution research on poverty finds: people are most likely to blame the poor for their own poverty.

In a society where family ties transcend the borders of one's own nuclear family, there is a high tendency for increased dependency. Though the ratio of age dependency on the working population has been declining (rather slowly) in recent times, the values are still higher and thus leave enough room for concern. In 2008, the dependency ratio on the working population was about 73.32, slightly lower than the 2007, 2006, and 2005 values of about 74.15, 75.02, and 75.90, respectively (ADI, 2010).

With a mean household size of about 4 individuals, with Greater Accra region recording the lowest at 3.4 and the Upper West region recording the highest at 6.5 (GSS, 2007), coupled with an average annual household income of about GH¢1,217.00 and an average per capita income of about GH¢400 in Ghana, the dependency rate on the working population is undoubtedly significant. Given that average annual household expenditure in Ghana hovers around GH¢1,918.00 and an annual per capita consumption expenditure around GH¢644.00 (*ibid*), it is quite surprising how the poor survives with lower incomes, as noted above. This undoubtedly leads to a

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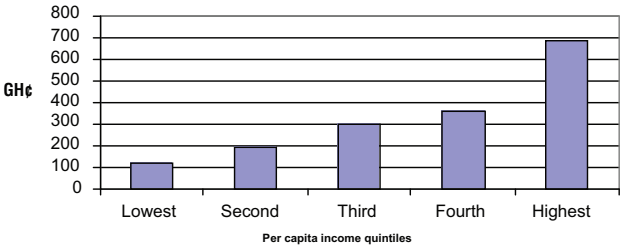
highly significant financial burden. The figure below shows that the mean annual per capita income of the lowest quintile of Ghana's working population is just above GH 100, whiles the highest quintile almost touches the GH 700 mark. A very significant gap of about GH 600 is thus observed.

Figure 1 Mean annual capital income



Source: Ghana Statistical Service, 2008

Closely related to these developments is the fact that, as at 2008, seven out of every ten adults aged 15 to 64 were engaged actively in economic activities, ibid. However, having been engaged in any of the three most important sources of household income from economic activities in Ghana-income from agricultural activities (35%), wage income from employment (29%) and income from self employment (25%)-returns that accrue from such activities are spent partly on dependents. As much as this exists as a truism, the rate of dependency varies from males to females, depending on who is the family head. The GLSS-5 indicates that a bigger proportion of households are headed by males (70.5%). The proportion of households headed by females is higher in urban areas outside of Accra (35.1%), rural coastal (34.3%) and rural forest (31.2%) than in Accra (28.1%) and rural savannah (14.9%). On the other hand, the proportion of households headed by males is highest in the rural savannah (85.1%).

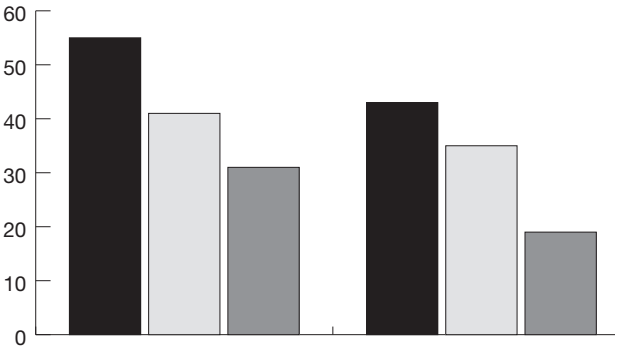
These working household heads usually become the focus of all who seek financial support at any point in time. As a matter of social and family responsibility to give to the needy, society has ignored the consequences of such dependencies on individuals who are usually over-burdened with requests from their dependents. Additionally, for the sake of moral uprightness, it is only appropriate to support the needy. However, it is very difficult to define the members of a given 'basket' of dependents. People tend to free-ride on the provision of moral requirement and thus individual support becomes non-excludable to the extent that a potential benefactor is identified. By this, financial assistance can be likened to a public[1] good, loosely defined. Though this appears to be the case, unlike 'pure public goods', financial assistance is highly rival[2] in consumption. Interestingly, most of those who pose such financial burdens usually do not contribute to the generation of such finances directly. We tend to ignore the possibility of such actions rendering these benefactors poor some time in their lives and eventually joining the pool of poor individuals.

It may seem obvious that males are at the front of such barrage of inconsequential dependencies. This is because, most households are headed by males (GSS-5, 2008) and thus the dependency rates tend to be higher for males than for female workers in the family. Typically, even in a family where both males and females are in some form of formal employment it is usually the males who are overburdened with such financial commitments. Consequently, most people tend to stall in their career development process, lifetime investments, as well as raising a happy family. Increased dependency may lead to increased dwindling standards of living.

Figure 2 (below) shows that female-headed households are on average less poor than male-headed households.

Over time, most people find themselves living below the $1 poverty mark per day. In a study by Bane et al (1986), they observed that less than 40% of poverty spells occurred when the income of the household head reduced, whereas about 60% of all poverty spells ended with an increase in the household head's income. This is in support of the argument that over-dependency, which tends to reduce the income of household heads ensures increased poverty, whereas low dependency has a milder effect.

Figure 2 Poverty incidence by gender of household head, 1991/92 TO 2005/2006
Poverty line: ¢3,708,900.



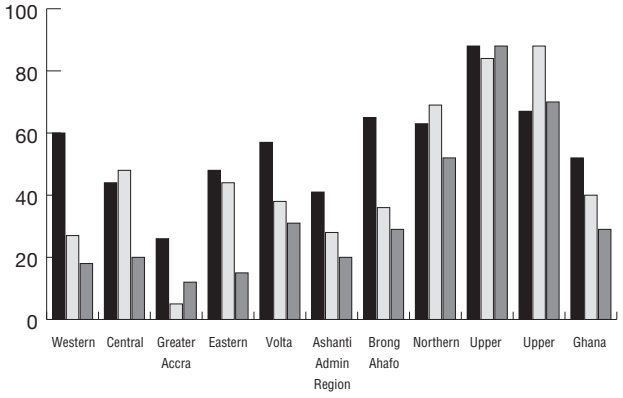
Source: Ghana Statistical Service, 2008

[1] *This can be described as any good that can and does benefit everybody at no cost to the beneficiary.*
[2] *Financial assistance is rivalry because the benefits that accrue to individuals vary depending on who has the first-mover-advantage, all else being equal.*

It is important to note that dependence on the working population is inevitable and that at the very least could be a function of one other individual. Eventually, poverty becomes inevitable. The GSS (2007) defines poverty as consisting of consumption poverty, which is concerned with those whose standard of living falls below an adequate minimum defined by a poverty line. Thus, a poverty line, below which individuals are considered as poor was constructed and noted to be GH 370.89. The table below shows the regional distribution of poverty within the Ghanaian economy.

It is observed from Figure 3 that by the 1991/1992 period, the Upper West region of Ghana had the highest level of poverty, with Greater Accra recording the lowest. The pattern has generally remained so for most part of the period before 2005/2006. Most worrying is the 88% incidence of poverty on the population of the Upper West region of Ghana. However, in about a decade, the incidence of poverty in the Greater Accra region rose from 5% in 1998/1999 period to 12% in 2005/2006. Apart from Greater Accra and Upper West regions that have experienced increases in poverty rates since 1998/1999, Central, Western, Eastern, Ashanti, Brong Ahafo, Upper East and Northern regions have actually witnessed declines over the period up to 2005/2006.

Figure 3 Poverty incidence by administrative region, 1991/92 TO 2005/2006
Poverty line: ¢3,708,900



Source: Ghana Statistical Service, 2008

In view of the above, this study seeks to investigate the basic individual characteristics that make them vulnerability to poverty as a result of being over-burdened with dependency (free-riding). That is, the study assess the ex ante risk that if an individual is not currently below the poverty line, will slip past it, and the ex post possibility that those who are already in poverty will remain in it with increased severity.

Literary review

Empirical work on the incidence of poverty in Ghana with emphasis on free-riding is at best non-existent. Most of the previous studies on poverty concentrate on the determinants of poverty, their effects on economic growth, and regional distribution of poverty. Yet, some other studies including Brown et al (2004) take a rather new position, noting that various livelihood strategies-cohabitation, doubling-up with some other relatives, and working-have the potential of reducing poverty. In their study of livelihood strategies of nonmetropolitan single mothers in the United States of America, they noted that the above mentioned livelihood strategies are strongly associated with economic well-being. Most importantly, they viewed employment as a panacea to economic well-being reform. However, work-based solution to poverty may seem inadmissible by individuals who have little or no formal education or job training coupled with the unavailability of jobs that pay living wages in predominantly rural areas.

Adam and Sawhill (2001) concur that the correlation between family structure, vis-à-vis single parenthood or married couple, and poverty status persists when studied over time. In another study by Lichter et al (2004) in which they estimated the effect of having a child out of wedlock on a woman's probability of being poor after having controlled for women's demographic characteristics and employment status, they observed that the incidence of single parenthood has a considerable impact on the incidence of poverty. Another relevant study by Wilson and Neckarman (1987) argues that much of the growth in black female headship of households is due to the rising male joblessness, which eventually leads to a reduction in the available pool of "marriageable men".

Bauman (1997) observes that being in co-residence with other relatives (not necessarily family) did not help in any significant measure to alleviate financial hardships. According to him the obvious reason for this effect is that most of these dependents tend to keep their money to themselves. Whiles they keep their money to themselves, their daily livelihood in the households becomes the burden of the household head. Consequently, household heads become over-burdened with increased expenses which eventually affect their financial soundness over time. In confirmation to this, Gardiner et al. (2006) observe that large families have much higher poverty rates than average. This therefore brings to bear the weakness in the recent method of calculating poverty in which the incomes of all members of a given household (related by blood) are summed together and compared with a given income threshold depending on the size of the

household. Of course there have been scores of arguments pertaining to the proper definition of poverty. Notable among them are Citro and Michael (1995) who have argued that cohabiting individuals should be counted as part of poverty measures as if they are members of the same "family". Yet, Mayer and Jencks (1989) have argued that all persons living in a household should be counted, regardless of family relationship. However, due to the fact that these people do not contribute to household expenditure financing in the most part, none of the above suggestions may prove useful.

It may seem obvious that paid employment reduces poverty at the individual level. In a study by Islam (2004), he observed that employment intensity (measured in terms of employment elasticity with respect to output) of growth had a positive and significant influence on poverty reduction. Similarly, in a study in the rain-fed traditional farms in rural Sudan, Elzaki et al (2009) note that having a job offers protection against poverty, but having only one off-farm source of income is not enough to fight poverty adequately.

It has also been empirically observed that female household heads have a higher incidence of poverty relative to their male counterparts, *ibid*.

Elzaki et al. (2009) note once again that poverty is much prevalent in households with a large number of individuals (thus, high dependency rate) relative to those with smaller number of individuals. Anyanwu (2005) reached a similar conclusion in his study of rural poverty in Nigeria.

Households with heads with at least vocational education are observed to have a lower risk of poverty compared with households where the heads have only informal or primary education (Elzaki, 2009). In another study by Anyanwu (2005) on rural poverty in Nigeria, he observed that individuals with primary education and below had a higher probability of being poor relative to those with higher levels of education. Olaniyan (2000) opines that the education level of the household head was the single most important determinant of household poverty in his study of *the role of household endowments in determining poverty in Nigeria.*

The effect of age distribution also seems to play a very significant role in the levels of poverty of individuals. As individuals move up the age ladder, their levels of poverty increase as well, *ibid*. However, at higher age brackets, poverty levels tend to decline, albeit, marginally. He also observes that individuals within the age group 45–54 contribute most to the levels of poverty in society, on a rather consistent basis.

Methodology

1 Data and definitions of variables

Data for the study is obtained from the Ghana Living Standard Survey (GLSS), round five, published by the Ghana Statistical Service (GSS, 2008). Data covering 8,687 individuals are used in this study. Specifically, the dataset comprises the gender of household head (Gender), number of jobs ever done by individuals (Numjob), household size (Hsize), marital status (Mars), annual income of individuals (Income), total annual household expenditure (Totexp), age of individuals (Age), education level of individuals (Educlevel), individuals with a second job (Secondjob), household head with second job (Gensecondjob), age category of individuals with a second job (Agesecjob), and ecological zone of individuals (Ecolzone). 'Gender' tries to investigate whether households are headed by males or females. Male-headed households are denoted by 1, whiles female-headed households are denoted by 0. 'Mars' also investigates the marital status of individuals, with 1 denoting married and 0 not married. The 'income' variable is split into those whose annual earnings are below the lower poverty line (GH 370.89) and those whose earnings exceed this value. 'Totexp' also considers individuals who spend below GH 100 per annum, those who spend between GH 100 and GH 2000 per annum, and finally, those spend above GH 2000 per annum. The 'Age' categorization considers individuals between ages 15 and 30, 31 and 60, and 61 and beyond. Individuals who have work in less than 10 different jobs over their lifetime are also separated from those who have worked in more than 10 jobs, in considering the 'Numjob' variable. The 'Ecolzone' variable categorizes individual locations into coastal, forest, and savannah zones. Finally, individuals with primary or no education, those with post secondary education as well as vocational, teacher training and diploma certificates are, and those with university degrees are categorized.

The data shows that seven out of every ten adults aged 15 to 64 are engaged in some form of economic activity with majority being engaged in agricultural activities, formal sector employment, and self employment. The proportion of the economically active population aged 15 to 64 years who were not working in the last seven days prior to the data collection but were available for work were defined as the unemployed. The unemployment rate was recorded at 3.6%. It was much higher in urban areas (6.3%), particularly in Accra (8.9%) compared to rural areas (1.6%), by 2008. In urban areas, the unemployment rate was slightly higher for males (6.5%) than for females (6.2%) but the reverse was the case in the rural areas.

The employed were considered to be those who worked for economic gain in the last seven days prior to the data collection.

The data goes on to indicate that about 58.5% of the total population have ever been engaged in some form of relationship, be it consensual union, marriage, divorced, separated or widowed, whilst 41.5% have never married. Due to the above considerations, this study seeks to investigate on a broader note, the factors that contribute to the incidence of poverty (IP) in the Ghanaian economy, at the individual level.

2 Emperical model

In 1976, Sen introduced a characterization of the poor based on two key axioms: the monotonity axiom and the transfer axiom. The monotonity axiom requires overall poverty levels to increase if the income of a poor person reduces. On the other hand, the transfer axiom postulates that poverty levels will increase if a pure transfer is made from a poor person to someone with more income. However, the index is not decomposable into the various categories of poverty (Foster and Shorrocks (1991) and more importantly, it fails to satisfy the transfer axiom (Shorrocks, 1995). In reaction to these weaknesses, several other indices have emerged. The most famous among them was developed by Foster, Greer and Thorbecke (1984), usually called the FGT index. They formulated an additively decomposable index of poverty aversion based on the distance between the actual income of a poor household and the poverty line. Several studies including Ahmed et al (1991); Bigsten et al (2003); Elzaki (2009); Greer and Thorbecke (1986); Haddad et al (2001); and Bogale et al (2005) have used this approach in studying various aspects of poverty.

Thus, in this study, the FGT poverty class of index is adopted. Given the income levels of households (yi) as a measure of well-being in increasing order up to the nth household, the FGT poverty class of index can be expressed as (Teal, 2001):

$$p^{a} = \frac{1^{q}}{n} \sum_{i=1} \left[\frac{z - y_i}{z} \right]^{a} \qquad (1)$$

Where n is the total number of individuals under consideration, q is the total number of poor people, y_i is the income of the *ith* individual, z is the poverty line, and α is a parameter characterizing the degree of poverty aversion. The value of z to be used is the national absolute (lower) poverty line provided by GSS (2007). This measure focuses on what an adult per year needs to meet the nutritional requirements of their households. So, individuals whose total expenditure falls below this poverty line are considered to be poor. This is because, even if they devoted their entire budgets to food, they would not be able to meet their minimum nutritional requirements. Based on this measure, this study uses a poverty line of GH 370.89 per adult per year. The most common values of α used in most empirical works are 0, 1 and 2. When α=0, then we arrive at the poverty head count ratio (or the fraction of poor people in a given population which measures the incidence of poverty), when α=1, we obtain the poverty gap (how far, on average, the poor is away from the poverty line), and when α=2, the severity[5] of poverty (which gives more emphasis to the poorest of the poor) is obtained.

Subsequently, to estimate the causes of poverty and the probability of falling below the poverty line, the approach of Bogale et al (2005), Elzaki et al (2009), Francis (2006), and Krishna et al (2006), in which a binary logit model is specified is followed. Although the probit model could be used in this study, Amemiya (1981) observes that there exists a relationship between the logit and probit estimates. Thus, it is possible to derive estimates for the probit model after deriving those for the logit model. So, I specify a binary logistic regression (BLR)[3] model of the form:

$$\boldsymbol{IP}^{*} = \beta_0 + \boldsymbol{X'}\,\beta_1 + \mu \qquad (2)$$

Where $\boldsymbol{X'}$ is a 1x22 matrix of independent variables and β_i represents a 22x1 matrix of coefficients.

$\boldsymbol{IP}^{*}$ is an incompletely observed (latent) dichotomous variable determined by:

$$\boldsymbol{IP} \begin{cases} 1 \text{ if } \boldsymbol{IP}^{*} > 0 \\ 2 \text{ if } \boldsymbol{IP}^{*} \leq 0 \end{cases} \qquad (3)$$

$\boldsymbol{IP}^{*}$ represents a situation of high incidence of poverty, whereas $\boldsymbol{IP}^{*} \leq 0$ represents a situation of low incidence of poverty. We also note that μ is independent of X and it follows a logistic distribution. Following the specification above (equation 3), the probability of observing a high incidence of poverty (IP =1) is expressed below:

$$\begin{aligned} \text{PR}\,(\boldsymbol{IP}_i = 1 | \boldsymbol{X}) &= \boldsymbol{P}\,(\boldsymbol{IP}_i > 01 \boldsymbol{X}) = \boldsymbol{P}\,\mu > \angle\,(\beta_0 + \boldsymbol{X'}\beta_{i)}\,|\boldsymbol{X}] \\ &= 1 - \boldsymbol{G}\,[\angle(\beta_0 + \boldsymbol{X'}\beta_i)] \\ &= \boldsymbol{G}\,[\beta_0 + \boldsymbol{X'}\beta_i] \end{aligned} \qquad (4)$$

[3] *The advantage with the BLR model is that it is able to predict the probability of an event occurring, in this case, the probability of an individual experiencing a high incidence of poverty.*

In the spirit of a logit regression model, this can be written as:

$$\Pr(\boldsymbol{IP}_i = 1) = \frac{\exp(\beta_0 + \boldsymbol{X'}\beta_i)}{1 + \exp(\beta_0 + \boldsymbol{X'}\beta_i)} \quad (5)$$

And:

$$\Pr(\boldsymbol{IP} = 01\ \boldsymbol{X}) = \boldsymbol{P}(\boldsymbol{IP^*} \leq 01\boldsymbol{X}) = \boldsymbol{P}[\mu \leq -(\beta_0 + \boldsymbol{X'}\beta_i) \mid \boldsymbol{X}] = \boldsymbol{G}[-(\beta_0 + \boldsymbol{X'}\beta_i)] \quad (6)$$

or:

$$\Pr(\boldsymbol{IP}_i = 0) = \frac{\exp[-(\beta_0 + \boldsymbol{X'}\beta_i)]}{1 + \exp[-(\beta_0 + \boldsymbol{X'}\beta_i)]} \quad (7)$$

Corresponding odds ratios[4] are computed using:

$$\frac{\Pr(\boldsymbol{IP}_i = 1)}{\Pr(\boldsymbol{IP}_i = 0)} = \boldsymbol{e}^{\beta_0 + \boldsymbol{X'}\beta_i} \text{ or } 1n\left(\frac{\Pr(\boldsymbol{IP}_i = 1)}{\Pr(\boldsymbol{IP}_i = 0)}\right) = \beta_{0+}\boldsymbol{X'}\beta_i \quad (8)$$

Where $\boldsymbol{G}[\beta_0 + \boldsymbol{X'}\beta_i]$ is the cumulative distribution function for μ taking on values between 0 and 1 for all real numbers $(\beta_0 + \boldsymbol{X'}\beta_i)$, that is, $0 < \boldsymbol{G}[\beta_0 + \boldsymbol{X'}\beta_i] < 1$, $\forall (\beta_0 + \boldsymbol{X'}\beta_i) \in \Re$, β_i is the *k*th element of β.

Unlike linear regression models, the non-linear nature of equation (1) warrants the use of maximum likelihood estimation methods. In order to obtain the maximum likelihood estimator, conditional on the covariates, I specify the density function *ip* given x_i. Thus:

$$f(ip|x_1;\beta) = [\boldsymbol{G}(\chi_1,\beta)]^{ip}[1 - \boldsymbol{G}(\chi_i,\beta)]^{1-ip},\ ip = 0,1 \quad (9)$$

β is absorbed into x_i for simplicity. From the above, when *ip=1*, we get $\boldsymbol{G}(x_1,\beta)$ and when *ip=0*, we get $1\text{-}\boldsymbol{G}(x_1,\beta)$. To obtain the log-likelihood function, we take the log of the above equation which gives us:

$$l_i(\beta\ 1\ x_i) = ip_i \log[\boldsymbol{G}(x_i\beta)] + (1 - ip_i)\log[1 - \boldsymbol{G}(x_i\beta)] \quad (10)$$

With 8,687 sample observations in this study, we obtain:

$$\boldsymbol{L}_i(\beta \mid x_i) = \sum_{i=1}^{n} l_i(\beta \mid x_i) \quad (11)$$

The maximum likelihood estimate, β, maximizes this log-likelihood, representing the logit estimator of our model. The β estimates thus obtained are consistent, asymptotically normal and asymptotically efficient, barring the presence of heteroscedasticity.

The advantage with using a logit model lies in its easy computations, ability to allow for easy application of interaction terms in a regression model, ability to predict probabilities, and the flexibility in interpreting coefficient estimates.

Results

Upon estimating the FGT poverty class of index, the results showed that when *a=0*, the poverty headcount ratio or the proportion of total population that are poor is about 0.77. Given that the data for the study is the most current according to the GLSS (round 5), it can be concluded that a large number of people still live in poverty. Such individuals earn GH 370.89 or below per annum and thus are unable to cater for their basic nutritional needs for the period. Coupled with high dependency rates, the plight of such individuals are worsened since they now have to share the already insufficient income with some other dependents. Thus, Ghana still has a high incidence of poverty.

When *a=1*, the poverty gap is about 0.75. This measures, on average, how far the poor are away from the lower poverty line. This shows that on a scale of 0 to 1, the poor population is very much below the poverty line. There is therefore an enormous gap to be bridged in subsequent years, given that the deadline for the millennium development goals is fast approaching (2015).

At *a=2*, a value of 0.74 shows that poverty is still severe among the poorest of the poor. These people have the huge task of trying to catch-up with the relatively not-so-poor population before even worrying about jumping the lower poverty line of GH 370.89. This also shows that there is a high degree of redistribution of income among the poor. This is due to the fact that the poor trade hugely among themselves. Thus, they circulate and concentrate the same amount of money among them over time.
In conclusion, much is desired in trying to fight poverty in Ghana. Perhaps, the 2015 deadline for the achievement of the MDGs appears to be fast approaching than policies that are being implemented to ensure their achievement.

Results from the logit estimation are reported below. These try to investigate the actual determinants of the incidence of poverty in Ghana. From table 1.0 below, it is observed that the annual income level of an individual, total annual expenditure of an individual, household size, individuals aged between 31 and 60 years, gender, marital status, individuals with some level of education (at the various levels), individuals with secondary jobs, individuals who have worked in less than ten different jobs over their lifetime, individuals aged between 15 and 30 (and 31 and 60) years who also have secondary jobs, and

[4] *See justification for using odds ratios on page 28.*

the ecological zone an individual resides in are the major determinants of poverty in Ghana, at different significance levels.

Out of these variables the ones which are negatively related to the probability of being poor are annual income level of an individual, total annual expenditure of an individual, individuals aged between 31 and 60 years, gender, marital status, individuals with secondary jobs. The rest of the variables are positively related to the probability of being poor.

Contrary to the above, variables such as individuals aged between 15 and 30 years, individuals with no education, individuals who have worked in more than ten different jobs over their lifetime, and the gender of individuals with secondary jobs, do not contribute to the incidence of poverty in Ghana, even at different significance levels.

Table 1.0: Determinants of poverty in Ghana

Variable	*Coefficient*	*Standard Error*	*P-Value*
Income	-0.243	-6.328	0.073
Totexp1	0.512	0.001*	0.000*
Totexp2	-2.134	0.196	0.000*
Hsize1	2.611	0.531	0.000*
Hsize2	0.597	0.265	0.024**
Age1530	0.014	0.183	0.937
Age3160	-0.115	0.069	0.095***
Gender	-0.409	0.143	0.000*
Mars	-0.470	0.096	0.004*
Educlevel1	0.178	0.109	0.103
Educlevel2	0.961	0.124	0.000*
Educlevel3	1.037	0.333	0.002*
Educlevel4	1.116	0.327	0.001*
Educlevel5	1.265	0.391	0.001*
Numjobs1	0.360	0/137	0.009*
Numjobs2	0.089	0.415	0.831
Secondjob	-0.327	0.207	0.072***
Gensecondjob	0.071	0.175	0.685
Age1530secjob	0.663	0.251	0.008*
Age3160secjob	0.474	0.188	0.012**
Ecolzone1	1.656	0.117	0.000*
Ecolzone2	1.607	0.090	0.000*
Constant	3.269	0.645	0.000*

Values approximated to 3 decimal places

Pseudo-R2 = 0.3484 *Log likelihood = -2492.1328*

LR $CHI^2(22)$ = 2664.77 *PROB > CHI^2 = 0.0000*

Number of observations = 8687

** Significant at 1%* *** Significant at 5%*

**** Significant at 10%*

Marginal effects and odds ratios

Due to the non-linearity of the logistic regression model as well as the dummy nature of regressors, there emerge some complications with the use of marginal effects to analyse the effects emanating from each regressor (see Greene, 2003). Thus, to investigate the effects of the regressors on the probability of being poor, the study considers the change of the odds ratio as the regressand changes. The odds ratio (OR) of a regressor is interpreted using ***100(1-OR) %***. The results are reported in table 2.0.

Poverty and gender

Anyanwu (2005), Elzaki et al (2009) and Simler et al (2004) have argued that female household heads have a higher incidence of poverty compared to their male counterparts. The results show that male household heads are about 33.6% likely to be less poor compared to their female counterparts. This therefore supports the feminization of poverty phenomenon. The reason this is the case is that most female household heads are largely petty traders with wide poverty gaps. Furthermore, with the responsibility of providing food and caring for the households members who may largely be free-riders, they are unable to take up more than one job like their male counterparts do. Thus, increased number of dependents increases the likelihood of female household heads being poor.

Poverty and marital status

Most studies such as Adam and Sawmill (2001) and Lichter et al (2000) have argued for the strong correlation between the marital status of an individual and the severity of poverty. The study shows that married individuals decrease their probability of being poor by 37.5% relative to those who are not married. The obvious reason is that married couples are able to pool together resources to support one another, unlike the unmarried individual who will have to depend on own limited resources. Thus, married individuals are able to benefit from 'synergistic' advantages that aid in their jumping over the poverty line, basically due to the absence of dependency because of the pooling of resources.

Table 2.0 Odds ratio estimates for the determinants of poverty in Ghana

Variable	*Coefficient*	*Standard Error*	*P-Value*
Income	0.784	0.057	0.001*
Totexp1	0.002	0.001	0.000*
Totexp2	0.118	0.023	0.000*
Hsize1	13.609	7.222	0.000*
Hsize2	1.817	0.481	0.024**
Age	0.892	0.061	0.095***
Gender	0.892	0.061	0.095***
Mars	0.664	0.060	0.000*
Educlevel2	2.613	0.324	0.000*
Educlevel3	2.821	0.941	0.002*
Educlevel4	3.054	1.386	0.001*
Educlevel5	3.543	1.386	0.001*
Numjobs1	1.434	0.197	0/009*
Secondjob	0.689	0.143	0.072***
Age1530secjob	1.941	0.302	0.008*
Age3160secjob	1.607	0.061	0.012**
Ecolzone1	5.236	0.615	0.000*
Ecolzone2	4.987	0.449	0.000*

Values approximated to 3 decimal places

Pseudo-R2 = 0.3484 *Log likelihood = -2492.1328*

LR $CHI^2(22)$ = 2664.77 *PROB > CHI^2 = 0.0000*

Number of observations = 8687

** Significant at 1%* *** Significant at 5%*

**** Significant at 10%*

Poverty, age and jobs

Some studies (including Olaniyan, 2000) have argued that the older an individual gets, the higher the probability of being poor. The fundamental reason for this outturn is that individuals become less productive at old age, coupled with their inability to accumulate enough savings during this period to compensate for the loss in productivity and income. The period of old age is when previous savings made during periods of productive activity are usually spent. This study shows that any additional age of a household head decreases the probability of such individual being poor within ages 31 and 60 by 10.8%, relative to those above age 60. Though individuals in such age brackets suffer most from dependencies, this seems to have a minimal effect on their wellbeing. This is due to the fact that individuals in such age brackets are able to engage in more productive jobs such that they earn enough to take them out of the poverty zone. However, household heads below age 30 do not contribute to increased poverty rates in Ghana.

On the other hand, household heads between ages 31 and 60 who have a secondary job increase their probability of being poor by 60.7%, relative to older household heads. As individuals earn more within this age bracket, they are duly recognized as potential benefactors in their families and societies. Hence, their financial burdens increase with increased dependency rates. Similarly, a household head between ages 15 and 30 who also has a secondary job increases their probability of being poor by 94.1% relative to those above age 60. This outcome may not seem surprising at all as individuals within this age bracket have a lower probability of securing gainful employment opportunities. However, as individuals advance in age, they are more likely to secure high-paid jobs which reduce their vulnerability to poverty, as evident from above.

Furthermore, individuals who have ever worked in less than 10 different jobs over their lifetime increase the likelihood of their being poor by 43.4% relative to those who have worked in 10 or more jobs. This is so because most of these individuals do not explore the job market for better employment opportunities. They stay in one employment situation for so long which usually come with little improved finances, if any at all. However, those who perform two different jobs concurrently are able to reduce the probability of their being poor by 31.1% relative to those who perform single jobs. Such individuals are able to accumulate huge sums of money that ensure their ability to exceed the poverty line. As argued by Elzaki et al (2009), having a job offers protection against poverty, but having only one off-farm source of income is not enough to fight poverty adequately. This supports the finding that secondary jobs are an important tool in poverty alleviation.

Poverty, and income/expenditure levels

High income levels are expected to alleviate poverty in every human society. As this study notes, any additional increase in an individual's income beyond the lower poverty line (GH 370.89) decreases the likelihood of being poor by 21.6%. Individuals are now able to provide their basic nutritional needs.

The results also suggest that individuals who spend less than GH 100 are able to reduce their likelihood of being poor by about 99.8% with any additional increase in expenditure resulting from increased dependency (free-riding) relative to those who spend above this value. Given a lower poverty line of GH 370.89, this conclusion seems valid as long as expenditure levels fall below the GH 100

mark. On the other hand, individuals who spend above the poverty line but below GH 2000 per annum (with some borrowing to supplement their incomes) are only able to reduce their likelihood of being poor by 88.2% with any additional increase in expenditure relative to those who spend above this limit. In instances where the increased expenditure is on food, then this conclusion holds given that individuals are now better resourced to consume highly nutritious meals.

Poverty and household size

Studies by Anyanwu (2005), Bauman (1997), Elzaki et al (2009), and Gardiner et al. (2006) have argued about the diverse effects of household size on the severity of poverty. Households with less than five individuals are found to be 1260.9% likely to be poor with any additional member relative to those with larger number of individuals. It is observed that such smaller households comprise mainly of parents and their children, who are mostly not gainfully employed. Couples usually give birth to a large number of children with the hope that these children will take care of them in their old age, given the absence of well-developed social security systems and low savings (Anyanwu, 2005) in Ghana. Similarly, households with between 5 and 15 individuals are found to be 81.7% likely to be poor with any additional member compared to those with a higher number of individuals. Such large households are observed to comprise children, other relatives (including in-laws), and non-relatives. It is realized that as the household size increases, the probability of an individual being poor reduces, albeit significantly. The significant feature of such large households is that most of the individuals are employed in one or more jobs. As they do so, they relieve the household head of the burden of having to take care of everybody's needs. Self-help spirits are motivated and particularly in the Ghanaian society where it is 'almost' a must to share ones riches, the working group supports in providing the needs of all individuals. Hence, the household head is saved from 'hitting' the poverty line. This finding contradicts that of Bauman (1997) who opines that such individuals rather keep their money to themselves. It also goes contrary to that of Gardiner et al (2006).

Poverty and level of education

Literature on the effect of education on poverty is at worst difficult to count. Given that labour is the most valuable asset of the poor, increasing their levels of education is expected to reduce their poverty levels as well. A vicious cycle of poverty emerges such that low levels of education lead to increased poverty whiles increased poverty leads to low levels of education (Anyanwu, 2005). Due to the high opportunity cost of education, the poor usually abstain from it in order to have enough time to work for survival's sake. This study shows that individuals with at most junior high school education are more likely to be poor by 161.3% relative to those with higher levels of education. Anyanwu (2005) and Elzaki (2009) have observed that individuals with primary or basic education stood a higher risk of being poverty than those with higher levels of education. On the other hand, holding a vocational or teacher training certificate increased the likelihood of being poor by 205.4% relative to those with bachelor's degrees or higher. This may seem impractical but the obvious explanation for this in the Ghanaian setting is that lower levels of education other than a bachelor's degree do not substantially lead to higher income levels. However, most of these levels of education are costly to attain and thus individuals spend more on them only to receive meager salaries during employment. The situation is even worse for diploma and certificate holders; with about 254.3% likelihood of being poor relative to those with bachelor's degrees and/or higher levels of education. Thus it may only be appropriate to seek higher levels of education with at least a bachelor's degree as the terminal one, since all other lower levels do not significantly help reduce poverty rates. This is what Spence (1973) noted in his essay on "Job Market Signaling", when increased education does not translate into higher wages especially when such levels of education are attained at higher costs. This notwithstanding, Olaniyan (2000) observed that the education level of the household head was the single most important determinant of household poverty.

Poverty and ecological zone of individuals

The results of this study show that the location of an individual matters for the severity of poverty in the Ghanaian economy. Specifically, the study observes that individuals in the coastal zone of Ghana increase their likelihood of being poor by about 423.6% relative to those in the savannah zone. Likewise, individuals in the forest zone also stand the chance of increasing their probability of being poor by 398.7% relative to those in the savannah zone. As observed, individuals in the savannah zone of Ghana are employed largely in wide-spread informal activities whereas their counterparts in the coastal and forest zones search for non-existent formal sector employment. Thus, the dependency rate (free-riding) in

the savannah zone seems very much less relative to other zones as majority of individuals are engaged in some form of largely informal employment. Also, the results are evident from the fact that recent attention has shifted largely towards the three northern regions in the savannah zone of Ghana. This has been part of an effort to reduce their levels of poverty at the expense of the coastal and forest zones. Consequently, there has been a paradigm shift of poverty from the savannah zone to the coastal and forest zones.

Policy recommendations

The results above give support to the fact that policy interventions are necessary to reduce poverty levels in Ghana.

Given that female household heads are more likely to be poor than their male counterparts, policy should seek to provide females with enough funding to augment their business capital. Banks should move towards extending loans to female groups and individuals at low interest rates to improve their businesses. Traders should be encouraged to form associations in order to improve their chances of securing loans from banks to revamp their businesses. Also, to ease the burden on married couples, there should be advisory services offered them with regard to the advantages involved in pooling together resources; in situations where both parties are employed.

Another significant recommendation is for government to increase the poverty alleviation campaign in all regions of the economy, bringing an end to the over-concentration on the three northern regions. There should be a decentralization of the process to include all district, municipal and metropolitan assemblies (DMMAs). However, there should be strict monitoring of officials to ensure that best practices are being followed. To achieve this, local offices for poverty alleviation (LOFPA) should be established in the DMMAs. The LOFPAs should have a special mandate to effectively reduce poverty in their localities and should also be accountable to their regional head offices. To this end, there should be increased research on the determinants of poverty in each district, municipality and metropolis. Corporate bodies should particularly be encouraged to support this process in the communities they operate. There should also be education on the need for individuals to engage in secondary income earning activities aside of their primary occupations. Thus, self-help spirits should be motivated.

To a larger extent, individuals should cut down on expenditures that go into wants and other luxuries and try as much to optimize their resource use. They should be educated on taking advantage of dividend yielding investment opportunities that will ensure a regular stream of income rather than embarking on spending sprees with their incomes.

Lastly, the government should seek to ensure that majority of the country's population attain university education. Due to the rising cost of education beyond that which individuals can afford, the government should increase its subsidies to the sector or ultimately provide free education at the university first degree level (at least). By this strategy, most students will work their way up to the University just to enjoy the free education. Eventually, the state benefits from the human capacity it has been able to train. However, to achieve this, there should be a restructuring of the educational system to including courses that are 'useful' to the country so that graduates will duly be gainfully employed. Aside of improving the livelihoods of individuals, this will also help the economy to grow.

Conclusion

This paper studied the incidence of poverty in Ghana using GLSS (2008) data covering 8,687 individuals. The results showed that by 2006 the proportion of individuals living below the poverty line stood at 0.77. To worsen the situation, these individuals are very much distant (poverty gap) from the poverty line by 0.75 on a scale of 0 to 1. In addition, the core poor population is about 0.74 in proportion to the total number of poor people. This shows that majority of the people still live in poverty. Thus, poverty alleviation measures implemented since the inception of the millennium development goals have achieved little success. What has basically been done is a 'switching' of poverty from the savannah zone to the coastal and forest zones without seeking to reduce the severity of poverty in general across the country.
In conclusion, policy should seek to drive the wheels of poverty alleviation faster than it is being done.

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4 • Media freedom and political stability in Sub-Saharan Africa: a panel data study

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Abstract

Political stability is often cited as a key determinant of growth in Sub-Saharan Africa (SSA) although little research that identifies the factors that ensure political stability in SSA is available. A pertinent determinant of political stability in SSA may be press freedom since on one hand, the press can contribute to political stability by keeping the electorate informed thereby keeping a check on graft, fraud, embezzlement and other corrupt practices of government officials. On the other hand, however, the press can be manipulated to generate political instability by misinforming the public so the exact relationship between press freedom and political stability in SSA is ex ante unclear. By investigating the determinants of political stability and accounting for possible of endogeneity bias, this paper (i) isolates the most pertinent variables that affect political stability in Sub-Saharan Africa and (ii) investigates to what extent press freedom mitigates or worsens the incidence of political instability in the SSA region. A panel of 31 SSA countries from 1984–2007 is used in static and dynamic panel data frameworks to investigate the determinants of political stability and to verify the relationship between media freedom and political stability in SSA. Important determinants of political stability are found to be mainly related to economic performance, macroeconomic policies, unemployment the level of education and regime type. Preliminary results also suggest that media freedom may be a vital determinant of political stability in SSA although less so than economic, political and social factors. Ongoing estimations suggest elasticities of political stability with respect to media freedom calculated at different values of media freedom are nonzero. The research result should help guide policy makers in the different nation states of SSA in drafting pragmatic media and economic policies that will promote political stability in their respective countries.

Key words: Press Freedom, Political Instability, Panel Data, Elasticity, Sub-Saharan Africa

Introduction

Considered a perennially unstable region with minuscule growth prospects and often plagued by powerful influences from within and without and by its own inherent demons, Sub-Saharan Africa (SSA) seems more stable recently and is growing (Armah, 2009). Reasons for this growth have been attributed to good governance and political stability (Armah, 2009). Note that Political stability as defined here reflects good governance. It represents legislative strength as well as the ruling government's popularity, its ability to carry out its declared programs and its ability to stay in office. This definition of political stability does not however reflect catastrophic events, including wars.

We concede that there remains some debate about both the theoretical validity and empirical robustness of the political stability-growth claim although it has been touted by influential leaders such as current US president Barack Obama and former British premier Gordon Brown. For proponents of the conditionality theory that economic prosperity is predicated on political stability however, it seems priceless to find answers to questions like (i) what

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are the pertinent determinants of political stability specifically in SSA, (ii) how sensitive is political stability to changes in these factors and (iii) how distinct are these factors from causalities of political stability on the larger global scale?

Ironically, although the statistical relevance of a myriad of factors believed to stimulate political stability have been investigated on a global scale (e.g. poor economic performance, regime type, tribalism, and inequality etc)[1], little attention has been paid to formulating an empirical model to verify the determinants of political stability specifically in SSA. Mbaku (1989) and Seifu (2009) are, however, notable exceptions. Further in spite of the considerable albeit old literature that exists on the theoretical underpinnings of the media freedom-political stability link (See for example Ogbondah (1994)) very little empirical verification of the media freedom-political stability link has yet been undertaken.

We argue that for SSA empirical justification of the free press-political stability link is urgently needed as the relationship is ex-ante indeterminate and is essentially an empirical question. On one hand, the press can contribute to political stability by informing the electorate thereby keeping a check on graft and corrupt practices of government officials. On the other hand, however, the press can be manipulated to generate political instability by misinforming the public. Even if we knew that press freedom affects political stability we still need to know by how much press freedom (or the lack of it) stimulates (hurts) political stability.

By formalizing an empirical model to isolate the determinants of political stability, and accounting for possible endogeneity bias between the indices of political stability and press freedom, this paper contributes to the literature by investigating the factors that determine political stability in Sub-Saharan Africa and in particular to what extent press freedom mitigates or worsens the incidence of political instability in the Sub-Saharan African region.

A panel of 31 SSA countries from 1984–2007 is used in both a static and a dynamic panel data framework to investigate the relationship between media freedom and political stability in SSA. Other significant determinants of political stability are also identified. Preliminary results suggest that the most important determinants of political stability are economic in nature although media freedom is also an important determinant of political stability in SSA because elasticities of political stability with respect to media freedom calculated at different values of media freedom are nonzero and increase with increasing freedom of the press. The research result should help guide policy makers in the different nation states of SSA in drafting pragmatic media and development policies that will promote political stability in their respective countries.

[1] *See Blanco and Grier (2010), Auvinen (1997), and Mbaku (1989).*

Literature review

The last two decades of the twentieth century were marked globally by what Huttington (1991) labeled the "third wave" of democratization. This "wave" did not leave SSA untouched. In West Africa for example decades old military regimes (e.g. Ghana, Benin, Niger and Mali) were replaced by democratically elected governments even though the electoral processes tended not to be free from some manipulation aimed at advantaging incumbents. Undoubtedly military regimes in SSA had come to symbolize powerfully the chronic political instability that bedeviled developing polities in the post colonial era.

Understanding the nature, causes and consequences of political instability in SSA has attracted the attention of both developed and developing country scholars in contemporary times. Fosu (1992) examined the impact of political instability on the economic growth of 31 SSA countries from 1960 to 1986. He concluded that on average political instability undermines economic growth. Nkrurunziza and Bates (2003), Gyimah-Brempong and Tynor (1999) concern themselves as well with the inverse link between political instability and economic growth. In a particularly influential work Collier and Hoeffler (1998; 2000/2003) through econometric analysis conclude that primary resource dependence (operationalized as primary commodity exports as a percentage of GDP) is correlated with a higher risk of conflict. In this view the opportunity for economic advantage is a powerful motivation for armed conflict and hence a strong driver for political instability in developing polities. This Collier-Hoeffler construal for explicating the cause of political instability has however been critiqued by some scholars who questioned its methodological approach (Sambanis 2002; de Soysa 2002; Ross 2004a) while other academics like Aning and Hutchful (2004) while pointing out its reductionist bent insist on a broad and sophisticated political economy analysis of the causes of contemporary conflicts and by extension political instability.

The rents framework in all its variants (Bates, 1981; Frimpong-Ansah, 1991; Krueger, 1974; Lal, 1984) posits essentially to borrow Mbaku's (1989:65) words "that rent-seeking on the part of heterogeneous groups of political entrepreneurs is responsible for the political instability in African governments." In other words the causes of political instability in Africa lie in state intervention in the

market and the attempt by political elites to profit from this. State incapacity understood to mean broadly the inability of the state to perform its developmental, bureaucratic and regulatory functions is considered by some scholars (Sobek, 2010; DeRouen et al) as a key determinant of political instability. Sobek (2010:269) captures the thinking of such scholars when he asserts that "in the most general sense, state capacity affects the opportunity of groups to engage in actions against the state." In a somewhat unique Seifu (2009) concludes that colonial heritage (whether the African Country was colonized by England, France, Portugal, Italy or Spain) and income disparity were the key determinants of regime survival in SSA.

The foundations of press freedom and its link to political stability have also been extensively discussed in the literature (Novel, 2006; UNESCO, 2008; Soola, 2009; Ogbondah, 1994; Egorov, Guriev and Sonin, 2006). However, surprising though it may seem, empirical validation on the political stability-media freedom is scarce in the literature. Even worse, SSA-specific empirical research on the Press freedom and political stability link is non-existent. We therefore seek in this paper to contribute to the empirical literature on the determinants of political stability in SSA although we do put particular focus on investigating the role of press freedom if any in the attainment of stability.

As democratic governance becomes the norm in SSA, media freedom, which is seen as crucial in promoting political participation and accountability, has taken on added significance. Media freedom however seems to present a Janus-faced paradox in relation to political stability in SSA. The role of Radio Télévision Libre des Mille Collines (RTLMC) in the Rwandan genocide of April-June 1994 provides an empirical, contemporary, reflection of this paradox. The RTMLC spurred on the massacre of Tutsis and moderate Hutus. More recently, Zimbabwe has emerged as a bastion of press control in SSA. Other countries, for example Ghana, have peculiar laws that allows the government to charge journalists with "causing fear and panic"

Comeforo (2010:219) is on point when he states that "to serve its democratizing function, conventional wisdom argues that the media must be objective and independent, and not merely a megaphone for powerful interests." In order words media freedom can be made to serve other narrow interests which may not be necessarily coterminous with the public order and welfare. For developing polities this can pose real threats to political stability. Chomsky and Herman (2008) present a model in which they sketch out the processes by which elite interests manipulate the media in the global North. Does media freedom in developing countries portend such a possibility as posited by Chomsky and Herman? If so the implications for political stability in developing countries ceases to be benignly magnanimous and should be decomposed more carefully. Clearly then the exact relationship between political stability and media freedom in SSA is ex ante unclear. In this work, aside of confirming the most pertinent determinants of political stability in SSA, we seek to make some meaning of the crucial media-political stability link in a democratizing SSA.

Theory, empirical model, methods and data

Theoretical relationship between media freedom and political stability

Ogbondah (1994) highlights a possible route through which a free press can theoretically inhibit political stability in SSA. According to him "African leaders argue that given SSA's subservient position in the global economic system, a deleterious colonial legacy and the fragility of institutions in newly independent SSA countries, a free press as pertains in the USA and UK can too easily lead to instability of government to function and to internal chaos (Aggarwala, 1977, Mboya 1970 and Sommerlad, 1966)." The argument that free press is inimical to stability emphasizes the harsh reality that since SSA has low levels of literacy and education suggest that even if SSA residents did get information from different sources, they may not be able to adequately process the information to arrive at a reasonable consensus. The confusion that emanates from a lack of comprehension can fuel chaos leading to political agitation and potential conflict. Therefore since SSA residents can be manipulated by the press (as happened in Rwanda in the 1990s), press control is not only potentially beneficial for stability, it is necessary to ensure political stability and economic development in SSA.

A more pragmatic view of the relationship between media freedom and political stability may be that the former positively stimulates the latter implying press freedom is an essential ingredient for political stability on the sub-continent. A free press keeps the electorate informed by revealing information on and thus keeping a check on graft, fraud, theft, bribery, embezzlement, smuggling and other corrupt practices of government officials. Since corruption and graft have been identified as especially inimical to economic growth, reduction in corruption that results from freeing the press may encourage political stability since a good performing economy will likely discourage political insurrection which results in political instability.

Model

Although we are especially interested in the effect of Media Freedom (used interchangeably here to mean Freedom of the Press) on Political Stability in Sub-Saharan Africa (SSA), we first try to determine in a holistic manner the determinants of political stability. We employ a modified version of Blanco and Grier's (2010) empirical model used to investigate the determinants of political stability in Latin America. We modified their model by introducing some key variables likely to be pertinent in Sub-Saharan Africa. We acknowledge that a few variables originally employed in Blanco and Grier's (2010) empirical model are not included in our model because of lack of data for the respective SSA countries.

Following Blanco and Grier's (2010), we will discuss the mechanism by which the different variables influence political stability by first aggregating these variables into broad groups then focusing on each variable one at a time in each of the broad groups of variables. Blanco and Grier's (2010) identified the broad groups of variables affecting Political Stability in Latin America as (A) regime type, Factionalism and Regime Duration (B) Neighbourhood Instability, (C) Inequality (D) Socio-demographic Conditions and (E) Macroeconomic factors. Subject to data availability we propose an empirical model such as in (1)

$$\mathbf{PS}_{it} = \delta + \delta\, \mathbf{PF}_{it} + \theta\, \mathbf{X} + \mu_{it} \qquad (1)$$

Where Political Stability (PS) is the dependent variable, PF is Press Freedom, X is a vector of explanatory variables apart from Press Freedom and μ_{it} is an iid error term with a zero mean and a constant variance. Note that ignoring the details of what variables are in the broad groups for now, the broad groups of determining variables include (a) Press Freedom (b) Regime type (c) Different Measures of Inequality (d) Socio-Demographic Variables (e) General Economic Performance Factors (f) Macroeconomic factors (g) Level of agricultural participation in the economy and (h) Other Relevant Variables in the SSA Context.

The next section provide details of what variables are in each group and briefly describe how and in which direction each of these variables are related to Political Stability while the data section will expand on the sources, frequency and construction of the variables used in the study.

a. Media freedom and political stability

Media freedom or Free Press (FP) mitigates the negative effects of corruption on political stability and may actually promote stability by offering avenues for discourse and calling attention to potentially volatile issues before they blow up Ogbondah (1994). However, as Mbaku (1989) argues the press can also be manipulated to incite instability. Media freedom is expected to positively affect stability although the sign of the relationship between media freedom and political stability is really an empirical question.

b. Regime type

According to Blanco and Grier's (2010), the effect of regime type, democracy (DEMOCRACY) or autocracy, on political stability has enjoyed significant attention in the literature (see for example, Rummel (1995), Auvinen (1997), Przeworski and Limongi (1997) and Feng (1997)). Although some researchers, for example Schatzman (2005) have found mixed results with regards to the relationship between democracy and political stability, the overarching consensus appears that democracy should positively influence stability because it allows a broad section of the population to participate in the political process (Tulchin and Brown 2002; Ellingsen, 2000; Parsa, 2003 and Blanco and Grier, 2010).

c. Inequality

A highly unequal distribution of income will likely enhance social discontent, since individuals will perceive that income is unfairly distributed, leading to agitation and instability (Blanco and Grier's, 2010; Perotti, 1996; Auvinen and Nafziger, 2002; Alesina and Perotti, 1996; Perotti 1996; and Odedokun and Round, 2001). Inequality is expected to be negatively related to stability.

d. Socio-demographic variables

The socio-demographic variables used in this study include the levels of educational attainment (PRIM) and urbanization (URBAN) of the population. Anderson (2003) explains that false beliefs as documented by Hobbes can cloud the judgment of an uneducated person and incite him into taking destabilizing action without properly accounting for the potential costs. Education is expected to be positively correlated to stability. In terms of urbanization there is little consensus about its effect on political stability. While Collier and Hoeffler (2004) find a positive urbanization-stability link, Auvinen (1997) and Annett (2001) find a negative relationship.

e. General economic performance factors

The variables categorized under economic performance include Economic Growth (GROWTH), and Unemployment (UNEMPLOY). Needless to say these factors are likely related to each other by some latent time-invariant factor that affects political stability and all

three of these variables concurrently. Low economic grow will lead to insurrection especially when income levels are low and unemployment is high (Blanco and Grier, 2010; Collier and Hoeffler (2004) and Grossman (1991)).

f. Macroeconomic factors

The main macroeconomic variables considered were (i) A measure of Economic Policy (POLICY) as described in Burnside and dollar (2000), (ii) Investment as a share of GDP (INVEST_GDP) and (iii) Foreign Aid (AID). It is expected that policies and investment will both promote stability but the effect of foreign aid on political stability is ambiguous. On the one hand aid and spur growth which encourages stability but on the other and aid can elicit rent-seeking behaviour that can be particularly de-stabilizing.

g. Other relevant variables

Other variables relevant in the SSA context include dummies respectively for French colonial heritage (D_FRA_COLONY) and English (D_ENG_COLONY) colonial heritage and a proxy for the effect of extensive practice of traditional agriculture on stability (AFRIC LF). Its ex ante unclear what the signs of the relationships between the colonial legacy variables and political stability will be. However since SSA had more than two colonial asters it's possible to put in both dummies simultaneously or one dummy after the other. Mbaku (1989) argues that countries with a large percentage of the labor force engaged in agriculture can easily be de-stabilized because the government tends to transfer rents from agriculture without due compensation to traditional agricultural practitioners. In a country with a large number of traditional agricultural practitioners, therefore, stability will be especially elusive. Following Mbaku (1989) we employ the percentage of the labor force engaged in agriculture to capture such effects in the empirical model of political stability.

Methods

Note that the empirical methodology employed attempts to accounts for problems of mis-specification resulting either from a non-constant error variance (heteroskedasticity) or from endogeneity bias that can be caused by (i) by persistence in the dependent variable (ii) by the confounding effect of an omitted variable that concurrently affects the dependent and some of the independent variables or by (iii) unobserved time constant country-specific effects. We do however concede the small sample size and a lack of sufficiently strong and exogenous instruments prevented an exhaustive treatment of endogeneity. Further, difficulty in obtaining data for some pertinent model variables implies that there is likely omitted variable bias still present. The inter-related nature of the correlations between variables also implies that signs of such bias are difficult to establish. Finally note that variables that were insignificant but did not reduce the R-square when they were excluded from the model were not included in the regressions reported in the results section. Examples of such variables include (a) measurements of inequality (such as the poverty head count ratio, and the portion of the population earning 20% of national income) and (b) a measure of bureaucratic quality

Data

The press freedom data are from Freedom House International while the political stability data are from the Political Research Service (PRS). Although some of the dummy variables use in the paper, for example, Colonial Legacy are constructed by the author, the bulk of the of the data on the explanatory valuables such as the growth data are from the World Development Indicators (WDI) of the World Bank, the Penn World Tables, and the World Banks' Africa Database CD. The data range from 1984 to 2007 and cover six four-year periods (i.e. 1984–1987 to 2004–2007).

To avoid possible multicollinearity problems due to the likely high correlation between the independent variables, a correlation matrix of the explanatory variables developed and is presented in Table 1. It is clear from Table 1, that the pair wise correlations are not too high or lower than one, so multicollinearity is not likely to a serious problem. Table 2 presents definitions and descriptive statistics of the data including means, standard deviations, minima and maxima. Figures 1 and 2 show that while press freedom (F) appears to be positively related to political stability in a stable country like Ghana, it is negatively related to political stability in an unstable country like Somalia. The ambiguity in the empirical relationship between PS and media freedom (PF) is obviously an important motivation for the research. Note that the Media Freedom variable (FP) as used in this research is on a 1–3 scale where 1 represents not free, 2 is partly free and 3 is free. The data was obtained from Freedom house and only considers print but not electronic media.

Figures 3 and 4 demonstrate that Political Stability is very much a recent phenomenon because stability has improve substantially for both stable and unstable countries while Figures 5 and 6 displays the political stability values for a set of SSA countries for two different time periods; an older period 1994–1999 and the more recent 2004–2007 period. For this group of SSA

countries political stability situation is relatively unchanged over time despite heterogeneity in the data among countries.

Discussion of results

The empirical model in (1) enables us to identify the important determinants of political stability in SSA and to quantify the response of political stability to changes in these factors. We acknowledge the apparent arbitrariness in the (0–12) political stability PS scale. However numerous studies, for example, (Armah, 2009) have used this PS scale from the ICRG's PRS dataset to quantify political stability so we regard a positive marginal effect as indicative of positive relationship between political stability the relevant variable.

The main results of the analysis are presented in Table 3. The different columns of Table 1 display results from different variants of estimation of (1) where (except for column 1) result are corrected for possible serial correlation and heteroskedasticity. Column 1 contains OLS results of the basic model where the BD (2000) AIDPOL interaction variable and the agricultural participation (AGRIC_LF) variables are not included in the model. Column 2 contains both the AIDPOL and AGRIC_LF variables. To account for possible endogeneity due to feedback from free press to political stability we lag the FP variable one period. Column 3 contains all the variables in column 2 but with lag FP replacing FP. Fixed effect estimation is employed to account for potential unobserved time constant country–specific effect endogeneity in a static panel data framework with the results presented in Column 4 of Table 3. Finally the results of one step Arellano and Bond (1991) dynamic panel estimation are presented in column 5.

Of the different results presented, Column 3 of Table 2 is chosen as the model of choice because it is a more complete model with a high R-square as well as reasonable signs and strong statistical significance of variables. In addition, the significant lag which indicates that it takes time for media freedom to affect political stability is reasonable given that the lag eliminates endogeneity due to feedback from PF since PFt-1 is pre-determined in (1). We place less faith in the fixed effects and dynamic panel data models because of the small size and potentially small variations in the variables over time. From column 3 of Table 3, it is clear that the most important determinants o political stability in SSA are economic in nature because investment, growth and economic policy are all significantly related to political stability at conventional significance levels as are urbanization, democracy and education. The signs of these variables are consistent with expectations since Blanco and Grier (2010) finds similar results for Latin America. Perhaps unsurprisingly, unemployment is strongly negatively correlated with political stability indicating that a considerable portion of instability in SSA may be due to lack of job opportunities.

Since the signs of some the variables that are not significant (French and English colonial legacies respectively) are difficult to guess ex ante we will not dwell on them. However it is notable that the portion of the labor force engaged in Agric is positive but the sign of aid and its interaction with policy are negative indicating that rent seeking through aid is destabilizing.

With regards, to media freedom, Column 3 of Table 3 shows that it is positively and significantly related to Political Stability in SSA at the 95% confidence level because the coefficient of PF (0.6) is positive with a p-value of 0.05. However to gauge the magnitude response we calculate elasticities of political stability at the three different levels of media freedom (1, 2 and 3) and obtain elasticities of 0.1, 0.2 and 0.3 respectively. Although these values are less than one (inelastic) which indicates that political stability is not very responsive to changes in media freedom, the fact that the elasticity increases as we move from a shackled press (FP =1) to a free press (FP = 3) provided some comfort that increasing freedoms for the press bodes well for political stability in SSA.

Conclusion and recommendations

The paper set out (i) to determine pertinent determinants of political stability specifically in SSA, (ii) to find out how sensitive is political stability to changes in these factors and (iii) how distinct are these factors from causalities of political stability on the larger global scale? From the results above, we conclude that press freedom, investment, growth and economic policy are all significantly related to political stability at conventional significance levels as are urbanization, democracy, education and unemployment. In particular a free press is supportive of political stability in SSA because the elasticity of political stability with respect to press freedom is non-zero and increasing in press freedom. Furthermore the variables identified as promoting press freedom are mostly economic in nature and not very different from the factors that promote political stability in other parts of the world for example Latin America. The results clearly indicate that policy makers in SSA should put economic development even higher on the Agenda than it is now because it can actually reduce discontent and generate stability but media freedom is also important for reducing corruption. SSA government should invest in educating

the labor force, construct good roads, guarantee stable power, build shipping ports to reduce transport costs, endeavour to reduce the cost of borrowing and guarantee press freedom in order to promote economic development which is priority number one. A strong economy will also support political stability. Further research should more carefully account for different sources of endogeneity and acquire data on variables like rent seeking, corruption, tribalism, religious composition, regime duration, inequality and neighbourhood instability in order to define a more complete model of political stability. The interactions between variables like democracy, press freedom, economic policy and urbanization should also be more carefully assessed in order to obtain a more robust model of the determinants of political stability in SSA.

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Appendix 1

Figure 1 Political stability vs press freedom for Ghana (stable country), 1984–2007

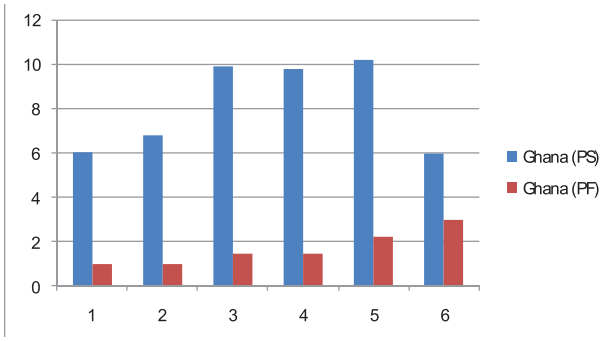
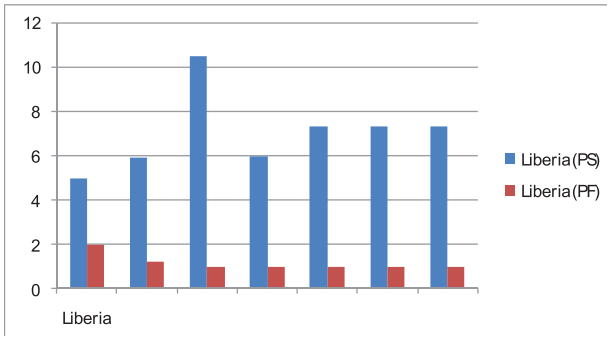


Figure 2 Political stability vs press freedom for Liberia (unstable country), 1984–2007



Note: Thereappears to be a negative relationship between Press Freedom (PF) and Political Stability (PS)
Data Source: PS is from ICRG s PRS dataset while PF is from Freedom of the Word's Index

Figure 3 Political stability for the most stable SSA countries, 1984–2007

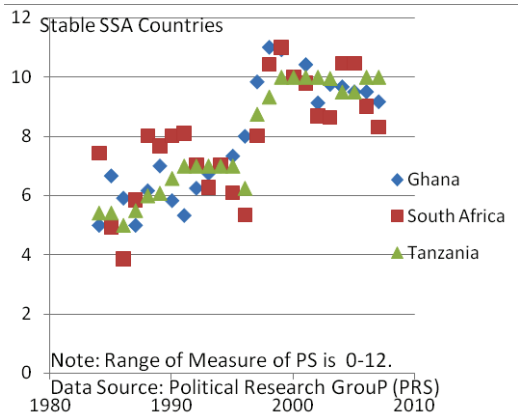


Figure 4 Political stability for the least stable SSA countries, 1984–2007

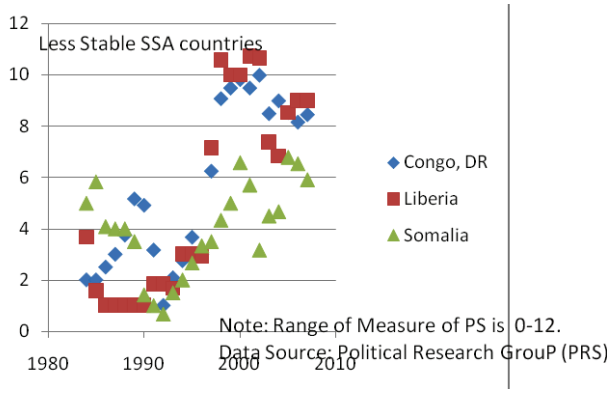


Figure 5 Political stability for SSA countries, 1984–2007

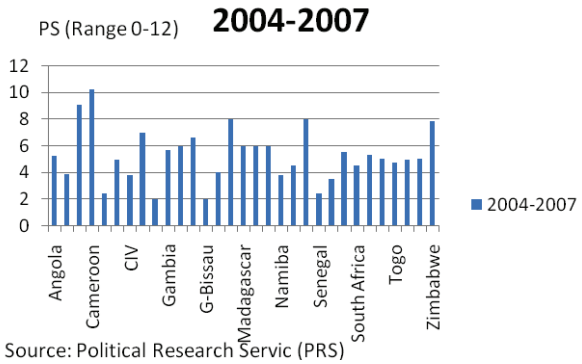


Figure 6 Political stability for SSA countries, 1996–1999

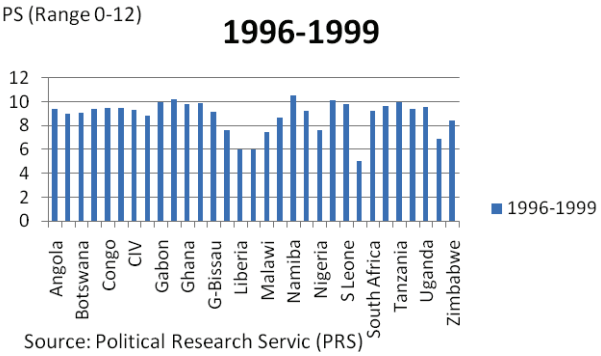


Table 1: Descriptive statistics of key variables

Variable definition (expected sign of correlation with PS)	*Mean (standard deviation)*	*Maximum (Minimum)*	*Source of data, index or Constructed variable*
Political Stability (PS)	6.87		ICRG's Political Research
[NOT APPLICABLE]	(0.17)	(1.7)	Service Database
Press Freedom (PF)	1.46	3	Freedom House's
(+)	(0.04)	(0.0)	Press Freedom Index
Investment /GDP (INVEST_GDP)	0.42	15.11	World bank's Africa Database
(+)	(0.23)	(10.01)	CD
Economic Growth (GROWTH)	0.4	32.13	World bank's Africa Database
(+)	(0.345)	(-24.8)	CD
Economic Policy (POLICY)	0.46	2.3	Constructed variable
(+)	(0.05)	(1.48)	Following Sachs and Warner
Urban Dwellers/ Total Population (URBANIZATION)	32.72	83.75	World Bank Data
(Ambiguous)	(1.12)	(5.32)	
Regime Type (DEMOCRACY)	0.47	1	Dummy (Constructed variable)
(+)	(0.03)	(0.0)	
Education (PRIM)	6.18	8	World Development Indicators
(+)	(0.05)	(4)	
Foreign Aid/ GDP (AID)	0.2	1.7	OECD'S DAC
(Ambiguous)	(0.01)	(0)	Database
French Colonial Legacy (D_COLONY_FR)	0.4	1	Dummy (Constructed variable)
(Ambiguous)	(0.04)	(0)	
English Colonial Legacy (D_COLONY_ENG)	0.45	1	Dummy (Constructed variable)
(Ambiguous)	(0.04)	(0)	
Unemployment (UNEMPLOY)	1.64	26.4	World bank Data
(-)	(0.23)	(0)	
Poverty Headcount at NationalPov line (POV _HDCOUNT)	3.7	36.5	World Bank Data
(-)	(0.074)	(0)	
Bureaucratic Quality (BUR_QUAL)	1.48	0	ICRG's Political Research
(-)	(0.074)	(4)	Service Database
Portion of GDP due to top 2 deciles (INC_SHAREHIGH)	2.77	23.11	World bank Data
(-)	(0.35)	(0)	
Portion of GDP due to lowest 2 deciles (INC_SHARELOW)	0.632848462	4.7	World bank Data
(+)	(0.07) (0)		
Portion of Population employed in Agric (AGRIC_LF)	13.36	24.18	World bank Data
(Ambiguous)	(0.42)	(1)	
Export Instability Index (EXINST)	0.543330852	4.5	Constructed variable
(-)	(0.05)	(-0.11)	

Table 2 Correlation Matrix of Selected Explanatory Variables

			Invest			Urbanisation		
	PS	PF	DP	Growth	Policy	On	DEM	PRIM
PS	1							
PF	0.071254002	1						
INVEST_GDP	0.360827594	0.06512653	1					
GROWTH	0.417982118	-0.00605501	0.511575774	1				
POLICY	0.102430108	-0.095021643	0.20404438	0.031383221	1			
URBANIZATION	0.036573511	0.122513331	-0.049783999	0.053662995	0.06309219	1		
DEM	0.473470011	0.101461486	0.199203085	0.298355507	0.037652795	-0.027932282	1	
PRIM	-0.046756247	0.122059957	-0.012787897	0.011653995	-0.133403665	-0.138049959	-0.071439922	1
AID	-0.119797059	0.01522462	0.041914465	0.034350788	0.124688498	-0.184979771	-0.198881348	0.044244121
D_COLONY_FR	0.101066872	-0.037964727	0.078347558	0.099907407	-0.043452262	-0.046632778	0.225244762	-0.023377945
D_COLONY_ENG	-0.074881712	0.136335678	0.031306094	-0.043187569	0.140682041	0.015431344	-0.141446639	0.28293425
UNEMPLOY	-0.011679515	0.398062043	-0.030091506	-0.026398982	0.066512828	0.310463843	0.098812822	0.162046543
POV _HDCOUNT	0.046443073	0.137663682	0.001357355	-0.028419013	-0.074112184	-0.117566084	0.119037498	0.033672673
DEM_ACC	0.332915802	0.051338906	0.11017717	0.111089109	0.05408702	0.038521117	0.495177472	-0.107302186
BUR_QUAL	0.066859865	0.031318275	0.033213891	0.054519944	0.020052619	0.014538427	0.12508859	-0.14075447
INC_SHAREHIGH	0.122623452	0.089680955	0.03814664	0.036356978	0.065647761	-0.051711244	0.110233886	-0.170537338
INC_SHARELOW	0.133881135	0.103303106	0.057061678	0.062742724	0.012901429	-0.117522046	0.097815223	-0.028229097

Note: The SSA countries in the analysis include:: Angola, Burkina Faso, Cameroon, Congo, Congo DR, Cote d'Ivoire, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Madagascar, Malawi, Mali, Namibia, Niger, Nigeria, Senegal, Sierra Leone, Somalia, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia and Zimbabwe.

AID	D_Colony _FR	D_Colony	Unempl	Pov_HDCount	Dem_AC	Bur_Qu	Incl. Sharehigh	Incl. Sharelow
1								
-0.181954803	1							
0.226368138	-0.727957429	1						
-0.061569565	-0.125530379	0.203170033	1					
-0.071076926	-0.044813731	0.123662258	0.044223808	1				
-0.148712884	0.197593451	-0.16996188	-0.085447646	0.009320233	1			
0.078653131	0.155876803	-0.001977062	0.002362187	-0.060338529	0.319288446	1		
-0.096756045	0.23462236	-0.195662318	-0.065336389	0.278355332	0.049978483	0.090325815	1	
-0.016187936	0.149293799	-0.046115529	-0.026515215	0.291978946	0.017367208	0.009683026	0.745227345	1

Table 3: Growth regression

	(1)	*(2)*	*(3)*	*(4)*	*(5)*
	OLS	*OLS*	*POLS*	*FE*	*DYNAMIC*
	NO AIDPOL	*AGRIC LF*	*LAGGED FP*	*NO LAG*	*AB 1 Step*
PF	0.4	0.52	0.6	0.57	0.8
	(1.6)*	(1.9)**	(1.95)**	(1.56)	(1.21)
INVEST_GDP	0.12	0.1	0.1	0.12	0.12
	(2.2)**	(1.84)*	(1.56)	(1.87)*	(1.34)
GROWTH	0.1	1	0.12	1	0.14
	(2.6)**	(3.08)**	(2.73)**	(3.05)***	(2.82)**
POLICY	0.4	0.6	0.54	0.5	0.42
	(1.8)*	(1.94)**	(1.87)*	(1.19)	(0.7)
URBAN	0.02	0.02	0.02	0.02	0.01
	(2.2)**	(1.89)*	(1.05)	(0.52)	(0.04)
DEMOCRACY	1.9	1.84	1.5	1.8	-8
	(6.0)***	(6.10)***	(4.26)***	(4.82)***	(1.310
EDUCATION	0.8	0.7	0.72	-0.67	0
	(8.0)***	(5.40)***	(5.15)***	(-0.76)	0
AID	-0.4	-0.3	-0.51	-1.6	-2.3
	(-0.6)	(-0.45)	(-0.65)	(-1.46)	(-1.25)
D_FRA_COLONY	-0.4	-0.003	0.04	-0.54	-0.5
	(-1.0)	(-0.01)	(0.12)	(0.87)	(-0.64)
AIDPOL	-0.4	-0.8	-0.85	-1.3	
	(-0.43)	(-0.63)	(-0.68)	(-0.52)	
D_ENG_COLONY	(-0.5)				
	(-1.2)				
UNEMPLOY	-0.1	-0.1	-0.1	-1	0.02
	(-2.2)**	(-3.27)***	(-2.3)**	(-1.95)**	(0.12)
AGRIC LF	0.03	0.03	0.01	0.01	
	(1.13)	(1.16)	(0.3)	(0.03)	
LAGGED PS	0.5				
	(2.78)				
Observations	184	186	155	186	124
R-Square (Overall)	0.92	0.93	0.93	0.3	

Note. Errors are corrected for serial correlation and heteroskedasticity in the robust estimations. Outliers were deleted in each regression. Student t-statistics in parentheses. Significant at 10%; ** significant at 5%*** significant at 1%****

5 • Will hedging joint cocoa price and production risk benefit Ghana?

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Abstract

This paper assesses the usefulness of risk hedging on futures markets for a cocoa exporter subject to concurrent price and output (revenue) risks. The analysis is conducted for Ghana, the world's second largest exporter of cocoa beans. Using cocoa export revenue data, the cocoa exporter's utility maximization problem (UMP) is solved using a Constant Relative Risk Aversion (CRRA) utility function due to Nelson and Escalante (2004) which displays risk vulnerability. Risk vulnerability is the most natural restriction on preferences (Gollier and Pratt, 1996). Simulation results from solving the UMP indicate that as a result of production risk, optimal revenue hedge ratios are much smaller than optimal price risk hedge ratios for reasonable values of the risk parameter. When transaction costs are incorporated into the hedger's UMP, optimal revenue hedge ratios decline further although they remain positive. The findings indicate that limited use of the futures market is optimal for Ghana because it improves cocoa exporter utility relative to the unhedged position. These results should provide valuable information to policy makers in Ghana and other cocoa producing countries because they confirm that revenue risk hedging is a viable risk management alternative even when transaction costs are accounted for in the UMP of the hedger.

Key words: Transaction costs, risk management, cocoa, hedge ratio, risk vulnerability.
JEL Classification: MO; N27; Q13; Q14; and Q17

Introduction

Cocoa exporting Sub-Saharan African (SSA) governments typically depend heavily on cocoa export revenue to finance development projects, exposing them to export revenue risk (Borenstein, Jeane and Sandri, 2009 and Razzaque, Osafo-Kwaako and Grynberg, 2007). Export revenue variability emanating from either export price or production uncertainty can lead to undesirable consequences for sovereign exporters overly dependent on export revenue (Newbery and Stiglitz, 1981; Razzaque, Osafo-Kwaako and Grynberg, 2007). For instance, export revenue risk can increase the likelihood of default on sovereign debt and also lead to macroeconomic instability in export revenue-dependent SSA countries (Malone, 2005).

This paper focuses on the export revenue risk problem facing Ghana, the second largest cocoa exporter in the world where revenue risk is understood to comprise of both price and output risks. Ghana is chosen for analysis because it is somewhat typical of the cocoa exporting SSA countries and relies heavily on cocoa export revenue: cocoa provides nearly thirty percent of Ghana's export revenue (Pinnamang Tutu and Armah, 2011).

Export revenue risk has assumed great importance recently because non-market strategies including buffer stocks, buffer funds and commodity agreements designed to minimize commodity revenue risk have failed (Borenstein, Jeane and Sandri, 2009 and Larson, Anderson and Verangis, 2004). Further, because of the recent efforts by the World Trade Organization (WTO) to liberalize markets and foster competition in world markets, risk management methods such as the cocoa agreements and buffer stocks are not likely to be encouraged in the future (Lence, 2009; Borenstein, Jeane and Sandri, 2009). As an alternative, market-based risk

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management strategies including hedging may be used to manage export revenue risk.

Should marketing boards of cocoa revenue-dependent SSA countries such as Ghana use the futures markets to mitigate price and output (revenue) risks? Will futures hedging of revenue risk increase exporter's welfare relative to the unhedged position? How large should optimal hedge ratios be especially after accounting for transaction costs which have been shown in prior research to affect their attractiveness? Answers to these questions are potentially of value to policy makers as they provide information on the effectiveness of futures markets in hedging revenue risk.

We should clarify right at the onset that Ghana is slightly different from other cocoa producing West African countries (La Cote d'Ivoire or CIV, Togo, Cameroon, Nigeria and Uganda) in the sense that it produces the world's best quality cocoa and thus enjoys a significant quality premium but the genetic makeup of Ghana's cocoa does not differ much from the rest of West African cocoa. At the moment Ghana sells all it cocoa mainly to Europe by means of forward contracts. Granted that the high quality premium may augment the utility of Ghana as a cocoa exporter significantly enough to reduce Ghana's opportunity cost of not hedging to miniscule levels, if Ghana is sufficiently risk averse, a case could still be made for hedging revenue risk if the variations in output and price are substantive.

In a well-known paper, Rolfo (1980) analysed the Utility Maximization Problem (UMP) facing a cocoa exporting country exposed to simultaneous price and production (revenue) risk. The cocoa industry was selected for analysis because it is plagued with production uncertainty and risk (Rolfo, 1980). Rolfo focused on SSA's major cocoa exporters: Ghana, La Cote d'Ivoire (CIV), and Nigeria that together account for nearly seventy percent of world production and depend to varying degrees on cocoa export revenues to fund development (Gibson, 2007).

Rolfo's problem formulation described a sovereign cocoa exporter exposed to concurrent price and production risk taking a pre-harvest (September) position in the futures market to establish a price at harvest (March). In the absence of production risk, a traditional recommendation of protecting a long position in a physical market involves taking a short position of equal size in the futures market (Hieronymus, 1971; Rolfo, 1980). Given production risk, Rolfo (1980) finds limited or no use of the futures markets is superior to a full hedge.

While Rolfo's analysis is highly informative, his findings may be limited in several dimensions. For example, since his data ran from 1956 to 1976, the results are dated and may no longer be relevant for current hedging decisions. In particular, fundamental changes have occurred in cocoa markets since Rolfo's work. Consider Figures 1 and 2 which respectively provide plots of futures and subsequent spot prices (cash price), and variance of futures prices for cocoa from 1960 to 2008. Clear evidence emerges of a structural break in futures and spot prices, and in the variance of futures prices. The earlier period was characterized by lower and less variable prices, and by a closer relationship between futures and spot prices. Statistical evidence of a structural break in the variance of futures prices is presented in Table 1 which displays results of the Miller Jackknife test, a non-parametric test of structural change in the variance that does not assume equal medians. From Table 1, the null hypothesis that the ratio of the variances of futures price before and after 1978 is unity is strongly rejected at 5 % significance level. Since optimal hedge ratios are respectively influenced either by changes in the correlation between cash and futures prices or by changes in the variance of the futures price (over time), the structural change in 1978 indicates a need to reassess the cocoa exporter's hedging decisions. More importantly, Rolfo's analysis ignores transaction costs. Mattos, Garcia and Nelson (2008) demonstrate that when transaction costs are considered when solving the utility maximization problem of an agent, optimal hedge ratios may change considerably.

Here we re-investigate the revenue risk problem facing Ghana, the cocoa exporter, incorporating transaction costs and using more recent data. We first compute optimal hedge ratios using quadratic utility with zero transactions costs for different values of the Coefficient of Absolute Risk Aversion (CARA). Transaction costs are then incorporated into the cocoa exporter's utility maximization problem and the optimal hedge ratios are recalculated. We then repeat the analysis with a more realistic Constant Relative Risk Aversion (CRRA) utility function (Nelson and Escalante, 2004). The Nelson and Escalante (2004) utility framework allows for the more reasonable Decreasing Absolute Risk Aversion (DARA) and Decreasing Absolute Risk Prudence (DAP) assumptions. The Nelson and Escalante (2004) utility function also displays risk vulnerability which is the most natural restriction on preferences (Gollier and Pratt, 1996; Mattos, Garcia and Nelson, 2008). A search program in Visual Basic was developed to compute optimal hedge ratios by solving the UMP of the cocoa exporter with Nelson and Escalante (2004) type preferences exposed to revenue risk and transaction costs. We find that optimal hedge ratios are positive even when transactions costs and production risks are incorporated into the UMP of the

cocoa producer but they are small in magnitude. Thus, only limited use of the futures markets is optimal for the cocoa exporter vindicating Rolfo.

Literature review

The question of whether cocoa revenue-dependent sovereigns should hedge export revenue risk was first addressed by Rolfo (1980). Rolfo derived joint optimal price and output (revenue) risk hedge ratios for the major SSA cocoa producers: Ghana, CIV and Nigeria and found that limited or no use of futures markets may be superior to a full hedge. The optimal hedge ratio was computed assuming utility maximization of the exporters' final wealth.

Rolfo maximized logarithmic utility and quadratic utility functions to develop optimal hedge ratios from the UMP. The log utility function displays Constant Relative Risk Aversion (CRRA), a realistic preference representation, but does not allow the risk parameter to vary as it is fixed at unity. The log utility assumption is thus restrictive and unlikely to be very useful because it does not allow analysis of how the hedge ratios change as the risk parameter changes.

In comparison, the quadratic utility function implies increasing relative risk aversion (which means that risky assets are inferior goods) and satiation (which means that the utility starts decreasing after a satiation point). Both are not consistent with observed behaviour (Mattos, Nelson and Garcia, 2008; Nelson and Escalante, 2004). However, given quadratic utility, preferences can be represented by the mean and variance of the underlying wealth distribution, greatly simplifying the utility maximization problem (Rolfo, 1980).

The simplicity of the computation of the mean-variance hedge (MVH) derived by assuming quadratic utility explains its popularity of use in the literature despite inconsistency with the actual behaviour of economic agents (Outtara, Schroeder and Sorenson, 1990; Lence, 1996). Although more recent literature no longer assumes preferences with quadratic utility due to its unrealistic properties, the mean-variance model (that is typically implied by quadratic utility) is still used if the underlying utility displays CARA and returns are normally distributed. Here, for comparison to results derived from assuming a CARA utility function with normal returns, we employ a CRRA utility function first defined by Nelson and Escalante (2004) which is consistent with observed behaviour because it displays Constant Relative Risk Aversion (CRRA), Decreasing Absolute Risk Aversion (DARA), Decreasing Absolute Risk Prudence (DAP) as well as risk vulnerability. CRRA, DARA, DAP and risk vulnerability are desirable characteristics of utility functions (Gollier and Pratt, 1996; Nelson and Escalante, 2004; Mattos, Garcia and Nelson, 2008). Since Gollier and Pratt (1996) demonstrate convincingly that risk vulnerability is the most natural restriction of utility functions, the Nelson and Escalante (2004) CRRA utility function, which is risk vulnerable, is best suited for modelling risk preferences of agents and is employed in this research.

Apart from unrealistic preferences (which can undermine the accuracy of optimal hedge rations), changes in the assumptions used to develop optimal hedge ratios can influence their magnitude and usefulness (Benninga, Eldor and Zilcha, 1984). In particular, when any of the assumptions underlying the derivation of the mean-variance hedges (MVH) which can be derived from CARA utility changes, MV hedges change dramatically (Lence, 1996). Although both Rolfo (1980) and McKinnon (1967) relax the zero production risk assumption neither takes into account how transaction costs, such as brokerage fees, can affect the optimal hedge ratios. We relax both assumptions and investigate how production risks and transaction costs simultaneously affect the optimal hedge assuming the cocoa exporter has realistic preferences.

Following Rolfo (1990), Sy (1990) and Outtara, Schroeder and Sorenson (1990) also examined the costs and benefits of hedging commodity export revenue risk in a utility framework. Sy (1990) compared the relative costs and benefits from hedging the revenue risks of a basket of goods (cocoa, coffee and cotton) for CIV. Sy (1990) focused primarily on the change in utility from hedging price risk when production risk is introduced into the standard price risk hedging problem. He then compared the gains from minimizing risk using futures markets with gains in utility from mitigating risk using stabilization programs. In contrast to Rolfo (1980), Sy (1990) does not define a pre-harvest to harvest hedge horizon for his analysis. Instead, he defines an annual export price index as the ratio of annual total export revenue to the total export volume. He uses this annual price index (the cash) and annual average New York Stock Exchange futures prices from 1973 to 1984 to compute MVH ratios by Ordinary Least Squares.

Consistent with Rolfo's findings, Sy (1990) concludes the hedge ratios for mitigating cocoa price risk alone are positive and smaller than unity. In contrast to Rolfo's conclusions, Sy (1990) finds that when production risk is introduced, the sign of hedge ratios are ex ante unclear. They can be positive or negative depending on the joint distribution of futures prices, cash prices and production. However the benefits from market risk management exceed the benefits from stabilization policies so CIV will

benefit greatly from hedging cocoa market risks. Similar to Rolfo, Sy (1990)'s findings may be dated and not necessarily relevant to the contemporary risk management problem that SSA cocoa exporters face. Further, Sy (1990) also fails to include and analyse effects of transaction costs on the optimal hedge ratios.

Although they analysed coffee not cocoa revenue risk, the research by Outtara, Schroeder and Sorenson (1990) is relevant here because it uses a similar method to Rolfo (1980) to analyse a similar problem. Outtara, Schroeder and Sorenson (1990) investigated the possibility of reducing the CIV coffee marketing board's export revenue risk by using futures markets. Following Rolfo (1980), they develop optimal hedge ratios by maximizing a quadratic utility function for a coffee exporter exposed to export revenue risk. Futures prices from 1973/74 to 1986/87 were collected to generate forecast errors using the coffee contract on the New York Sugar, Coffee and Cocoa Exchange (SCCE). Cash prices and output forecasts were obtained from the United States Department of Agriculture (USDA). The futures forecast price is the May closing futures reported on the last day of October, while the futures price at expiration is the May futures reported on the first day of May. They concluded that the CIV could reduce revenue risk by 29 percent if it hedged 125 percent of production over the 1973/74 to 1986/87 period. Since Outtara, Schroeder and Sorenson (1990) suggest that CIV should hedge more than total output, CIV may derive speculative profits from declining prices over the period. However, speculation will increase CIV's risk making it an undesirable strategy given their risk minimizing objective. Similar to Rolfo (1980) and Sy (1990), Outtara, Schroeder and Sorenson (1990) use a CARA utility function. Further, like Rolfo (1980) and Sy (1990), Outtara, Schroeder and Sorenson (1990) do not investigate the effect of transaction costs on the optimal hedge ratio.

Borenstein et al (2009) also investigate the UMP facing an agricultural producer exposed to revenue risk. However although they focused only on price but not production risk they identified another utility-enhancing property of hedging not previously intensely discussed in the literature (although it had been highlighted by Malone (2005)). Specifically, Borenstein et al (2009) used a dynamic optimization model to estimate the welfare gains from hedging against commodity price risk for commodity-exporting countries. They consider a small open economy that is exposed to shocks in the price of the commodity that it exports. They then compare welfare from two scenarios: a baseline no-hedging case to the hedging case where hedging is done using futures contracts. They find that hedging has two dimensions of benefits: (i) it reduces income volatility and smoothens consumption (ii) it reduces the propensity for the sovereign to hold foreign assets as precautionary saving. This paper focuses on the first dimension of benefits although the benefit from the precautionary motive could also be substantial because it implies reduced interest on sovereign debt.

In a recent contribution, Lence (2009) also tries to solve the UMP facing an agricultural producer such as a cocoa exporter exposed to revenue risk. He investigates whether atomistic producers in developing countries should hedge revenue risk using a dynamic model that allows for price to influence expected production. He concludes that hedging reduces risk, increases production and lowers price because of a downward sloping demand function. Hedgers "win" when their production is small but lose when their production is large. For large hedgers, he finds hedging is sub-optimal because it reduces their welfare. However, it is imperative to recognize that the structure of the UMP in Lence (2009) work is somewhat different from the problem discussed in this paper. Here we investigate the market activities of Ghana's Cocoa Marketing Board (COCOBOD) which is responsible for exporting cocoa, not the production activities of atomistic producers as in Lence (2009). In effect, producers in Ghana do not sell to the world market, but rather they sell to the marketing board at a "stable price" which then will mean that there will be no added risk-response increase in production from the use of futures. As far as the COCOBOD is concerned, prices will not fall and output will not increase because of increased hedging activity since price discovery is exogenous here. Consequently, the reduction in producer welfare due to hedging that Lence (2009) identified will not likely be observed here.

We contribute to the literature by re-analysing the cocoa exporter's revenue risk problem as originally defined by Rolfo (1980) but in the post structural break cocoa market. In particular, like Rolfo, we focus on the risk minimizing property of hedging (not the precautionary saving motive) and use a realistic utility function due to Nelson and Escalante (2004) that exhibits decreasing absolute risk aversion (DARA), constant relative risk aversion (CRRA), risk vulnerability and decreasing absolute risk prudence (DAP). Like, Borenstein et al (2009), Rolfo (1980), Sy (1990) and Lence (2009), we determine if risk hedging is utility improving compared to the no hedging situation when transactions costs are zero. We then analyse the effect of transactions costs on the optimal hedge ratio and on exporter utility.

Problem formulation, model and methods

Despite export and domestic market liberalization in the 1990's, a substantial amount of the cocoa exported from Sub-Saharan Africa (SSA) is controlled by governmental agencies and not by private agents (Dand, 1999). In Ghana, in spite of domestic market liberalization in 1994, the government-run Cocoa Marketing Board (COCOBOD) remains a monopoly exporter of Ghana cocoa (Bulir, 2002). There are several private Licensed Buying Agents (LBAs) that can purchase the cocoa directly from the farmers but these LBAs must resell all the cocoa to COCOBOD at the port for export (Dand, 1999). Hence, COCOBOD is Ghana's sole decision maker on the marketing and exportation of cocoa. Funds generated by COCOBOD through its various activities are used for consumption smoothing, and to stimulate economic development and growth mainly through the provision of public goods like roads and education.

Substantial production variation exists in the amount of cocoa harvested and exported due to unexpected rainfall patterns, diseases and pest attacks (Rolfo, 1980 and COCOBOD, 2000). COCOBOD is therefore concerned about how production risk can alter the effects of export revenue risk on sovereign exporter utility. Further, COCOBOD is also concerned about the effects of price variability on export revenue risk because it directly faces the world cocoa prices which exhibit considerable price variability influenced respectively by elastic demand and inelastic supply (Razzaque, Osafo-Kwaako and Grynberg, 2007).

Elevated price and production risk result in considerable revenue risk with associated and undesirable consequences. Here, we assume the COCOBOD takes a pre-harvest position in the futures market in order to guard against unexpected variation in cocoa export revenues emanating from price or output risk at harvest time. The main Ghanaian cocoa harvest season commences in October and ends in January. The hedge uses New York Board of Trade (NBYOT) futures contracts and is assumed to be placed on the first trading day of July (pre-harvest) and closed on the last trading day of December (harvest). This six-month hedge horizon was selected for analysis of the revenue risk minimization problem using futures markets because it is most representative of the marketing situation faced by COCOBOD. At the decision date (pre-harvest, t = 0), the COCOBOD can sell h commodity contracts on the exchange each of which reflects a specific production quantity in the futures market at price f. At harvest (t = 1), COCOBOD can deliver the quantity of cocoa specified by the contracts to an identified delivery point which is unusual or can simply repurchase cocoa at the random futures price Pf on the exchange. Cash sales are made at the end of the hedging period, and COCOBOD will receive that price. Conceptually, losses in the cash market can be recouped in the futures market and vice versa.

We acknowledge here that existing literature on hedging production risk with futures has been criticized by Just, Khantachavana and Just (2010) and others. In particular the authors claim the existing literature on production risk (i) cannot discern production risk preferences (ii) cannot discern the factors that relate to production risk preference (iii) is replete with evidence that prior estimations of production risk were incorrect and (iv) acknowledges the failure of current models to generate policy relevant results. In the absence of viable alternative methods of production risk management choices, however, hedging offers the best odds to effectively minimize revenue risk out of the best existing methods so we use it here.

We perform the analysis using historical rather than expectational measures of production uncertainty. Production forecasts which were available when Rolfo performed his analysis have been discontinued (Gil and Duffus), and the limited number of observations and the presence of a structural break in production makes the usefulness of other forecast methods (e.g., ARIMA) limited.

Following Rolfo (1980), the formulation distinguishes between the random actual cash prices (P) when the hedge is lifted, and prices recorded on the futures exchange, f and Pf. P is the stochastic cash price received by COCOBOD and is used to reflect actual world cocoa cash prices. Both futures contract settlement price and the cash prices are used in computing optimal joint price-output hedge ratios. The revenue function of the cocoa exporter exposed to simultaneous price and output risks in the absence of transaction costs is defined in (1)

$$(1)\ R = PQ + h\,(f - P_{1)},$$

Where Q is the random quantity, h is the futures position, f is the futures price on the day the hedge is placed and Pf is the futures settlement price recorded on the last trading day. The returns or cocoa export revenue, R, are the sum of the returns in the cash market, and the returns the exporter realizes from transactions in the futures markets. When transaction costs are incorporated, the revenue function in (1) can be re-written as in (2),

$$(2)\ R = PQ + h\,(f - P_1 - b\ ),$$

b in (2) is transaction costs in the form of brokerage fees in US dollars per ton. The utility maximization problem (UMP) of the Ghana cocoa marketing board is modelled first with quadratic utility then with a constant relative risk aversion (CRRA) utility function U (.) where U (.)' > 0, U" < 0, and the utility function is concave. Utility is defined as a function of export revenue (R).

The cocoa exporter with quadratic (mean-variance) utility function

Quadratic utility which implies mean-variance preferences has extensive theoretical and empirical application in the literature (Peck, 1975; Rolfo, 1980; Chavas and Pope, 1982; Kahl, 1983 and Alexander, Muser and Mason, 1986). It is popular because of its simplicity. The UMP with quadratic utility function is given in (3) where h, the futures position, is the choice variable in COCOBOD's Utility Maximization Problem.

(3)

Max: $EU\ (\mu_R\ (R\ (h)), \sigma_R^2\ (R\ (h)) = \mu_R\ (R\ (h))\ \ \gamma\delta_R^2\ (R\ (h)) = E\ [E\ [\ PQ + h\ (f - P_1 - b)] - E\ [PQ + h\ (f - P_1\ \_b)]\}^2]$,

and $\mu_R\ (R\ (h))$ and are respectively the mean and variance of export revenue and γ is the risk parameter (the coefficient of relative risk aversion or CRRA). The optimal futures position obtained by solving (3) is given in (4)

(4)

$h = covariance\ [PQ,\ P_f] \mid \sigma_{pf}^2 + E\ [(f - P_1 - b) \mid 2\sigma_{pf}^2\gamma]$, where is the variance of P_f. Note that in equations (3) and (4), E is the mathematical expectation operator so the expected value of stochastic cocoa exporter revenue is, $E(R) = \mu_R\ (R\ (h)) = E\ [PQ + h\ (f - P_f - b)]$ and the variance of stochastic revenue is $\sigma_R^2\ (R\ (h))) = E\ \{[PQ + h\ (f - P_1 - b0]\}^2$. For clarity of presentation, in solving for h from the maximization of expected utility, we will left out the overall expectation sign (E) because the utility itself is a function of mean and variances which are also defined using the expectation (E) sign. However the computations are done with the correct expression of expected utility.

The first component of h in (4) is the pure revenue hedge, the coefficient of P_f in a linear regression where PQ is the dependent variable and Pf is the independent variable (Rolfo, 1980). The pure hedge is independent of the magnitude of the risk aversion parameter. However it does crucially depend on the sign of the correlation between output and the futures price at expiration with a positive correlation supportive of a hedge (Alexander, Muser and Mason, 1986). The second term is the bias in futures price (Rolfo, 1980) less transaction costs. This bias (also called the speculative part of the hedge) is included for completeness but may be zero if risk aversion is extremely high or if the market is efficient. If this bias (the speculative component) is non-zero its magnitude depends on the risk aversion parameter. When transaction costs are zero, (4) is identical to Rolfo (1980)'s derivations.

Cocoa exporter with Nelson Escalante (2004) utility function

Nelson and Escalante (2004) demonstrated that when the joint distribution of cash and futures returns are elliptically symmetric and final wealth satisfies the location-scale condition, expected utility can be written as a function of the first two moments of the return distribution (Chamberlain, 1983; and Meyer, 1987). We verified that final wealth satisfied the location-scale condition in the objective function developed using Nelson and Escalante's (2004) utility function. We used the Jacque-Bera test to ensure normality of returns as normality is an accepted form of elliptical symmetry. We thus maximize the expected utility of the Nelson and Escalante CRRA location-scale utility function as in (5)

(5)

Max: $EU\ (\mu_R\ (R\ (h)), \sigma_R^2\ (R\ (h))) = -1 \mid (\mu_R\ (R\ (h)\}^2 - \gamma\ (R\ (h)))$.

To maximizing (5), we simply maximize its denominator since both operations give the same answer. To identify h as the explicit choice variable, we re-write (5) as an explicit function of h and then maximize the denominator of the resulting function where h is the choice variable (6).

(6)

Max: $(\mu_R\ (R\ (h))^2 - \gamma\sigma_R^2\ (R\ (h))) =$
$(E\ [(R\ (h))^2 - \gamma E\ [(R\ (h - P_f - b)]\}^2 =$
$E\ [PQ + h\ (P_1 - f - b)]^2 - \gamma E\ [PQ - hb]]^2$.

Let σ_R^2 be defined as in (7)

(7)

$\sigma_R^2\ (h))) = E[R\ (h) - E(R\ (h))]^2 =$
$E\ [PQ - h\ (P_f - f - b)] - E\ [PQ - hb]]^2$,

We can then solve the utility function in (8) for h, the optimal hedge position.

(8)

Max $E\ [PQ + h\ (P_f - f - b)]^2 - \gamma E\ \{[PQ + h\ (P_f - f - b) - E\ [PQ + h\ (P_f - f - b)]\}^2$.

A closed form solution to (8) can be obtained as long as we assume a zero basis (i.e., assuming $P_f = P$) and is

included in the appendix. When we allow for non-zero basis, a more realistic case, a closed form solution is difficult to obtain but a search procedure similar to that employed by Rolfo (1980) and described in the next section can be developed to determine h, the optimal futures position and H, the optimal hedge ratio.

The optimal hedge ratio when basis risk is present

In the presence of basis risk ($P_f \neq P$), a search program was written in Visual Basic to solve for optimal hedge ratios. The search program uses the following algorithm: First set transaction costs, b = 0. For each pre-determined level of the hedge ratio ($H = h / \mu_Q$) between 0 and 1 in steps of 0.01, obtain the value of the utility function for the twenty-eight observations from t = 1 (1980) to t = 28 (2008). Next sum the twenty-eight values and divide by twenty-eight to get the expected value of the utility function over the period for that value of H. Repeat the calculations for each value of H from 0.01… 1.0. The value of H between 0 and 1 (0.01, 0.02…1.0) that corresponds to the highest expected value of the utility function over the period is the optimal hedge ratio. By repeating the search over the range of H values the optimal hedge can be found for different risk parameter values.

To identify the effects of transaction costs, b is included and changed and the process is repeated. The optimal hedge ratio corresponding to each level of transactions costs can then be compared to the optimal hedge ratios when b = 0 and those obtained from the MVH to determine how robust optimal joint hedge ratios are to changes in transaction costs and to preference type. For each pair of values of H and b, the expected utility can be computed and compared respectively to the expected utility where H = 0 and when both H and b have zero values. This enables a comparison of the utilities of a hedged and unhedged exporter given the presence or absence of transaction costs.

Description of the data

Transaction costs

Transactions costs are modelled as brokerage fees because the brokerage fee is the most important component of transaction costs. Six levels of brokerage fees in $/ton: 0, 10, 50, 100, 200, and 500 were selected. Note that each cocoa futures contract contains 10 tons of cocoa beans (the standard contract). Transaction costs can include a number of factors including information costs, monitoring costs, and actual monetary costs of trading related to brokerage fees. Here we examine fees from 0 to 500 $/ton. The likely range of brokerage fees that COCOBOD will face is between $0 and $100. However transactions costs incorporate huge start up fixed costs and other financial requirements which when spread over the total number of contracts purchased will increase the transactions cost per contract significantly. For example, there are costs associated with training the risk managers at the marketing board to use the futures market. Alternatively a foreign risk management firm could be contracted but either option is expensive. We therefore use $500 per contract as the cut off point for transactions costs.

Brokerage fees have been declining over the years and can normally be negotiated downward for large volume futures participants such as the COCOBOD. Brokerage fees vary depending on whether the hedge is large or small or whether the hedger wants full service or a per round term transaction. A very large prospective hedger such as the COCOBOD can obtain between 25 and 60 dollars per ton. Smaller hedgers will pay substantially more in brokerage fees per ton so the levels of brokerage fees we chose make sense.

Cash, futures and futures at expiration data

The data used in the analysis were limited to the 1980–2008 periods to avoid a structural break in 1978 in world cocoa prices caused mainly by the policies of the Ghanaian government. Hedge horizons were chosen so that December is the harvest month which coincides with October–January, the main cocoa harvest season in Ghana (COCOBOD, 2000). Cocoa futures and output data from 1980–2008 were obtained respectively from the New York Board of Trade (NYBOT) and the Ghana cocoa marketing board (COCOBOD). The NYBOT was used because it is liquid and because the cocoa contract traded has specifications that are compatible with the cocoa SSA countries export although almost no Ghana cocoa sells in NY. In order to keep our discussion and focused, we will explain why little Ghana cocoa trades in NY later in the paper.

Table 2 contains summary statistics for cocoa production and revenue for Ghana as well as for the futures and spot prices used in the research. Based on standard deviations of prices, revenue and production (assumed to reflect exports since in-country storage is minimal) it is evident that there is substantial price, production and revenue risk. Further, the mean of spot prices (1775.4) is bigger than that of the futures price (1514.2) which might be indicative of a bias in futures forecasts. The mean of the futures price at expiration (1553.2) is also greater than the futures price implying that the optimal hedge is an increasing function of the risk parameter (Outtara, Schroeder and Sorenson, 1990).

The basis at contract expiration is unusually large

($222 is about 12.5 percent of the spot price). This positive and large number is problematic because it implies a hedger may lock in a loss which cannot be compensated for by any gains in variance reduction through hedging. Typically, if the futures market is efficient such a basis should be greatly reduced by arbitrage activities. Empirical evidence suggests that the futures market can be inefficient in the short run due to informational inefficiency (McKenzie and Holt, 2002). This means arbitrage is not always effective in reducing the basis in the cocoa futures market. Further if prices are properly measured and the markets are efficient in an operational sense, the cash price in should Ghana be less than the cash price at the delivery point (NY or London) by the transportation costs to the delivery point. However it is possible that because we use an average price throughout the harvest period that the specific transportation cost differences are masked. In particular, large quality differentials can also mask the transportation costs. The issue of the basis will be taken up in the discussion section of the paper when we discuss why no Ghana cocoa trades in NY.

Note that the standard deviation of futures prices is smaller than that for spot prices, a favourable occurrence for very risk-averse agents and very volatile markets such as the cocoa market. This is because when the futures are less risky than the cash price, risk management using futures contracts is typically more effective. Table 3 contains results of correlation and covariance between the futures price, the futures price at expiration and the random spot price. It is clear that the futures at expiration are strongly correlated with the spot price. Correlation between all prices is high ranging from 0.9 to 1.

Before transactions were introduced into the model and in a bid to establish credibility of the researcher-written computer program used to solve the UMP of the COCOBOD, the visual basic program was first used to solve the hedger's UMP with quadratic preferences and then used to replicate Rolfo's result using Rolfo's own data. After ensuring that results were close to each other the computer program was used to calculate hedge ratios using recent data in the relevant range (1980–2008) and quadratic utility. Finally the model was used to solve the UMP using CRRA utility and the relevant data. The computations were first carried out with only the revenue data detrended. However the trend seems to have a negligible effect because when the calculations was also repeated with the revenue and futures cash both detrended there were no discernible changes in the results. The exercised helped to emphasize that Rolfo's formulation which was followed in this paper is accurate and appropriate and our computer program worked.

Results

The pure price hedge (minimum variance hedge), computed at infinite risk aversion, zero production risk and zero transaction costs or from the regression of cash on futures is 0.82 as shown in Table 4. This means, faced with just price risk, a typical cocoa exporter like Ghana should hedge 82 % of output in order to enjoy a level utility from export revenue greater than the unhedged position (zero hedge). Table 4 also displays optimal "revenue hedge ratios" for Ghana using quadratic utility for values of the risk parameter γ between 0.000000001 and ∞ which represent the range from a risk loving to an extremely risk averse cocoa exporter. An identical range was used by Rolfo (1980) so results using this range of γ make for an interesting comparison with his work. Note that to obtain equivalent values of ψ, the Constant Absolute Risk Aversion (CARA) for the quadratic utility, γ (the coefficient of relative risk aversion) must be divided by the mean of export revenue.

When $\gamma = \infty$, the second term drops out in equation (4) and we get the pure revenue hedge (Rolfo, 1980; Outtara, Schroeder and Sorenson, 1990). The pure revenue hedge (with infinite risk aversion), for quadratic utility, which can equivalently be computed using the regression of revenue on futures price for Ghana, assuming zero transactions costs is 0.44 as shown in Table 4. Further, for all levels of γ larger than 0.001, the revenue hedge is also 0.44. In comparison, Rolfo (1980) finds using quadratic utility that the optimal revenue hedge ratios for Ghana, is 0.6 for γ larger than 0.001 so our results are only slightly different from Rolfo's.

Since we are using data after the 1980 structural break, the market we analyse is in theory, fundamentally different from what Rolfo (1980) analysed. Therefore we expect to find similar but not identical results as Rolfo (1980) when we use the quadratic utility function. From Table 4, the optimal hedge ratios do not vary much with γ but similar to the results of Rolfo and Outtara, Schroeder and Sorenson (1990), they drop precipitously after a cut of value or γ. Here the threshold value of γ is 0.0001. The conclusion from the analysis using quadratic utility and zero transactions costs is that Ghana would benefit from hedging cocoa export revenue albeit to a limited extent. The Ghana Cocoa Marketing Board should only hedge a part of output.

When transactions costs are incorporated into the UMP for a typical SSA cocoa exporter such as Ghana facing concurrent price and production risks, optimal hedge ratios decline. Transactions costs alter optimal hedge ratios at a γ or CRRA of 4 corresponding to a CARA of 0.000005 using quadratic utility. From Table 5,

between $0 and $10 dollars per contract, the optimal hedge ratio shrinks from 0.44 to 0.38. This represents a 6 percentage point decline in the optimal hedge ratio. At any value of the transactions cost greater than $10, the optimal hedge ratio is negative meaning a long hedge is superior to a short hedge. A negative (long) hedge ratio means that the cocoa marketing board should go long both the commodity and the futures contract. That is, COCOBOD should execute a reverse hedge (Rolfo, 1980). However, reverse hedging is impractical here since it increases risk. Technically, a long hedge is a hedge used by buyers of a product where they buy the futures in anticipation of subsequent cash purchases. In this way, they protect themselves against price increases in the cash market because as long as futures and cash move up together they can resell the futures at a higher price and offset the loss in the cash market with a gain in the futures market. COCOBOD is a seller not a buyer of cocoa so it is seeking protection from price declines not price increases so the long hedge is not favoured here. In fact price appreciation is favourable to COCOBOD since it increases COCOBOD's utility.

When we compute optimal hedge ratios with the more realistic CRRA utility function (Nelson and Escalante, 2004), the results are different from the quadratic utility. From Table 6, the pure revenue hedge ratio (infinite risk aversion) for Ghana, computed at zero transactions costs using the more representative Nelson and Escalante (2004) utility function is 0.31. This is comparable to the finding of Rolfo for log utility (which is also a CRRA utility function but has a fixed CRRA γ value of 1). Rolfo finds that Ghana should hedge 0.15 of its export volume. The fact that the CRRA utility functions (Nelson and Escalante) display smaller hedge ratios than the quadratic utility is to be expected because the former also displays decreasing absolute risk prudence which means it is less sensitive to risk (Chen, X., H. H. Wang and R. C. Mittelhammer, 2006). Insensitivity to risk implies that as revenues increase COCOBOD is unlikely to seek more protection from risk because its preferences are not sensitive to risk. An agent with quadratic utility is more sensitive to risk as revenues increase and will seek more protection from risk leading him to choose a higher optimal hedge ratio.

The optimal hedge ratios using CRRA utility are fairly constant at different values of the risk parameter (γ). From Table 6, the optimal hedge ratio for Ghana remains constant at 0.31 at CRRA risk parameter value (γ) greater than 0.0000001, then turns negative. The constant optimal hedge ratio for values for the range of γ between infinity and 0.0000001 indicates that the speculative component of the hedge is inconsequential. For the range of γ greater than 0.0000001 or for risk lovers, the speculative part of the hedge dominates so the hedger is net long (Outarra, Schroeder and Sorenson, 1990). A long hedge here implies speculation which is not desirable here given the risk minimization objective outlined in COCOBOD's UMP.

Similar to the results of the quadratic utility analysis, the optimal hedge declines monotonically at risk parameter value (γ) of 4 for fairly reasonable values of transactions cost ($0 to $100 per ton). For Ghana, transactions costs appear to exert considerable influence on optimal hedge ratios using the Nelson and Escalante (2004) utility function although the transaction cost effect is less dramatic than in the quadratic utility case.

From Table 7, between $0 and $100 dollars per contract, which represents the feasible range of transactions costs for a large hedger such as Ghana, the hedge ratio declines from a value of 0.31 (the pure revenue hedge) to 0.2. This represents an 11 percentage point decline in the optimal hedge ratio. Figure 3 graphically illustrates the point that Table 7 makes albeit with slight differences. From Fig 3, any value of the transaction cost above $350 per contract results in a negative hedge ratio or a long hedge. A long hedge indicates a speculative position which does not make sense for COCOBOD whose primary focus is to minimize not increase risk.

Transaction costs have many components not all of which has been accounted for by brokerage fees. In particular for a SSA country such as Ghana, there is large hidden costs such as the cost of educating the will-be risk managers at the Ghana Cocoa Marketing Board about futures markets and contracts as well as other financial requirements for using future contracts all of which will increase the relevant feasible range of transactions contracts. In other words, there will be a fixed cost which will decline as the number of contracts purchased decreases in addition to the variable cost per contract. Still it is unlikely that the transactions costs paid per contract will be as high as $350. The results using Nelson and Escalante's (2004) utility suggest optimal hedge ratios for the Ghana Cocoa Marketing Board remain positive even after transactions costs are considered. Therefore, from the results of the Nelson and Escalante (2004) utility, limited use of the futures market appears to be optimal for Ghana even when we take transaction costs into account given reasonable values of the risk parameter.

The result obtained from using the Nelson and Escalante (2004) utility function, that revenue hedging with futures markets is utility improving, albeit to a very small degree, for the cocoa exporter, is in contrast to the conclusions from the quadratic utility analysis and from

Rolfo's (1980) recommendation but is consistent with the result obtained by Borenstein, Jeane and Sandri (2009), who compare the benefits of precautionary savings to the benefits from hedging for export-revenue dependent countries. Our results using the Nelson and Escalante (2004) utility is also consistent with the results of Sy (1990), who assesses the possibility of hedging cocoa revenue risk for CIV.

Lence (2009) also tries to solve the revenue risk problem for a producer. He finds the opposite result to this paper's NE 2004 analysis most probably because he endogenizes the production decision. He investigates whether atomistic producers in developing countries should hedge revenue risk using a dynamic model that allows for price to influence expected production. He concludes, in contrast to this paper, that hedging reduces welfare because although it reduces risk, it increases production and lowers price because of a downward sloping demand function. However, Lence's (2009) measure of hedging benefit to hedgers is a little narrow as it does not include the enhanced reputation from a constant stream of export revenue that enables commodity sovereign exporters to enjoy low interest rates on loans. Borenstein, Jeane and Sandri (2009) find substantial exporter utility gains due to hedging because of the enhanced credit reputation typically associated with sovereign exporters who hedge their revenues. By contrast, because the interest rates on the international market are prohibitive, countries that are dependent on export revenue but do not manage revenue risk often have little alternatives other than to settle for International Monetary Fund (IMF) loans with low interest rates but imposed stringent conditions that are detrimental to borrower welfare. For example, the Ghanaian government settled for an IMF loan in 2009 because internationally available loans had very high interest rates. The IMF condition for the loan was a freeze in government hiring. When armed robbery in Ghana escalated, the government was bound by a contract with IMF not to increase the police force to meet the challenge of rising crimes and murders. This chain of events could have been prevented if Ghana managed its export risk, reduced probability of default on loans and acquired a healthy credit to be able to enjoy low interest rates from international lenders.

From the result of the more representative Nelson and Escalante (2004) utility function used in this research, Ghana should hedge considerably less than full output when facing pure price risk. When faced with revenue risk, Ghana should hedge significantly less than it hedged when facing pure price risk for values of the CRRA risk parameter between 1 and 5. When transactions costs are considered, the typical SSA cocoa exporter will choose to hedge a very miniscule portion of his output. This result partly validates Rolfo's (1980)'s conclusions that a minimum use of the futures market or none at all is superior to a full hedge. This is because even though optimal hedge ratio is positive it is very small. The data used in this research spans 1980–2008 and Rolfo used 1956–1976 data and we have evidence of a structural break in 1978 so we did not expect Rolfo's result to be necessarily relevant to the UMP facing an SSA cocoa exporter today. However, the evidence suggests that Rolfo's conclusions remain relevant, at least in part, today.

Limitations of the research

The research suffered from a lack of access to data. In particular, the Gil and Duffus cocoa output forecasts which were originally used by Rolfo (1980) in his analysis were unavailable because they had been discontinued over two decades ago. Consequently, it was impossible to extend Rolfo's work using his own methods to the relevant date range of this research using data from an identical source. The result from such an analysis (if it had been done) could tell us how drastic an effect the changes in the cocoa sector have had on the UMP of Ghana as a cocoa producer and on corresponding optimal hedge ratios that minimize export revenue risk. Given that there was some difference in utility functions used by Rolfo and the current authors the result of the analysis described above will make for useful comparison to the research results obtained here in order to demonstrate the importance of getting the utility function right. Further, there still remains some ambiguity in the literature about the relevant values of the risk parameter. The results of the research are limited to an extent therefore by the accuracy of the second best solution of predicating our measure of CRRA on literature values instead of directly estimating it. Lastly the definition of utility as used here is narrow and should be generalized to reflect risk reduction from a smoothened income stream when export revenues are hedged.

Discussion of unusual results

Pertinent questions that still persist after careful interpretation of the descriptive statistics presented in Table 2 and include (i) why COCOBOD should consider hedging cocoa revenue risk a viable option in the first place given the large difference between cash and futures ($222/ton) (ii) from where does this large basis emerge and (iii) how should it be treated in the analysis and why does arbitrage not eliminate this basis?

To answer question (ii) first, the basis ($222/ton) is

primarily due to quality premiums paid to West African cocoa farmers and to Ghanaian cocoa farmers in particular because Ghana cocoa is the most quality cocoa. More specifically, the NYBOT offers quality premiums of $160/ton for West African cocoa but does not differentiate among the different types of West Africa cocoa (Ghana, CIV, Togo and Benin). Further for historical reasons, the NBOT does not receive much Ghana cocoa so does not offer a premium for Ghana cocoa. Gilbert (2009) suggests that Ghanaian cocoa draws a premium of 3 to 5 percent relative to CIV cocoa. Using data for this research as a rough guide, the mean cash price of cocoa (1980–2008) was about $1775 so the following three scenario is plausible: If we assume a middle value of 4 per cent as the price Ghana receives for its cocoa as premium relative to CIV then that amounts to about $71. If we add this to the West African premium of $160, we arrive at about $231 which is not much different from $222/ton differential between the FOB price in Ghana and the NYBOT futures price in NY. A report jointly prepared by the University of Ghana (UG) and the Institute of Developments Studies (IDS) also found that Ghana cocoa commands premium of up to US$200–250 per tonne over the prevailing international cocoa price. To answer question (iii) a reasonable thing to do will be to add the $231/ton quality premium to all the futures prices before using the futures data to calculate hedge ratios. Such an exercise is a useful exercise for further research. With regards to why arbitrage has not succeeded in eroding the basis, recall that since the cocoa revenue data used in the simulation data was obtained from COCOBOD while the futures data is from the NYBOT, the cash and futures data have a spatial difference so a strategy where traders go long the futures, stand for delivery, and then turnaround and sell on the spot market is not feasible. In fact, the large basis is due to quality differentials that cannot be arbitraged away. To further explain the quality differential, recall that Ghana cocoa is the world's most quality cocoa and enjoys a significant premium although no Ghana cocoa is sold on the NYBOT at the moment. In contrast, most of the cocoa sold in the NYBOT comes from South America. Some of the difference in basis may be explained by quality differentials because the cash price (P) in the revenue stream is based on actual cash prices received by COCOBOD but the futures at expiration that is defined in the export revenue stream are prices recorded by the NYBOT in New York. These later prices may be more heavily influenced by the average price of less quality non-Ghanaian e.g. (CIV and South American) cocoa since apart from SSA, South America dominates the NYBOT market. The failure of successful arbitrage to reduce the basis may also be due to insufficient liquidity in the market to support this speculation.

Finally to answer question (ii) or why COCOBOD should even consider hedging cocoa revenue risk in the first place when it is fully aware of the significant basis between cash and futures, it seems plausible to argue that since the quality differential is so big for Ghana cocoa, the COCOBOD may have ex ante has little reason to hedge if he is in fact performing a 'selective' hedging strategy where the decision to hedge is based on a "market view." It is also plausible, however, that the COCOBOD is concerned about placing an effective hedge should it decide to hedge because it is primarily concerned with risk. In this scenario, hedging is relevant and the effectiveness of the hedge (typically capture by the R-square in a regression of cash on futures) is high if the cash is closely related to the futures, depending on the degree of risk aversion. The more risk averse the hedger, the more effective the hedge.

COCOBOD may choose to hedge on the NYBOT instead of say LIFFE because the NYBOT is more liquid with much larger volumes traded leading to significant reduction in transaction costs. Cocoa prices are controlled by both demand and supply side factors. Specifically weak supply and strong demand drives prices up and the converse is true. At the moment cocoa prices are high on the back of subdued supply as CIV the world's largest cocoa supplier has cut back on exports. It is likely that CIV will ramp up exports in the future which pose a downward risk to prices through sustained and increased supply. Further though cocoa demand is fairly inelastic so that the industry has not been affected by low demand due to the global financial crisis, an extended sluggish recovery may pull demand back. This will further dampen prices. If the COCOBOD has real reasons to suspect a price decline then the hedging problem as defined here makes sense and an effective hedge will increase the COCOBOD's utility by averting the risk of cocoa revenue declines. Recall that for risk-averse producers with preferences defined like those in this problem, a reduction in the variability of the mean dominates the utility function (Adam, Garcia and Hauser, 1996). This means they may value risk minimization enough to forego the opportunity to make money. This is because the margins and transaction costs locked up in hedging activity could be earning interest at market rates. To calculate just how much money they can forego by hedging we can compute the "opportunity cost of hedging" following Mattos, Garcia and Nelson (2008). However it does seem that the size of the quality premium may be too big for its contribution to the hedger's utility to be overcome by gains from risk minimization unless the

hedger only cares about reducing risk in which instance, a case is made for the relevance of hedging cocoa revenue risk. However since find such low numbers for the revenue hedges we conclude that hedging even if it applies offers little over COCOBOD's current practice of forward-contracting. Rolfo was right.

Conclusion and suggestions for further research

SSA cocoa producers such as Ghana are typically exposed to both production and price risk which results in revenue risk. Revenue risk can be managed using futures contracts. However, the use of futures markets incorporates costs that may take away from the benefits. This analysis which investigated the effect of transaction costs and risk tolerance on the optimal hedge was carried out using cocoa revenue data from Ghana, a major SSA cocoa producer and respectively, quadratic utility and Nelson and Escalante's (2004) CRRA utility functions. We confirm Rolfo's result that the optimal hedge is increasing in the risk parameter for both utility functions for the range of data used. However, using quadratic utility, we find that for reasonable values of the risk parameter, and positive transaction costs we obtain very small positive hedge ratios or negative hedge ratios which imply that the cocoa exporter should hedge a miniscule portion of total export or not at all which is consistent with Rolfo (1980).

By contrast using the Nelson and Escalante (2004) utility function which is a more believable representation of preferences, optimal hedge ratios remain positive even after transactions costs are considered. Since the optimal hedge ratio is the solution of a utility maximization problem, the exporter can only do as well or better than not hedging. This means that for Ghana, limited use of the futures market is utility improving. This partly also confirms Rolfo results. The conclusion from this study is that from a utility perspective, limited use of the futures market for hedging revenue or not at all risk will benefit Ghana. However, given the unexplained positive and large quality differential between cash and futures which means the COCOBOD may lock in a loss in attempting to minimize risk, COCOBOD should keep forward contacting

Suggestions for further results

Although this paper does not focus on the enhanced reputation dimension of the benefits of hedging revenue risk, following Malone (2005), it will be interesting to simulate the reduction in the probability of sovereign default risk that a smoothened cocoa export revenue risk from hedging entails. The reduction in cost of sovereign borrowing from different degrees of income smoothing due to hedging should also provide valuable information to policy-makers.

More detailed analysis of the effect of transportation costs on the optimal hedge ratios and on the utility from hedging revenue risk will also provide pertinent information for Ghanaian policy makers. Incorporation of the utility derived from reduced borrowing rates and decreased probability of sovereign default on loans (that hedging entails) into the utility maximization problem of the cocoa-exporting SSA sovereign are also useful candidates for further research.

Further research must also investigate if the structure of domestic cocoa marketing in Ghana is likely to change from a focus on production exclusively for export to a focus on processing the produced cocoa and whether that change will reduce risks for COCOBOD making risk management less of an issue and hedging of little value. In particular, as Prebisch and Singer (1954) have argued, terms of trade decline over time for primary products like cocoa so it might be a good idea for the producers of primary products to move up the chain into processing. It could plausibly be argued that since comparative advantage is dynamic not static, by investing into technology, Ghana might actually secure a comparative advantage in processing cocoa over time which can help it process more cocoa beans. If Ghana substantially increases the proportion of cocoa beans processed domestically then hedging against variation in the process of cocoa beans becomes less relevant because cocoa input acquisition will be assured and the price will be pre-determined by forward contracts.

The move into processing critically depends on whether the value added per tonne of processing more than compensates for the lost premiums per tonne selling raw cocoa beans. Ghana enjoys quality premiums from selling the beans because Ghana cocoa is the most quality cocoa. It is the industry standard in terms of quality. Cocoa from all other countries is discounted to Ghana cocoa. Preliminary research by Pinnamang Tutu and Armah (2011), suggests that the value added from processing seems to be increasing over time and in turn, the tonnage processed by Ghana is inching up. However at the moment almost all the main crop cocoa (80% of total production) is still wholly exported. Research that identifies what combination of total beans produced should be exported and what percentage should be processed in Ghana will not only determine the value of hedging revenue risk (since hedging is less useful to processors) but will also be valuable information for Ghanaian cocoa policy makers seeking to maximize sovereign welfare from cocoa export revenue.

Figure 1 Cash and futures cocoa prices, 1960–2008

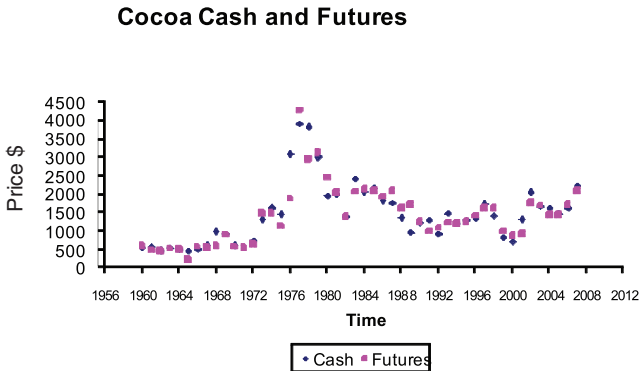


Figure 2 Futures price variations, 1960–2008

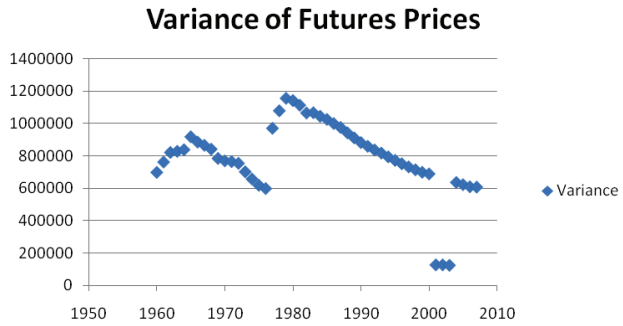
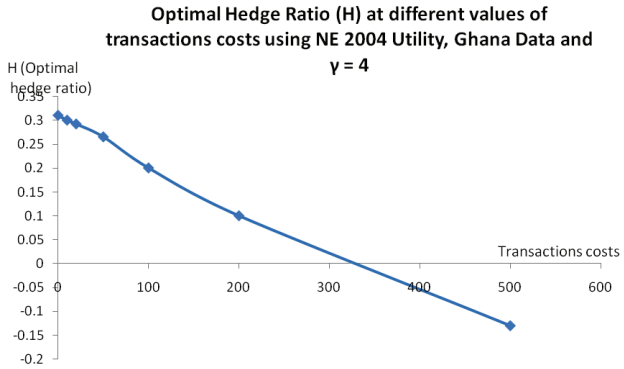


Figure 3 OHR at different transaction costs, = 4 and using NE 2004 utility



Data Source: Export Revenue data was obtained from the Ghana Cocoa Marketing Board

Table 1 Structural break test for the variance of cocoa futures price

	Structural break	*m*	*n*	*Q-stat*	*P-value*
Standard deviation of the futures price	July 1978	18	30	-5.0	< 0.001

Ho: The Ratio of the variances from the two periods is unity
Ha: Ratio of the variances from the two periods is not unity
m = # of observations before the break.
n = # of observations after the break.
MI: Miller jackknife test for differences in variance between two periods.
For large m and n, Q converges to a standard normal distribution. High Q-Stat is strong evidence of a structural break.

Table 2 Summary statistics for annual production and revenue Ghana, 1980–2008

*Production (*100 tonnes)*	*Mean*	*Std. dev.*	*Min*	*Max*
Ghana	493.37	69.79	360.05	653.32
Random revenue (*$1000) Ghana	885640.8	281240.4	353567.6	1301258

Prices ($)	*Mean*	*Std. dev.*	*Min*	*Max*
Cash	1775.37	453.72	890	2690
Futures at expiration	1553.22	441	877	2469
Futures forecast	1514.22	440.36	692	2513

Table 3 Correlations between cash and futures prices, 1980–2008

	Futures price	*Cash price*	*Futures at expiration*
Futures price	1		
	(194477)		
Cash price	0.86	1	
	(171581)	(205861)	1
Futures at exp.	0.9	0.96	1
	(174761)	(205861)	(195679)

Variance and covariances are in parentheses

Table 4 Optimal hedge ratios at different values of risk parameter for quadratic utility for Ghana as an cocoa exporter

Risk aversion parameter (γ)	*b = 0*
∞	0.44
1000	0.44
100	0.44
10	0.44
4	0.44
3	0.44
2	0.44
1	0.44
0.1	0.44
0.01	0.44
0.001	0.43
0.0001	0.41
0.00001	0.12
0.0000001	-1.00
0.00000001	-1.01
Cash hedge	0.82
Pure Revenue Hedge	0.44

Table 5 Comparisons of optimal hedge ratios (MVH) for Ghana at a value of the risk parameter (γ) of 4 and at different transactions costs using quadratic utility

Transaction costs ($b) given = 4	*Ghana*
0	0.44
10	0.38
20	-1
50	-1
100	-1
200	-1

Table 6 Optimal hedge ratios at different values of CRRA for Nelson and Escalante utility function for different values of the CRRA risk parameter for Ghana

Risk aversion parameter (γ)	*b = 0 Ghana*
∞	0.31
1000	0.31
100	0.31
10	0.31
4	0.31
3	0.31
2	0.31
1	0.31
0.1	0.31
0.01	0.31
0.001	0.31
0.0001	0.31
0.00001	0.1
0.0000001	-0.96
0.00000001	-19.96
Cash hedge	0.819
Pure Revenue Hedge	0.31

Table 7 Comparisons of optimal hedge ratios for the Ghana Cocoa Marketing Board at a CRRA rist parameter value (γ) of 4 and at different transactions costs (B)

Ghana Data, NE 2004 utility and CRRA transactions cost ($b per contract)	*Risk parameter (γ=4)*
0	0.31
10	0.3
20	0.292
50	0.265
100	0.2
200	0.1
250	-0.13

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Appendix 1

The closed-form optimal solution for the optimal hedge when basis risk is absent

Here P= P_f *so we can use that information* to solve the utility function in (A.1) for h, the optimal hedge position.

A.1

Max

$E\ (\Pi\Theta + \eta\ (P_f - f - b)]^2 - \gamma E\ \{[PQ + h\ (P_f - f - b) - E\ (PQ + h\ (P_f - f - b)]^2$

A closed form solution to (8) can be obtained if we assume no basis risk (i.e., assuming P_f = P) and is included in the appendix. When we allow for basis risk a closed form solution is difficult to obtain but a search procedure similar to that employed by Rolfo (1980) can be developed to determine h and by implication the optimal hedge ratio. The search procedure is discussed in more detail in the text and is the procedure used to generate our results because it is more practical to assume non-zero basis risk. Assuming no basis risk so that P_f = P, we can expand the last term in (A.1) to get (A.2)

(A.12)

$E\ [PQ - h\ (P_f - f - b) - E\ [PQ - hb]]^2 = \sigma_R^2\ (R\ (h))$

$= E\ (P^2Q^2) - [PQ]^2 - 2hE\ (PQ\ (P - f) + h^2E\ (P - f)^2.$

Let $h^2E\ (P - f)^2 = \sigma_{pf}^2$ so we have (A.3),

A.3

$\sigma_R^2\ (R\ (h))) = E\ (P^2Q^2) - [PQ]^2 - 2hE\ (PQ\ (P - f) + h^2\sigma_{pf}^2.$

To solve for h we need only consider terms that contain h in (A.3). Expanding the last two terms in (A.3) by adding and subtracting f and μ_Q, we obtain A.4

A.4

$\sigma_R^2\ (R\ (h)) = h^2\sigma_{pf}^2 - 2hE\ (\{P - f + f\}\ \{Q - \mu_Q + \mu_Q\}\ (P - f))$, where μ_Q is the mean of output. Simplifying this expression, we arrive ate (A.5)

A.5

$\sigma_R^2\ (R\ (h)) = h^2\sigma_{pf}^2 - 2hE\ (\{P - f\}^2\ \{Q - \mu_Q\}) + 2hfE\ (\{P - f\}\ \{Q - \mu_Q\}).$

Let $E(\{P\text{-}f\}\ \{Q\text{-}\mu_Q\})$ = covariance (P,Q) = $\rho\ \sigma_{pf}\ \sigma_Q$ where ρ is the correlation coefficient between P and Q, and σpf and σQ are respectively the standard deviation of P (= P_f) and Q. So now we have A.6

A.6

$\sigma_R^2\ (R\ (h)) = h^2\sigma_{pf}^2 - 2hE\ (\{P - f\}^2\ \{Q - \mu_Q\}) - 2h\mu_Q\sigma_{pf}^2 - {}^{2hf}\rho\sigma_{pf}\sigma_Q$

The maximization problem now becomes

A.7

Max $E\ [PQ + h\ (P_f - f - b)]^2 - \gamma\ (E\ \{[h^2\sigma_{pf}^2 - 2hE\ [(P - f)^2\ \{Q - \mu_Q\} - 2h\mu_Q.$

The futures position, h, is the solution of the optimization problem in (A.7) and is given by (A.8):

A.8

$h = [2\ \gamma\ E(\{P\text{-}f\}^2\ \{Q\text{-}\mu_Q\})] / [2\ \gamma\ \sigma_{pf}^2 - 2b^2] + [2\ \gamma\ f\ \rho\ \ \sigma_Q + \mu_Q\ ^2] / [2\gamma\sigma_{pf}^2 - 2b] - [2bE(PQ)] / [2\ \gamma\ \sigma_{pf}^2 - 2b].$

Assuming normality, the third and fourth moments of the distribution of price, revenue and quantity are all zero so h is given by

A.9

$h = [2\ \gamma\ f\ \rho\ \sigma_{pf}\ \sigma_Q + \mu_Q\ \sigma_{pf}^2] / [2\ \gamma\ \sigma_{pf}^2 - 2b] - [2b\ E\ (PQ)] / [2\ \gamma\ \sigma_{pf}^2 - 2b].$

Given normality, and in the absence of transactions costs, b = 0 and we get

A.10

$h = [f\ \rho\ \sigma_Q / \sigma_{pf}\ ] + \mu_Q.$

The hedge ratio H = h / μQ so from (A.10), we get (A.11)

A.11

$H = \rho\ (f / \sigma_{pf})\ (\sigma_Q / \mu_Q) + 1.$

Therefore if ρ is negative, both the correlation between Q and P and transactions costs (b) will tend to reduce the optimal hedge ratio. Note that equation (A.11) has a very intuitive interpretation because (f / σ_{pf}) is the inverse of the coefficient of variation of futures price at expiration and (σ_Q / μ_Q) is the coefficient of variation of stochastic output (Mackinnon, 1967). Clearly if $\rho < 0$ so that price and production are negatively related, then the optimal hedge ratio is less than unity. This result is similar to the conclusions drawn by Mackinnon (1967) and Rolfo (1980): in the presence of production risk and no transactions costs the optimal hedge ratio is less than unity. The more negatively correlated are price and output, the smaller the optimal hedge ratio. If in addition, price and production are not correlated then we get

A.12

$\rho = 0$ and $H = 1$ in an unbiased futures market.

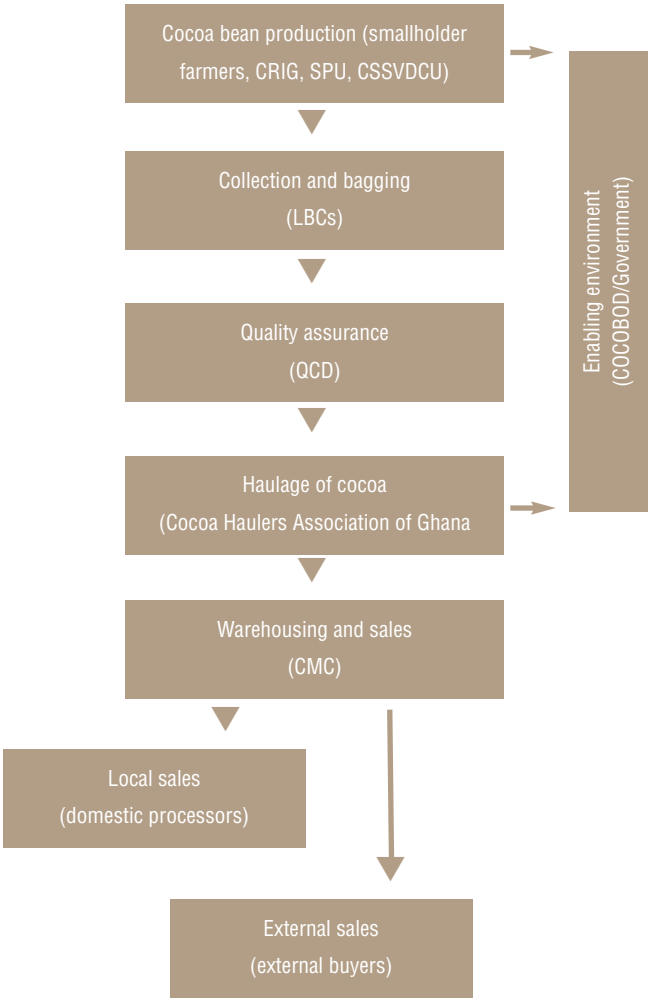
The cocoa exporter should fully hedge output. The result $H = 1$ is the usual case described by Hieronymus (1971) for a merchant faced only with price risk and has support in the literature (see Ederington, 1971; Rolfo, 1980 and McKinnon, 1967). If transactions costs are not zero then we get (A.13)

A.13

$$H = [2\gamma f \rho \sigma_{pf} \sigma_Q + \mu_Q \sigma_{pf}] / [2\gamma \sigma_{pf}^2 - 2b] \mu_Q - [2bE(PQ)] / \mu_Q [2\gamma \sigma_{pf}^2 - 2b].$$

Appendix 2

Ghana's unique domestic cocoa supply chain



LBC: Licensed Buying Agent
SPU: Seed Production Unit
CRIG: Cocoa Research Institute of Ghana
CCVDCU: Cocoa Swollen Shoot Virus Disease Control Unit
CMC: Cocoa Marketing Company
Source: Pinnamang-Tutu (2010)

[ii] *A recent related problem pertinent to export price risk emanates out of the uncertainty associated with variations in import price since most developing countries now import majority of the food they consume. See Sarris, Conforti and Prakesh (2011) for an excellent theoretical and empirical treatment of import price risk.*

[ii] *See Appendix 2 at the end of this paper and Pinnamang-Tutu (2010) for more details on the institutional organization of the cocoa industry in Ghana.*

[iii] *This hedge horizon is convenient because the cocoa futures market (NYBOT) has five contract months in a year: March, May, July, September and December.*

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