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On the scholarly contributions of the legendary George Adu

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Abstract

Beginning on a personal note, this paper succinctly presents the salient scholarly works of my teacher and mentor Dr. George Adu to the body of theoretical and empirical literature in economics. His contributions to the field of environmental and natural resources economics and macroeconomics in general cannot be overemphasized. While death might have cut his life short, George's considerable contributions to knowledge and society will continue to live on. He is a legend.

Keywords: George Adu; Environmental economics; Macroeconomics.

1. Introduction by way of a personal account

I was so much obsessed with pursuing a career in accounting after my Junior High School (JHS) in the early 2000s. This obsession took me to Business as a course at the Senior High School (SHS). My passion for accounting was largely driven by my dream of becoming an accountant not only because of the prestige that came with the profession, but the social belief that accountants were richer. In this endeavour, in 2005, I applied to study BSc. Business Administration at the University of Ghana and Bachelor of Commerce at the University of Cape Coast for the 2006/2007 academic year. Unfortunately, I did not obtain admission in both schools. In 2006, apart from these schools, I also applied to Kwame Nkrumah University of Science and Technology (KNUST) to read BSc. Business Administration in 2007/2008 entry. Similar to my earlier predicament, I did not get admission. However, I got admission to study BA Economics at KNUST as my second choice. While it was not my first choice, I did not want to waste another year at home. Even though accounting was my favourite subject at the SHS, I was equally good at economics but never thought of pursuing it at the higher level. I was always wondering whether I would be able to cope with the

difficult mathematics and complex graphs that often characterise economics. I enrolled at KNUST without being sure of myself. In Ghana, studying economics was perceived as the surest path to stinginess and for that matter, the subject of economics was not so much loved by many. At the KNUST where science and technology programmes dominate, social sciences students are not highly regarded.

When I reported to school in August 2007 as an undergraduate student, George Adu was one of the first lecturers to teach my class. He taught us Introduction to Mathematics for Economists I (ECON 153) & II (ECON 154) in a class of over 300 students comprising those majoring in economics and those who were taking it as a minor. He took us through his course outline and what the course entailed. He summarised economics and how mathematics shapes the discipline. George delivered a captivating first lecture. It was clear he had command over the course given his dexterity. He explained that, economics as a discipline was about managing scarce resources and maximizing utility, all of which can be modelled mathematically. At this point, I developed much love for economics while jettisoning my accounting plans. My interest continued to grow with George's lectures. This is because he could practically break complex economic theories with simple mathematics to the admiration of the entire class. George could also demonstrate to make a point to the class using his body language. I still remember vividly his lecture on matrix transposition. By raising his hands to the chest level and telling us to imagine ourselves sitting behind a wheel, George told us transposing a matrix was very similar to negotiating a right turn. He cleverly turned to the board, held each column of the matrix and "negotiated" a right turn with passion. His lecture on calculus and optimization techniques was next to none. My admiration for this young man continued to grow and I could not trade his lectures for anything.

For most part of my student life at KNUST, majority of our lecturers made us to believe that, even if a student could score 30 out of 30 in the mid–semester examination for her or his continuous assessment, no matter how brilliant a student was, it was impossible for that student to score all the remaining 70 points in a particular course unit at the end of semester examination. George's view about student marking and reward was different. His argument was, if the entire marks allocation ranges from 0 to 100, then it was possible for a student to score 100% since 100 is inclusive. Beyond lesson delivery, George's exam questions were also standard and practical. At the end of the semester examination, while I could not get 30 in the mid–semester continuous assessment score, by dint of

hard work and honesty on his part, I was able to score all 70 points in his course. This is not only memorable, it was the first time and certainly the last time I ever scored all points in my end of semester exams at KNUST.

Up to this stage, I never had a word with him and he did not also notice my presence in class because of the large numbers. However, I admired him from afar and certainly wished to be like him. He was celebrated in class not only because of his intellect, but he also happened to be the youngest lecturer in the Department of Economics. Unlike other lecturers, George only taught me for one academic year. I was hoping to meet him again in my third year in 2009/2010 academic year where he was teaching Mathematical Economics. In 2008, however, he left for his PhD in Economics at the Swedish University of Agricultural Sciences, Uppsala, Sweden.

Undoubtedly, George left an indelible mark in me and completely changed by career aspirations. He was a role model. After graduating with BA Economics in 2011, I was obsessed with pursuing a postgraduate degree in Economics. Among others, submitting a reference letter was one of the major requirements to secure admission. Although George was away in Sweden, he was the first person that came to mind as a potential referee. I sent him an email to introduce myself and picking him as a referee and mentor. I also sent him a copy of my transcript and certificate. In fact, it was this email that brought me closer to him. He accepted my request and took time off his busy schedule to continuously respond to the numerous reference requests from the several universities to which I applied. In fact, the daunting tasks of writing references and responding to the numerous reference requests from universities led to lecturers turning down students' request for references. George was the first point-of-call by my colleagues who were also applying for further studies. In my case, he was always the first to submit his reference. In addition, he was also sending me information about scholarship opportunities. Fortunately, I won the prestigious Commonwealth Shared Scholarship to pursue MSc. Development Economics at School of Oriental and African Studies (SOAS), University of London, UK. When I informed him about this good news via email, the excitement and encouragement in his reply was priceless. We were both active on Facebook which also kept our conversation alive. In one of our Facebook conversations, he told me winning a scholarship is a privilege which also comes with challenges especially coming from a developing country like Ghana. He offered his invaluable advice regarding how to surmount those challenges. I continued to maintain the relationship during and after my postgraduate studies. Even after

graduating in 2013 and returning to Ghana the same year, George was excited. He believed in me and told me Ghana needed me most. I still remember when it was a bit difficult settling in after returning to Ghana. I kept some distance from him. George sent me a WhatsApp message saying, Mallam – as he affectionately called me – you will be fine. Certainly, I got a job and George was the only referee my then employer randomly contacted for a reference.

George was also always encouraging me to pursue PhD. After unsuccessful attempts elsewhere, in 2015, I got admission at the University of the Witwatersrand, South Africa to pursue the PhD under the supervision of Prof. Imhotep Paul Alagidede who happened to be George's best friend whom he met during their undergraduate days at KNUST in 1998. Even during my PhD studies, George was instrumental as my PhD research area was largely influenced by a paper he published, something I will later talk about in this summary of his scholarly work. He provided useful comments especially at the early stages of my doctoral candidature and shared many recent graduate economics textbooks with me. Even after graduating, we maintained our friendship and bidding for consultancy assignments together. Fast-forward to late 2018, I sent him a WhatsApp message to say hi. As usual of him, he was cheerful and sounding fine. Few minutes after conversation, George got back and opened up to me about his sickness. We discussed the way forward and all that. Sadly, little did I know it was my last conversation with him. He later deactivated his WhatsApp. I sent him a text message on 27th November, 2018 to enquire about his health and "disappearance" on social media. I did not get a reply. I sent him another text on 23rd January, 2019 to check on him and how he was faring with his health. Again, I did not get a reply only to hear about the shocking news of his demise on 9th February, 2019.

George was a lovely and hard working man. While I write this with a heavy heart because the world has lost an illustrious young man, I also write to celebrate his life as a scholar. On this score, I chronicle some of his significant contributions to the economics discipline through his outstanding publications in top–peer reviewed journals.

2. Contributions to scholarly research: A summary

While I cannot adequately capture all George's contributions to academia, in this section, I concentrate on the significant ones. Undoubtedly, a key characteristic of George was his unflinching desire for collaboration. To him, apart from providing an opportunity for him to mentor youngsters, it was also an opportunity

for him to deepen his knowledge through peer-to-peer support. Because he believed in collaborative research, George's publications and research outputs were mostly co-authored with him performing the lead role in many. He had strong appetite for research in environmental and energy economics, economic growth, financial economics and applied econometrics. George also had sound interest in applied macroeconomics where his studies were largely motivated by contemporary issues.

In the field of environmental economics and at the time when Ghana was battling with issues around illegal logging of timber and the need to improve on living standard of people, George and his collaborators in 2012 published a paper on the contribution of agriculture to deforestation in the tropics. In their paper, George theoretically compared the deforestation path taken by profit maximizing agricultural firms in tropical regions to the path that will maximize social welfare based on optimal control techniques. By solving for the optimal choice of deforestation for both the private farmer and a social planner, George and his colleagues find that the socially optimal deforestation path that maximizes the discounted sum of net benefit of forest land use to society diverges from that of a farmer with the source of divergence being the cost of deforestation which is external to the farmer. The main thrust of their study was that, farmers' deforestation path ultimately results in outcomes which are socially sub-optimal. To him, in as much as forests contribute to greater agricultural productivity in the short term, forest depletion reduces agricultural productivity in the long run. This is because the negative externality stemming from the tropical deforestation can be very large resulting in a significant wedge between the socially optimal rate of deforestation and the optimal path taking by the private farmer. This paper is a follow up to a single authored paper he contributed to the maiden issue of this journal in 2009. The summary of that paper is fully captured in the tribute by Franklin Obeng-Odoom in this issue.

On how environmental policy shapes overall economic growth and the so–called pollution haven hypothesis, one of the most contentious topics in international environmental economics, George made important contributions. The central theme of this hypothesis is that, liberalising trade in goods results in relocation of pollution intensive production from advanced countries with restrictive environmental regulations to low and underdeveloped economies with weak environmental regulations. George theoretically examined the effect of environmental policy on growth in a small open economy relying on neo-classical model while controlling for environmental concern. By limiting the

role of government to taxing polluting firms and redistributing tax proceeds to households as a way of internalizing externalities, among others, George found that, environmental policy is deleterious to long-run growth with stronger effect in the open relative to closed economy especially if the country has strong aversion to pollution and serves as net exporter of capital. He further observed that, a high demand for environmental quality induces capital flight from the high income economies to poor countries with lesser demand for environmental quality. By solving for some 59 equations, George provided an alternative restatement of the popular pollution haven hypothesis. I remember this paper caught the attention of my environmental economics professor when I did a seminar presentation on "footloose hypothesis" while studying for my masters degree in the UK. It was one of the major and recent references I used.

George's passion to see underdeveloped countries grow was manifested in his papers. Many of the empirical studies for several decades opined that resource-poor countries tend to experience faster growth relative to resource-rich countries in what is popularly known as the resource curse hypothesis. During this time, research on this so-called resource curse hypothesis was scanty. Few studies were notable by celebrated authors namely Jeffrey Sachs, Andrew Warner, Dani Acemoglu, Xavier Sala-i-Martin and Arvind Subramanian. For most part, the immediate conclusion was that resource abundance was a crucial conduit to economic development failure. While this conclusion is inconsistent with the joy of countries' natural resource discoveries, it was particularly difficult to explain this empirical "paradox" from a theoretical perspective. Indeed, the transmission channel of this resource curse was largely linked to its effect on undermining human capital accumulation. George argued that, while this could be a potential channel of transmission through which the curse of natural resources manifests itself, they do not make a complete explanation of the curse. He therefore offered a theoretical explanation of the resource curse hypothesis using the directed technical change modelling framework that complements the existing theories in explaining the hypothesis. More specifically, George analysed the impact of asymmetry in factor endowments between resource-rich and resource-poor countries on equilibrium bias of technology development and adoption possibilities. George showed that the bias in equilibrium technology in the resource-poor North is influenced by its relative abundance of human and physical capital. He further argued that, this force is amplified by the relative abundance (scarcity) of physical (natural) capital. George also demonstrated that the equilibrium bias in technology in the resource-abundant South is

dependent positively (negatively) on the relative abundance (scarcity) of skilled (unskilled) labour and the relative abundance (scarcity) of physical (natural) capital in the North. In this case, the force is dampened by the relative scarcity of skilled labour and physical capital in the South. By utilizing the North-South perspective, George argued that the natural resource curse may be the result of skill/capital-biased technological change that makes technologies developed to suit the needs of the skilled/capital-abundant North inappropriate for the natural resource/unskilled labour-abundant South. Undoubtedly, this channel of transmission has become more important in explaining the curse as it is evident that the direction of technical change over the past six decades.

In a related study, George empirically tested for the possibility of this resource curse in Ghana relying on time series data while invoking the fully modified ordinary least square approach which controls for non-stationarity and potential endogeneity. Using two proxies of resource abundance – share of agriculture as a proportion of GDP and per capita cropland, George's study could not provide conclusive evidence on the resource curse given the varying impact of the proxies.

Indeed, one of the fiercely contested areas in environmental economics which George himself acknowledged is the relationship between environmental sustainability and continued economic growth. While the pessimistic school of thought holds that the best way to ensure environmental sustainability is to halt growth, the optimistic view argues that economic growth process does not occur at the expense of environmental sustainability especially in the presence of technological change. This is particularly crucial for sub Saharan African (SSA) countries where incomes are low coupled with poor climate conditions. George and his colleagues empirically examined the effect of climate change on economic growth in SSA using an augmented neoclassical stochastic aggregate production function with a Cobb-Douglas framework. Results from their study showed that, while there is a relationship between temperature and growth, the short run effect of temperature is relatively deleterious. They further found that the impact of temperature on growth exhibits a "Laffer effect" with a turning point of 24.9 ºC. With this empirical finding, George and his colleagues brought clarity in the seemingly heated debate between the pessimistic and optimistic schools of thoughts in climate change – economic growth nexus.

Coming from a developing country, access to clean fuel was a challenge. For most part, fuel wood collection was the order of the day. This was exacerbated by the presence of heavy tropics. On the environmental impacts, the continuous deforestation and reliance on biomass energy, especially the use of inefficient

cookstoves and methods by households poses a major threat to the survival of livelihoods and entails significant externalities on the global environment and climate. In Ghana, while successive governments made attempts to address this energy poverty and encourage the adoption of improved fuel, the successes chalked were very minimal. More importantly, the energy ladder hypothesis failed to explain the adoption of modern fuels suggesting that, the determinants of fuel switching was far more complex than what the simple relationships show especially in developing economies including Ghana.

Given these complexities, issues around the functional form of energy choice were questionable. While theory assumes a non-linear demand for energy function, the precise form of non-linearities remained unknown. Although existing studies have accounted for this by introducing some quadratic square terms, what still remained as an empirical challenge was the extent to which the existing studies have adequately capture the inherent non-linearity in the fuel choice functions, since the exact form of the relationship is unidentified, a priori. Using two nationwide household surveys – Ghana Living Standard Surveys 5 and 6, George and his colleagues waded into this by applying the semi-parametric probit model which offers more flexibility in capturing the thresholds in the relationship without imposing any functional form prior to estimation. Findings from their study revealed that, the imposition of parametric functional form prior to estimation on factors such as age of household head, income, and household size as done in the existing studies was inappropriate as they tend to bias the marginal effects. Empirically, this particular study proffered significant contribution to the extant literature as it brought a different perspective into the discussions on household energy demand models. At the policy level, this study provided excellent implications and energy policy design for Ghana and other developing countries in search of sound strategies to promote the up-take of efficient household fuels.

Beyond environmental economics, George also had a special interest in macroeconomics where his contributions in this area were driven my contemporary trends. I remember somewhere in 2010/2011 when the discussion on Ghana's inflation drivers gained traction, George joined the discussion by empirically examining the factors explaining the inflation dynamics. He observed that, while other drivers are notable, output growth has the strongest impact on inflation and that targeting supply-side constraints would be useful in moderating price inflation. Three years after this study, there were crucial lingering questions: Are there significant asymmetries in regional and sectoral

inflation levels in Ghana? What could be the likely sources of the potential asymmetries in inflation persistence and where are they prevalent? What are the macroeconomic implications for poverty? In this endeavour, George and his colleagues comprehensively analyzed the national and regional inflation dynamics in Ghana. They also investigated core and headline inflation persistence across 13 sectors using fractional integration methods. This study contributed significantly to the literature. First, George and his friends find varying levels of asymmetries in the inflation persistence both regionally and sectorally with the degree of persistence contingent on whether month-on-month or year-on-year inflation is examined. With regard to the welfare implications, their study uncovered that, inflation at the micro level disproportionately affects the poor more thereby increasing the welfare cost of inflationary shocks and distorting consumption choices with dire ramifications for economic growth.

Closely linked to this in shape but fundamentally different in form was George's work on the impact of financial development on economic growth in Ghana. Indeed, the impact of well-developed financial system on growth has been extensively documented in the finance-growth literature. Key proponents of the growth-enhancing effect of finance included Joseph Schumpeter, Ross Levine, Robert G. King among others. Ross Levine for instance argues that, financial development promotes economic growth via the functions it plays inter alia mobilizing savings and allocating credit, ameliorating information asymmetry, ensuring sound corporate governance, monitoring investments and providing opportunities for risk transfer. Based on this, the extant studies concluded that higher financial development spurs economic growth. Indeed, few scholars, however, cast doubt on the positive effect of finance. Wading into this debate, George and his colleagues investigated the long run growth impact of financial development relying on several proxies of finance. They also created an index of financial development using the principal component analysis while examining structural breaks in the series. Results from their autoregressive distributed lag (ARDL) approach to cointegration revealed that, whether finance supports or inhibits economic growth depends on the indicator of finance. To test for the robustness of this evidence, George and his colleagues included the structural break period of growth as a shift dummy in the model. Even after this exercise, all the financial development proxies maintained their signs and level of significance albeit marginal changes in the magnitude of effects. Given this, they concluded that, the finance-growth link is sensitive to the choice of the proxy. Undoubtedly, this study helped in deepening our understanding especially in the face of conflicting findings eminent in the literature.

Admittedly, this significant work in 2013 completely changed my life as it totally influenced the research area of my PhD. Reading through the study, it directed my attention to re-engage the literature on finance-growth nexus. Doing this led me to uncover crucial nuances which were relatively under studied and that gave birth to my PhD thesis on the studies of financial development and economic growth in SSA. Indeed, George's significant work is one of the major references for my final year undergraduate Development Finance class and postgraduate students of Financial Markets.

Issues around stock markets and returns were also of considerable interest to George. For instance, while the popular existing studies have advocated for linearity in the relationship between macroeconomic factors and stock markets using parametric approaches, George argued that, such imposed explicit parametric functional form specifications produce constant estimates which are mostly wrong. He therefore led a pioneering study to re-examine the macroeconomic forces and stock market performances in Ghana using the local-linear non-parametric kernel regression based on discounted cash flow. They show that, relative to the existing studies, the relationship is intrinsically non-linear and with varying implied elasticities. Closely linked to this is his work on stock returns. While the extant existing studies on the distribution of stock returns rely on the normality assumption as a starting point, George led his colleagues to question the rationale behind this assumption and proceeded to formally test for normality by invoking the multivariate joint test for skewness and kurtosis. By using BRICS as a case, they find that the distribution of stock returns exhibits peakedness with fatter and longer tails, and this is invariant to both the unit of measurement and the time horizon of returns. Relying on the family of generalized autoregressive conditional heteroskedasticity (GARCH) models, they find that, while volatility clustering is observed in all markets, the clustering decays exponentially for all with the exception of Brazil. George and his colleagues also confronted this prediction of capital asset pricing model (CAPM) with BRICS index returns data and did not find complete support of the prediction that the expected return and risk are positively related.

Indeed, there are other excellent works by George in interest rate, exchange rate dynamics and pass-through effects on domestic prices, private investment, output fluctuations and fiscal deficits. For brevity, I do not highlight the unique individual contributions in each of these areas.

3. Conclusion

This paper aims at highlighting the salient scholarly contributions of George Adu. I document that, until his demise on 9 February 2019, George contributed significantly to both theoretical and empirical literature in economics. His excellent works and considerable novel findings in the research shined the light on notable issues and extended the scope of knowledge in his chosen field(s). While death may have cut his life short by laying its icy hands on him, his significant contributions to literature and society cannot be overemphasized. Admittedly, the vacuum created by his absence will be hard to fill. Although George is dearly missed, we celebrate his life, his selfless spirit and what he was able to achieve during his relatively shorter career in academia. Undoubtedly, George lived his life well and we pray the ancestors accept him.

Dr. George Abu

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Honors, scholarships, and fellowships

African Guest Scholar, The Nordic Africa Institute, Uppsala University, Uppsala, Sweden (Sept. 2015 - Aug. 2016), Natural resource revenues and public investment in resource-rich economies in Sub-Saharan Africa (UNU-WIDER Funded project, Final Report Submitted)

DRUSSA Policy Fellow, Ministry of Trade and Industry, Accra-Ghana, March - August, 2015 (Funded by the Association of Commonwealth Universities & Science and Technology Policy Research Institute, Accra-Ghana)

An Empirical Analysis of Exchange Rate Dynamics and Pass-Through Effects on Domestic Prices in Ghana (Funded by the IGC, LSE, Project completed)

A Regional Analysis of Inflation Dynamics in Ghana: Persistence, Causes and Policy Implications (IGC, LSE, London, Feb. 2014 - July 2014)

The Nexus between Climate Change and Economic Growth in Sub-Saharan Africa (AERC/UNU-WIDER Grant Project, 2012 -2013)

Graduate Scholarship, Department of Economics, SLU, Uppsala-Sweden (2008 - 2012).

SIDA Scholarship for a PhD course in Natural Resource Economics at the University of Gothenburg, Sweden (February-March; 2008).

Completed projects and consultancy services

Principal Investigator, African Centre for Economic Transformation (ACET) Project on "Delivering Public-Private Partnership Benefits to Mining Communities in Ghana" (September 2014 - March 2015).

Principal Investigator, UNDP Project on "Using the Extractive Sector to Enhance Ghana's Human Development: the case of Mining" (October 2013 - May 2014).

National Consultant for joint UNEP-UNIDO Project on Resource Efficient and Cleaner Production Financing in Ghana (January - May, 2013).