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Ronald A. Fleming
University of Kentucky

Bruce A. Babcock
Iowa State University, babcock@iastate.edu

Erda Wang
Iowa State University

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Resource or Waste? The Economics of Swine Manure Storage and Management

Abstract

In Iowa, the release of confinement swine odors and manure nutrients into the environment has become an important issue. The objective of this paper is to measure the net benefit of using swine manure in alternative production systems. Net benefit is calculated for two storage technologies, two target nutrients, two crop rotations, and two levels of field incorporation after application. This investigation shows that applications based on phosphorus can better match crop nutrient need, and thereby lead to higher profits.

Disciplines

Agricultural and Resource Economics | Agricultural Economics | Economics

**Toward a Theory of Food and Agriculture
Policy Intervention for a Developing Economy
with Particular Reference to Nigeria**

Gbolagade B. Ayoola

Working Paper 97-WP 187

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**Center for Agricultural and Rural Development
Iowa State University
Ames, Iowa 50011**

Dr. G. B. Ayoola was a visiting scholar in the Department of Economics, Iowa State University, Ames and is Director of the Centre for Food and Agricultural Strategy (CEFAS) at the University of Agriculture, Makurdi, Nigeria.

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PREFACE/ACKNOWLEDGMENT

I came to Iowa State University in the summer of 1996 with a preconceived notion that the agricultural and industrial sectors of a developing economy, within their active interrelationship, engage each other in an "embrace". And the form and function of this situation, I believe, represents an important source of knowledge about the policy process for agriculture and rural development in developing countries of the world. Therefore, during the three months of my stay in Heady Hall (Economics Department) I held extensive discussions with faculty and interacted with other people outside to consider the issues involved in a "deathly embrace" theory of sluggish agriculture based on my initial observation of the agricultural economy of Nigeria over the years. Consequently, a synthesis paper is necessary to document the outcomes of the present stage of this theory with respect to the initial ideas and how these ideas have been shaped by the views of my host colleagues at Iowa State University.

I want to especially thank the two people who have provided me with the general direction and enabling intellectual environment to develop the idea to the present stage, Professor John Miranowski (Chair of the Economics Department) and Professor Stanley Johnson (former Director of CARD and now Vice Provost for Extension). Also, I appreciate the time and mental inputs of the following faculty members who discussed with me on various aspects of the topic: William Meyers, Harvey Lapan, Arne Hallam, Maureen Kilkenny, Joe Herriges, Patrick de Fontnouvelle, Daniel Otto, Walter Enders. Nonetheless, I absolve all these people of the responsibility for any residual errors of omission and commission inherent in the final version of the paper.

TOWARD A THEORY OF FOOD AND AGRICULTURE POLICY INTERVENTION FOR A DEVELOPING ECONOMY WITH PARTICULAR REFERENCE TO NIGERIA

The absence of a definite theoretic frame for analyzing, prescribing or evaluating policies for agricultural development in developing countries is quite obvious. The main observation concerns the disparate analysis of the situation by experts with no conscious effort to converge their views at a single point; there is neither a consensus about what the common theoretic frame of policy analysis should be nor a deliberate attempt to formulate one, a situation which has made progress difficult and slow as policies tend to work in different directions over time. Yet it is recognized that, for the overall advantage of the system, it is necessary for all forms of policy analysis concerning production, marketing, infrastructure, research and other aspects of the economy to be carried out within a single internally consistent theoretic frame to generate effective intervention modes.

The perceived need for a distinct theory of agricultural policy for developing countries is based on the intuitive reasoning that the theoretical foundation of agricultural development in developed economies is fundamentally different from the conditions prevailing in developing countries where the agricultural sector has generally lagged behind industry and lacks sufficient competitive competence to make parallel intervention work. To corroborate this reasoning, Dr. Schuch in his comment on Nicholl's (1969) paper, has noted that one of these theories, specifically the one expounded by Shultz (1953), was from the standpoint of a mature economy.

In any case, the absence of a coherent theory of agricultural policy unique for developing economies has meant that actions cannot be focused, which explains much of the basis for stagnation. Evidence abounds in several countries of Africa and other developing areas of the world that the huge resources flowing from domestic and international sources to upgrade their farming systems and enhance technology in the last half century have not yielded commensurate progress in food security and quality of life. Therefore, the policy angle also requires more intense concentration as a potential source of the problem.

This study presents a theoretical framework for policy intervention in the agricultural sector of a developing economy. It argues that the sluggish growth and development of the sector is deeply rooted in the agriculture-industry (A-I) interrelationship; and given the original statement of the dual economy model and the initial (colonial/post-colonial) pursuit of development initiatives in that context, the role of that relationship to the joint fortune of both sectors cannot be taken for granted nor absolutely neglected as has been done by development experts, policy analysts, and policy authorities for several decades. The rigorous investigation of the relationship is specially warranted for the developing economy in which the Shultzian idiom

of "growth centers" or the "leading sector" hypothesis have failed to hold. Schuch (1969) reiterates that such a theory "was not concerned with the problem, currently receiving so much attention in developing countries, of how agriculture can be made more productive so that it can contribute to the industrial development of the country". Similarly the "industrial policy" for agriculture, as recently expounded by Johnson and Martin (1993), is primarily premised on the well-developed agricultural economy of the United States rather than that of a developing country.

The goal of this paper is to initiate the process that will eventually lead to a concise theory of policy intervention specifically suitable for the prevailing conditions in developing countries. At the same time I wish to inform you about the main features of the Nigerian agricultural policy environment to arouse interest in the analysis of that environment in relation to the advanced agricultural system of the United States. Moreover, the developing countries are also concerned with the important question addressed by Nicholls (1969) and others (Ruttan 1969, Tang 1959, Sisler 1959, Bachmura 1956, Sinclair 1957, Bryant 1966) of "How can the gains from industrial development from industrial development be distributed on as wide a base as possible" to benefit agriculture?

The paper is in three main sections: the formal theoretic proposition is made first (I), to be followed by the possible directions for modeling and controlling the system (II), then by the constellation of related theories and models (III) and, finally, an illustration with some evidence about Nigeria (IV).

I. The Main Proposition and Hypotheses

The traditional duality of the national economy provides the logical starting point for illuminating the relationship between agriculture and industry with respect to policy analysis. Consider as usual an economy divided into two broad sectors; typically we speak of agriculture/industry or rural/urban, agriculture/nonagriculture, backward (traditional)/advanced (modern) and other such dichotomies. The taxonomy employed in this study is the simple agriculture/industry format wherein industry definition includes the "service complex" consistent with Thorbecke and Field's (1969) definition of nonagriculture. The main problem is the apparent failure of the two sectors, as characterized by the weak link between agriculture and industry governing the effectiveness of intervention policies. It would appear that the rigorous exploration of the inner mechanisms of this link within a uniform theoretic context holds the key to functional intervention in developing economy agriculture.

Therefore, we describe the system as having two organs depending on each other for thrusts and feedbacks, or “inputs” and “outputs”; when both organs wait for each other to perform the expected roles the system stagnates somewhat. Otherwise it tends to slow down. This situation might be called the “deathly embrace” of the two organs in the system. At present we think of the simple embrace case involving industry and agriculture sectors of the national economy so the joint fortune of both sectors can be looked into by exploring the relationship between them in terms of structure and transmission mechanism. In Haessel's (1970) review of the literature on dual economy models, he concludes that the general direction was toward “formulation and implementation of development policies which exploit the interrelationship between industry and agriculture in a manner which promotes the mutual development.” But development experience in the countries of Africa and other developing economies in general have indicated otherwise: the “manner” has not successfully explored this relationship for active policy intervention in these places. The present proposition attempts to fill the gap through a broad theoretic framework for investigating the system for the causes and consequences of mutually embracing the sectors with a resulting slow pace of economic growth so the specific policies can be considered or evaluated against the functionality of the entire linkage system.

It is a matter of careful observation to conjecture that the developing economy depends upon both sectors waiting for each other to perform their reciprocal roles. Professor Francis Idachaba, a keen observer of agricultural economy events in Nigeria, suggests in a preliminary comment that the theory may be subsequently extended to the regime of “multiple embrace”—“to show that it is not only ill-health in agriculture that holds down industry and vice versa but that ill-health in the transportation sector, social services, education sector and others lead to more severe illness of the agricultural sector.” Though that reasoning makes considerable sense, especially in the context of integrated rural development strategies dominating the scene in several developing economies and also because that idea gives substantial scope for future application of the theory, these factors will be held constant initially and considered as exogenous to the system. Nevertheless, they represent the key instruments of policy intervention for facilitating the main agriculture-industry system.

The general proposition proceeds in the context of both sectors operating in the same national market framework, in which case traditional market analysis will apply in the structure, conduct, and performance of the system. In this context a number of testable hypotheses emerge to characterize the sources of embrace in the system and reveal the possibilities for policy intervention.

Structure

The link system has a structural dimension which governs the market for products and inputs with respect to concentration and differentiation. Thus, a malstructured relationship of agriculture with industry represents critical sources of embrace. The variable of policy decisions to “de-embrace” such a system will include appropriate fiscal, monetary and trade instruments for eliminating a lopsided concentration of enterprises on both sides of the link as well as reducing the degree of possible product differentiation therein. The following hypothetical propositions follow directly from the structural context for a developing economy:

1. A structural problem exists through the numerical imbalance of agricultural production units with those of industry, which creates disproportionate volumes of goods and services across sectors; to the extent that the free flow of commodities is impaired along with the numerical imbalance, then the organs of the A-I system embrace each other.

2. Structural failure is the result of misalignment of the component parts, so certain production units are far larger or smaller than proportionately required relative to other units of the same or other sector in the system; this creates considerable waste in resource use and missing targets that specific production units should impact upon, so to this extent agriculture and industry embrace each other.

3. Structural failure emanates from missing components, which reduce the capacity of the system to produce and consume; the resulting capacity underutilization handicaps dependent production units within and between the sectors to the extent to which an embrace of the sectors occurs in the system.

Conduct

The conduct of the A-I system pertains to the presence of certain factors in the production and consumption processes in both sectors that inhibit the smooth working of the joint market system. The main factor is the limitation of freedom of entry or exit into the individual and joint markets. The following hypotheses apply.

1. Poor conduct of the A-I system exists in the presence of active or passive barriers to enterprise and trade in a developing economy; to the extent that implicit and explicit restrictions to entrepreneurship and commerce inhibit market competitiveness in agriculture and industry, several points of friction exist to lead to system embrace.

2. Poor conduct of the A-I system results from the absence of a government system that permits democratic economy and allows the maximum participation of production and consumption units in the policy decision processes; to the extent that enterprise initiatives in these

units are stifled in the circumstance is the same extent that the two sectors are incapacitated to perform the roles expected of them, leading to system embrace.

3. Poor conduct of the A-I system is a consequence of the widespread state domination of the enterprise system; the extent of resource waste and leakages emanating from direct and indirect domination of the private enterprise system is the same extent that both sectors are inefficient in the production, distribution and consumption of foods and services, hence their poor role performance and consequent embrace.

Performance

The key variable to judge overall performance of the A-I interactive system is income; it is a strong quality of life variable also, thereby making it useful in the context of integrated rural development. Therefore, income levels in agriculture and industry represent the principal vehicle for establishing internal and external harmony of the system. The American experience shows that policy actions to align and realign the income level in agriculture with the level in industry is an effective mode of intervention to upgrade overall system performance.

However, the following propositions emanate from the developing economy setting.

1. Poor performance of the system manifests itself in the historically inferior income status of the agricultural sector compared with the industrial sector; to the extent that the income levels for both sectors fail to match effort-for-effort, to that extent the second-generation problems relating to migration, structural employment and others will obstruct the connectivity of both organs, causing them to embrace.

2. Poor performance of the A-I system reflects the weak distributional impact of national income relative to sector contributions and capabilities; to the large extent that income from a leading sector is not sufficiently channelled for enhancing the productivity of the other sector at any point in time, one sector lags behind to pull(or at least slow) down the progress of the other sector at that point in time, depicting an embrace of sectors.

II. Modeling and Control of the A-I System

To give practical utility to the concept of sector embrace as a framework for policy analysis requires the rigorous modeling and control of the A-I system. However, it is recognized from the outset that a unique analytical model or control model cannot be conceived before investigating the system empirically, given the wide dimension of development issues involved. The progress toward a good model of both types probably depends upon the concentration of model builders on these issues to produce the appropriate structure and transmission mechanisms

for describing the system under realistic assumptions, coupled with generating computable numerical solutions for estimating the parameters of the modeling system.

Professor Harvey Lapan, Iowa State University, has been instrumental in developing an initial approach to a structural model of the A-I system in joint input use by both sectors in a single competitive national market framework; given the two-input resource base of the dual economy, land (T) and labor (L) we have:

1. $X[T_x, L_x] \Rightarrow$ agriculture sector (X);
2. $Y[T_y, L_y] \Rightarrow$ industry sector (Y);
3. $T_x + T_y \leq T \Rightarrow$ total stock of land available;
4. $L_x + L_y \leq L \Rightarrow$ total stock of labor available.

In this framework the production possibility frontier specifies in theory the maximum employment of land and labor by both sectors of the economy. Then the empirical task is that of locating the locus of joint input use in the domain bound by the frontier and the axes. As a first utility of the model analysis, the relativity of any point of resource use against the frontier can be explained in the context of sector embrace, following which candidate policy prescriptions will emerge and can be evaluated within the same context.

By extension we can demonstrate the critical links between the sectors in terms of output of one serving as input of the other in addition to both drawing from a common pool of national resources and the fact that each sector also utilizes part of its own output in the production process. In this case we have:

5. $X[T_x, L_x; Q_y^x, Q_x^x] \Rightarrow$ agriculture sector;
6. $Y[T_y, L_y; Q_y^y, Q_x^y] \Rightarrow$ industry sector.

That is, sector outputs behave as intermediate inputs in the A-I system; so net output (N) is defined for each sector:

7. $N_x = [X - Q_x^x - Q_x^y] \Rightarrow$ agriculture sector
8. $N_y = [Y - Q_y^y - Q_y^x] \Rightarrow$ industry sector

In the final analysis, output of one sector is an argument in the net output of the other sector and vice versa. Since net output is what is actually available for consumption and trade, the fortunes of agriculture and industry are intricately joined in the A-I system as formulated. Subsequently, this joining helps in the determination of the "static embrace" status of the system directly through the derivation and estimation of a suitable quantity or measurement index, depending on actual specifications.

The computation of the dynamic embrace status requires the introduction of time into the analysis as:

9. $T_x(t) + T_y(t) \leq T(t);$
10. $L_x(t) + L_y(t) \leq L(t);$
11. $X_t = F\left[T_x(t), L_x(t); Q_y^x(t-1); Q_x^x(t-1); \alpha(t), R(t)\right];$
12. $Y_t = G\left[T_y(t); L_y(t); Q_y^y(t-1); Q_x^y(t-1); \beta(t), R(t)\right].$

By implication, α and β represent technological progress in agriculture and industry, both to capture the endogenous growth in the Haris-Todaro (1970) and Romer (1992) senses, which depends on total investment in agriculture and industrial output; $R(t)$ is a government or policy factor.

The important issue, however, is how decisions are to be made to achieve profit maximization and efficiency in the production units so that the scope of policy intervention can be determined. The mechanism for doing so involves de-embracing the structure, conduct and performance of the A-I system. It is envisioned that mode will make policy intervention be more focused, more targeted, and most effective.

A second candidate model for investigating issues and elements of sector embrace of the A-I system come from the Walrasian/Kuhn-Tucker rural-urban equilibrium model, as applied by Kilkenny. Dr. Kilkenny has suggested how the computable general equilibrium model can be initialized and verified with a bi-sectoral Social Accounting Matrix that can be used for simulations of the system. The effect of how changes in relative transport costs can possibly affect relative sectoral wage rates can be shown and the location of "even production-cost-oriented" firms can be determined.

Given that the system can be modeled in this or other possible ways, the next task is its control through appropriate modes. This task appeals to the well-developed "optimal control theory" for formulating and estimating appropriate model control of economics systems (Intrilligator 1971, Kendrick and Taylor 1971). The common policy problem for agriculture in this regard is production control of agricultural commodity outputs to match commodity outputs, with desired levels those used in American agricultural policy for nearly seven decades.

We formulate a Calculus of Variation model (CAVAM) of optimal control for the A-I system akin to that in an earlier study (Ayoola 1991), in which a performance index, I , serves as the state variable and a critical input, X , (usually land) is the control variable. We desire to determine the adequate levels of X over a given planning horizon between time now (t_0) and time in the future (t_n). The objective functional in the continuous dynamic sense is:

$$1. \quad J = \int_{t_0}^{t_n} I(X_i(t), \dot{X}_i(t), t) dt.$$

That is, the time rate of change of X (\dot{X}) and time itself (t) are also arguments in the system equation in addition to X so the objective is to maximize the cumulative value of J or its temporal average over the planning horizon to $t < t_n$, subject to certain boundary conditions; i.e.,

$$2. \quad \text{Max } J = \int_{t_0}^{t_n} I(\dots) dt \quad \text{s.t. } X(t_0) = X_0; \quad X(t_n) = X_n.$$

The solution criterion is the standard Euler equation, to yield the optimal time path we desire as

$$3. \quad \frac{\partial I}{\partial X_i} = \frac{d}{dt} \left(\frac{\partial I}{\partial \dot{X}_i} \right).$$

The technical implication of the control model for the A-I system is that the functional form for $I(\dots)$ should be at least twice differentiable. Of course we are not as seriously constrained in policy studies, in the choice of functional form for econometric estimation as in production function studies which frequently rely on a priori forms such as the Cobb-Douglas. Therefore, the simplest functional form to consider is probably the quadratic form, with or without an interaction term.

However, the more critical problem facing the control model is the actual estimation as is, rather than the choice of appropriate functional form. As discussions with the various experts reveal, there are no computable algorithms in place for the estimation of the CAVAM in the continuous time sense. This suggests that we should settle for estimation by way of discrete time approximations, for which computable numerical solutions presently exist. The consensus, however, is to the effect that the disparities in results generated for optimal control of the A-I system would be negligible or minimal.

In any event, some automation of the control analysis may be sacrificed to still retain the continuous time property of the CAVAM, in particular among the class of control models. The analysis becomes much easier with the aid of software packages for performing mathematical operations such as Mathematica or Mathcad Plus. In the specific case of CAVAM, the presence of a standard solution criterion in the form of a Euler equation helps further to eliminate the messier aspects of the mathematical operations that could have made the results of hand differentiation and integration very unreliable.

III. Constellation of Theories and Models

The major thrust of the deathly embrace theory (DET) is the provision of scope and dimension to agricultural policy analysis unique to a developing economy. But it is not as if many of its main elements are new in the sense of an omnibus development theory and model application. Therefore, it is worth the effort to briefly synthesize some aspects of orthodox

development theory that have been cited earlier and attempt to determine the coordinates of DET within the context of development economics as a single body of knowledge.

The concept of dualism is the logical starting point as the basic template for discussing these issues. According to Fei and Ranis (1969), the concept predates the modern history of development economics. Reference is made to the eighteenth century physiocrats who envisioned a circular flow mechanism between two sectors of the economy described rather crudely as “a predominantly agricultural sector and a smaller service sector.”

Thus, it is not by mere accident or original creation that subsequently thoughts emerged to explore the agriculture-industry relationships in the search for economic growth of the past half century or so. The conclusion reached in Dr. Haessel's (1970) review of efforts in this direction is that the query of the nature of the interrelationships between agricultural development and industrialization is unresolved. In the review, reference is made to the initial conception of development in a leading sector whereby “deliberately planned, rapid industrialization would pull the backward agricultural sector to higher levels of development,” implying a somewhat passive agricultural sector.

Subsequently, the analysis has shifted to question the notion of a passive agriculture sector and focus attention on the active relationship with industry; the works of Lewis (1955), Thorbecke and Field (1969) are relevant in this respect, among others. The logical conclusion is that the application of emerging theory to a country would depend on “its resource endowment, and its phase of development.” This conclusion finds continuity in DET, which is premised on the notion of agriculture as an active sector and in constant synergy with it; moreover, it contains the special provision need for a country at the lower phase of development.

The modeling of the dual economy has been a rigorous research enterprise parallel to the discussion of dualism as a concept. First, on the theoretic plane, is the two-sector model of general equilibrium as a consequence of the “Cambridge controversy.” Johnson (1970) surveys the main aspects of the one-sector Ricardian and Hicksian models in this regard and expounded the two-sector model beyond the comparative statics level. Also Haessel (1970) has developed “a theoretic analysis of intersectoral relationships in a five-sector, optimizing model of a dual economy.” The important conclusions drawn span the aspects of public investment in subsistence agriculture relative to commercial agriculture; private capital accumulation; impact of food and other commodity aid; and population growth and economic development. The empirical study by Sandee (1969) involves formulation and testing of a programming model for a dual economy, leading to conclusions about marginal productivities of population and the virtues of austerity if food imports are nonexistent.

land mass of 923,768 square kilometers (about 355,000 square miles) stretching across the agroecological zones from the long coastal line along the Atlantic through the dense rain forest south (east and west) and through the extensive derived savannah “middle belt” area to the semi-arid and arid north. By casual observation there is probably no crop worth growing that is either not in existence cannot be adapted to grow somewhere in the country. The land endowment also includes the presence of special environmental niches such as the temperate high elevations at the Jos and Mambilla plateaus.

Moreover, the available water supply is massive, varying from marine resources of the Atlantic coast to the fresh water of the Niger and Benue Rivers that trisect the country conveniently, together with their dense networks of tributaries. By and large, the extreme south is a tree crop economy (cocoa, coffee, kola, timber and other forest products); the middle belt is a food crop economy including food grains and tubers, while the extreme north is known for the varied livestock population (cattle, sheep, goats and poultry). The country used to pride itself in mountainous “groundnut pyramids” and cocoa domes in export trade. In the heyday of Nigeria’s agriculture these commodities, as well as palm products and other items, represented the leading sources of foreign exchange, until the petroleum boom of the early 1970s.

The oil money created an immense urban boom, which attracted youth into towns in large numbers. The farming population probably did not decrease significantly, but the proportion of aged ones increased sharply. Gradually, the agricultural growth slumped both in its share of the primary export market and domestic availability of food or other agricultural products. Table 1 shows some relevant selected features about the country based on information from World Bank publications while Table 2 presents some arable crop production figures from information from the Federal Office of Statistics.

Intervention Policies

Initial progress in agriculture can be ascribed to natural endowments, in part including a huge human capital, and in part from the development policy of the British colonial government. It does not matter now what the implicit or explicit objectives of the colonial agricultural administration have been, generally criticized for being “surplus extraction” philosophy (Idachaba 1983), the relevant fact is that by the time of independence in 1960 the country's agricultural standing was firm. We used to speak of the “cocoa west,” “oil palm east,” and “groundnut north” at that time.

The administration of Nigerian agriculture that culminated in that status of the country began with the modest effort of the British to establish a Botanical Station at Ebute-Metta near

Lagos in 1893. This transformed into the first Forest Department in 1900, apparently to further strengthen the surplus extraction of forest products. The first truly Agriculture Department for the south was established at Moore Plantation in Ibadan in 1910, quickly followed by the one for the north at Samaru in Zaria in 1912. Both of them were merged together as one Agricultural Department in 1921, following the amalgamation of the north and the south in 1914. This one-department situation lasted until the 1950s, when a federal constitution empowered the separate regions (East, West and North) to establish their individual agriculture ministries that then rolled over to the independence (post-1960) era.

The series of adjustment policies for agriculture sponsored by the colonial department over time has laid the basic template for agricultural development of the country. Perhaps the most visible among these is the erstwhile market intervention board's policy initiated in 1945 as a deliberate attempt of the colonial agricultural administration to undertake the reconstruction of Britain's metropolitan economy after World War II through market reform in the colony. A number of such boards rolled over independence to become the back bones of the individual regional economies. They evolved, in three generations, across the eras (Idachaba and Ayoola 1991): (i) marketing boards with national mandate along specific commodity lines (1945-54); (ii) marketing boards with regional mandate along multiple-commodity lines (1954-76) and; (iii) commodity boards with national mandate along specific commodity lines (1977-86). The typical marketing or commodity board bought export produce at fixed prices after harvest and sold at a profit, but there was no export restitution. In the case of food commodities the board served only as a buyer of last resort, and at fixed prices, and held strategic or buffer stocks until they were scarce and then resold the commodities to the public. In this way farmers, were protected against drastic price declines after harvest and pronounced fluctuations of prices in the world market. At the same time consumers were protected against abnormal food price increases during a period of scarcity. However, the overall assessment of this policy is negative (Anthonio 1984, Akintomide 1971). The general consensus is that the price stabilization function was not performed well, mostly for political reasons, while the process for fixing the annual prices worked against competitiveness. Moreover, farmers have thrived on government loans for several years (Table 3). Therefore, all six or seven boards in existence were swiftly abolished in 1986 at the onset of a comprehensive Structural Adjustment Program (SAP).

Aside from the legacy of intervention board policies, the first post-independence decade (1960-70) featured a number of successive production support policies. In the earliest time, the old Western Region launched an integrated rural development program in the form of an extensive farm settlement scheme fashioned after the Israeli "moshav," to be copied quickly in

the Eastern Region. Subsequently, the federal government launched the National Accelerated Food Production Program (NAFPP). The key policy instruments employed by these early efforts included agricultural extension, modern inputs, and mechanization.

After the initial focus on the tree-crops sector in the south, the World Bank became important to Nigeria's agricultural development in the second post-independence decade (1970-80) with the policy of an "agricultural development project" (ADP). A typical ADP is a food production development investment jointly funded by the World Bank, through credit for meeting off-shore costs, with the federal government, and respective state governments. The first generation projects started in the north (Funtua, Gombe and Gusau) in 1974 as enclave types. Enclave projects expanded and matured into state-wide projects, while some of the states did not undertake the enclave projects before implementing state-wide projects. By 1985 all states were covered by state-wide projects, presently numbering 31 with the Federal Capital Territory, Abuja. The World Bank has also supported the livestock sub-sector considerably through a series of National Livestock Development loans.

An ADP has four or five years of investment life involving a multiple instruments policy, with special attention on improving the system of agricultural extension with the "training and visit" (T&V) system together with a revamped input delivery system and selective rural infrastructure. After more than two decades of ADP policy, associated with several million dollars in external capital infusion by the Bank, the projects have come of age while the debate about them now centers on sustainability issues.

Another major policy effort that took its root in the second independence decade is the River Basin Development Authorities (RBDA). Eleven of them were initially created to upgrade the utility of the vast available water bodies; the surface and sub-surface aquifers are meant for exploitation for irrigation services and associated services. Though the number of RBDAs grew to 19 during the second republic, this was later reversed to the original 11 consistent with reform measures in the latter part of the 1980s. That same reform program established the National Directorate of Food, Roads and Rural Infrastructure (DFRRI), conceived as a catalyst for accelerating the pace of agricultural development under the SAP. By and large, the SAP has sufficiently deregulated and decontrolled the overall economy through eliminating rigid trade controls, establishing a foreign exchange market, and privatizing and commercializing of parastatals.

Nevertheless, one notorious policy survives the process of reform for upgrading the competitiveness of the agricultural sector, and that is fertilizer policy. Nigeria is both a huge producer and a huge exporter of fertilizers, with the largest nitrogen plant on the continent and a

number of bulk blending plants; but that is not the real policy problem. The real policy problem is that government is historically the sole buyer of the products from these firms and also the only supplier to the millions of farmers. There is a bewildering size of state organization for procurement and distribution of fertilizer in the country featuring an immeasurable degree of enterprise inefficiency and massive leakages. The contemporaneous monopoly-monopsony role in the same body as in Nigeria is a rare phenomenon that is not consistent with any known market economy theory to date. It manifests itself in many symptoms, the high transaction costs for farmers from the inevitable black marketeering, a flourishing cross-boarder trade through smuggling, and the presence of several categories of unintended beneficiaries of policy advantages in the society.

Discernible Embrace Points

This account gives the background required for substantiating the deathly embrace theory of developing agriculture in Nigerian. The main question for policy is: why, after one century and more of deliberate development efforts through food and agricultural policy intervention, does a developing country agriculture, such as Nigeria's, remain a poor performer? The general evidence of poor performance is in the changes observed in the status of agriculture over time in the presence of the government's policies. We have moved step-wise from a country that used to be a net exporter of agricultural products (e.g., second to Ghana in world supply of cocoa; first in world supply of palm products; and leading in the world supply of several others) to one that soon became a net importer of food grains, meat and meat products, and frozen fish. An earlier analysis has shown that the degree of food dependency of Nigeria on food grains from the United States, wheat specifically, now surpass acceptable regimes of food security concerns.

Such concerns became important issues in the early 1980s when petroleum prices slumped on the world market. Consequently, Nigeria could no longer settle its import bill commitments. As a result, essential commodities, including rice and other food items, were being rationed to the public.

First is the evidence of embrace in terms of structure, which is quite substantial. On the one hand, by way of number, size and completeness the market for producing primary commodities for use in industry as raw materials falls out of line with the market for utilizing agricultural raw materials in the industry. As a result, there is a large excess capacity in the agricultural sector that leads to immense waste of farm outputs. On the other hand, the market for producing industrial commodities as inputs in agricultural production falls short of the capacity required to meet the demand for such items in agriculture. This condition illustrates the

failure on both sides of the market structure to satisfy reciprocal needs of both sectors. Thus an embrace needs to be addressed through policy instruments that will improve the structural relationship between agriculture and industry. Take the case of technology policy for agricultural development in Nigeria, in which several product and process technologies built up through the ADP system are held in storage, waiting for the industry to produce them on a large scale to meet the needs of farmers. As a result, less appropriate technologies are imported, but these fail to produce the desired productivity increases. This situation may not lead to the realization of the comparative advantage in the country. As a consequence, the world economy may be worse off.

Second is the evidence of defects in terms of conduct of the link system. The conduct of the joint market system for agriculture and industry leaves very much to be desired owing to (i) the inherent barriers to free domestic and international trade; (ii) the nonparticipation of the farm producers in the policy process; and (iii) the dominant role of government in enterprise activities of the agricultural sector. The barriers to trade include tariff and nontariff types, which were only alleviated under the SAP introduced in 1986 but not eliminated. Hitherto the presence of import licensing and fixed exchange rate represented implicit barriers to external trade. Even with SAP in progress, to date some of the liberalization policies have suffered significant reversals from time to time; the banning and unbanning of grain imports and exports of cassava, as well as a temporary ban of raw cocoa beans, illustrates the policy instability during the SAP period. On the domestic front, the agriculture market is replete with instances of restrictions to commodity flows. In some instances certain state and local governments have consciously inserted a wedge into the path of commodity movements, such as levying in-state taxes on food items moving across the states or physically blocking vehicles carrying these items. At one time, the Kaduna state government officially prevented the outward flow of grain in reaction to a temporary shortage. The reciprocal effects of bad trade policies on both sectors cannot be wished because they create critical avenues for system embrace. To remove or at least reduce the strength of such an embrace requires policies that improve upon the conduct of both sectors simultaneously. Particular mention should be made of the fertilizer policy that presently holds development down through manifest inefficiency and its dampening effect on the growth of private initiatives for enterprise in fertilizer manufacture and trade.

Third is evidence of embrace due to poor performance of the sectors in a lopsided rewards system. Specifically, the income generating capacity of industry by far outweighs that of agriculture both at the micro and macro levels. But the rural or farming community frequently undertakes an implicit evaluation of farm incomes in relation to off-farm incomes, meaning that

there is a tendency for both income levels to be integrated somewhat through labor supply mechanisms. The wide disparity between them at any time will lead to movement of labor away from the sector with low income to that with higher income and the gradient or speed of that movement is governed by the presence of effective policies for establishing an equilibrium. My observation of U.S. agriculture policy is to the effect that much of the prosperity of the sector has probably resulted from sustained policy for integrating agricultural income with industrial income; there have been several ways since the early 1930s that farm incomes have been upgraded to parity with industry incomes. In Nigeria, such a policy environment does not exist implying that the labor markets are weakly integrated and development is largely in one direction—towards industry. The fundamental difference between the two policy environments is that the government of Nigeria, through the commodity boards, has entered into the market fully to perform actual market operations meant for the private sector. The United States has consistently applied this income policy through production controls without performing such direct market functions as buying and selling of agricultural produce in the market. Even when the price stabilization policy was eliminated in Nigeria through abolition of the commodity boards, the environment was not right because of the total absence of any particular instruments for integrating sectoral income levels. The absence of a definite income policy presently represents a huge void in the Nigerian agricultural economy. Consequently, there is no basis for the reciprocal benefits of development in both sectors to accrue to each other.

Finally, there is a need for an overall policy to achieve equitable distribution of income between the sectors. The observation about Nigeria is to the effect that the mechanisms for channeling income across the sectors is somewhat asymmetrical. It would appear that the initial boom of agriculture has permitted the flow of farm income to industry for development purposes more than the industry has permitted to happen in reverse. The use of marketing board surpluses and farm produce taxes for development of nonagriculture was actively debated in Nigeria as one aspect of the criticism levied against market intervention policy. That debate has created some sentiments in favor of agriculture where income has been derived or extracted to develop the industry. But that has not been the case in proportionate terms during the industry boom. The observation that the period of the immense oil boom, together with the associated foreign exchange build-up, coincides with the period of the heaviest external borrowing for agricultural development suggests that the reverse flow of industry wealth into agriculture is relatively slow. One case is the huge financial reserve generated from the proceeds of the price and quantity advantages that accrued to the country through petroleum sales during the Gulf war that could have a great impact if they had been diverted into agricultural development. Also a special

“petroleum trust fund” has been created recently from the proceeds of government, resulting from the official pump price increase, but not enough to being allocated to agriculture.

The foregoing observations of the Nigerian agricultural economy over time lead to one important conclusion for policy analysis: unless we conceive of the individual fortunes of agriculture and industry within a joint analytical or theoretic framework, we may perpetuate the sluggish growth of both sectors by taking development of one sector as given while attention is being focused on the other sector. The close link between the sectors needs be actively explored in the development process. The incremental contribution of a deathly embrace theory is that it provides a suitable framework to explore this link as applied to developing countries in an integrated analytical setting, thereby keeping the overall policy process more sharply focused.

Conclusions

The review of agricultural policy in developing countries suggests the absence of a common theoretic framework for the analysis, an unacceptable situation for effective guidance of the authorities responsible for managing the economy to make definite interventions. The evidence from Nigeria supports the notion of the dual economy with the sectors in constant embrace. The modeling and control of the interrelationship between agriculture and industry to illuminate the nature and mechanisms of the embrace is a way to provide the required framework for the analysis within the context of a consistent theory of policy intervention.

The theoretical proposition is in terms of the agricultural and industrial sectors as parts of the economic system, waiting for the other to reciprocate thereby leading the system to stagnate. Recall the several hypotheses put forward in this respect: structure, conduct, and performance dimensions. Also, the A-I system has been modeled in terms of competition of both parts for resource use in a single national market configuration with the reciprocal inputs and outputs specified as well as the elements for capturing the technology and government factors. Subsequently, the optimal control problem is addressed using a stylized Calculus of Variations model.

Within this theoretic framework we would be able to investigate the joint fortune of agriculture and industry and provide more effective policy guidance toward their mutual growth. Finally, focusing on the notion of deathly embrace of sectors helps to extend the frontier of knowledge about the probable explanations of the perennial failure of intervention policies for developing agricultural economies of the world.

References

- Akintomide, M. A., "Comparative Analysis of the Marketing Boards System and Other Arrangements for Commodity Markets," international Conference on the Marketing Board System, Nigerian Institute for social and Economic Research. Ibadan, 29 March-3 April 1971.
- Antonio, Q.B.O., "Marketing Development in Nigeria: A Review of Relevant Government Policies," in J. P. Feldman and F. S. Idachaba (eds) *Crop Marketing and Input Distribution in Nigeria*, Ibadan Federal Agricultural Coordinating Unit, December 1984.
- Ayoola, G. B., "Control of Agricultural Production Systems," *Modelling, Simulation and Control*, C. AMSE Press, Vol. 27, No. 1, 1991, pp. 15-29.
- Bachmura, "Migration and Factor Adjustment in Lower Mississippi Valley Agriculture: 1940-50," *Journal of Farm Economics* 38: 1024-42, November 1956.
- Byant, W. Keith, "Causes of Inter-Country Variations in Farmers' Earnings," *Journal of Farm Economics* 48, pp. 557-577, August 1966.
- Fei, John, C. H. and Gustav Ranis, "Agriculture in the Open Economy," in Erik Thorbecke, ed., *The Role of Agriculture in Economic Development*. Columbia University Press, 1969.
- Fox, Karl A., "Toward a Policy Model of World Economic Development with Special Attention to the Agricultural Sector," in Erik Thorbecke, ed. *The Role of Agriculture in Economic Development*. Columbia University Press. 1969.
- Fox, Karl A. and Harry C. Norcross (1952), "Some Relationships Between Agriculture and the General Economy," in Stanley R. Johnson, Jati K. Sengupta and Erik Thorbecke, ed., *Demand Analysis, Econometrics, and Policy Models*, Iowa State University Press, Ames, 1992.
- Haessel, Walter Werner, *A Theoretical Analysis of Intersectoral Relationships in a Five-Sector, Optimizing Model of a Inert Economy*. Ph.D. thesis, Department of Economics, Iowa State University. 1970.
- Idachaba, F. S. and G. B. Ayoola, "Market Intervention Policy in Nigerian Agriculture: An Ex-post Evaluation of the Technical Committee on Produce Prices," *Development Policy Review*, Vol. 9 (1991), 285-299.
- Idachaba, F. S., "Self Reliance as a Strategy for Nigerian Agriculture." Proceedings of the Nigerian Economic Society Conference 1994.
- Intrilligator, M. D., *Mathematical Optimization and Economic Theory*, Prentice Hall, Inc., 1971.
- Johnson, Harry G., *The Two-Sector Model of General Equilibrium*, Chicago: Aldine.
- Johnson, S. R. and S. A. Martin, eds., *Industrial Policy for Agriculture in the Global Economy*, Iowa State University Press, 1993.
- Kendrick, D. A. and L. Taylor, "Numerical Methods and Nonlinear Optimization Models for Economic Planning," in Chenery ed., *Studies in Development Planning*. Harvard University Press, 1971.
- Kilkenny, Maureen, (undated), "Transport Costs and Rural Development," JEL Classification Codes: R12, D58.
- Lewis, W. Arthur, *The Theory of Economic Growth*, (London: George Allen and Unwin, Ltd., 1955.)

- Nicholls, William H., "The Transformation of Agriculture in a Presently Semi-Industrialized Country," in Erik Thorbecke, ed., *The Role of Agriculture in Economic Development*, Columbia University Press, 1969.
- Nicholls, William H., "Industrialization, Factor Markets, and Agricultural Development," *Journal of Political Economy* 69: 319-340, August 1961.
- Ruttan, Vernon W., "Growth Stage Theories, Dual Economy Models and Agricultural Development Policy," University of Guelph, Department of Ag Economics, Pub No. AE 196812 (1968).
- Ruttan, Vernon W., "Two Sector Models and Development Policy," in Wharton, Clifton R., Jr., ed., *Subsistence Agriculture and Economic Development*, Chicago: Aldine Publishing Co., 1969, pp. 353-360.
- Ruttan, V. W., "the Impact of Urban-Industrial Development on Agriculture in the Tennessee Valley and the Southeast," *Journal of Farm Economics* 37:38-56, February 1955.
- Sandee, Jan, "A Programming Model for a Dual Economy," in Erik Thorbecke, ed., *The Role of Agriculture in Economic Development*. Columbia University Press, 1969, pp. ____.
- Schultz, Theodore W., "The Economic Organization of Agriculture", New York, 1953.
- Schultz, Theodore W., *Transforming Traditional Agriculture*, (New Haven: Yale University Press, 1964.)
- Sinclair, Lewis S., "Urbanization and the Incomes of Farm and Nonfarm Families in the South," *Journal of Farm Economics*, 39:510-516, May 1957.
- Sisler, D. G., "Regional Differences in the Impact of Urban-Industrial Development on Farm and Nonfarm Income," *Journal of Farm Economics*, 41:1100-13, December 1959.
- Tang, A. M., "Economic Development in South Piedmont, 1860-1950," Chapel Hill, 1959.
- Thorbecke, Erik and Alfred J. Field, "Relationships Between Agriculture, Nonagriculture, and Foreign Trade in the Development of Argentina and Peru," in Erik Thorbecke, ed., *The role of Agriculture in Economic Development*. Columbia University Press, 1969,

Table 1: Nigeria - Selected features of the Agricultural Economy for sample years.

	1965	1980/81	1990	1993/94	Notes
Land area					
- Total (1000 sq km)	924	924	924	924	
- Crop land (%)	-	33	-	36	
- Permanent pasture (5)	-	44	-	44	
- Forest (sq. km)	-	-	156	-	
- Other	-	23	-	21	
Population					
- Total (mill.)	-	87.6	115.5	108	1994 estimate based on different (1991) census figure.
- Agriculture (%)	-	54	43	-	
- Industry (%)	-	8	7	-	
DGP Distribution:					
- Ranking	17	54	17	19	Ranking by GDP per capita from lowest to highest among the countries of the world
- Total DGP (MM \$), of which:	5380	93,082	34,760	35,200	
* Agriculture (%)	55	27	36	43	
* Industry (%)	12	40	38	32	
* Manufacturing (%)	5	8	7	7	
* Services (%)	33	32	25	25	
DGP Growth (%)					
- Total	-	6.9 ^a	1.6 ^b	2.4 ^c	Average annual growth. ^a over the past 15 yrs; ^b over the past 10 yrs; ^c over the past 5 yrs.
- Agriculture	-	1.7 ^a	3.3 ^b	2.2 ^c	
- Industry	-	13.1 ^a	1.0 ^b	0.3 ^c	
- Manufacturing	-	14.6 ^a	-	-	
- Services	-	-	2.8 ^b	4.5 ^c	

Source: World Bank, *World Development Report*, Various issues.

Table 2: Nigeria: Agricultural Production, 1993/94, Selected commodities.

	Quantity	%
Grain Crops (000 tonnes):	14,816	100.0
Maize (corn)	4,505	30.4
Rice	1,303	8.8
Millet	3,595	24.3
Guinea corn (sorghum)	5,413	36.5
Legumes (000 tonnes)	3,954	100.0
Beans	1,946	49.2
Groundnut	2,008	50.8
Root/Tuber (000 tonnes):	35,177	100.0
Yam	15,861	45.1
Cassava	17,261	49.1
Cocogam	2,100	5.9
Others (000 tonnes)	753	100.0
Melon	490	65.1
Cotton	263	34.9

Source: Federal Office of Statistics, *Facts and Figures about Nigeria*, Lagos, 1995.

Table 3: Indebtedness of Commodity Boards to the Central Bank of Nigeria as at 30 November 1986 (Naira million).

Board	Total loan granted 1976-86	Total loan plus accrued interest	Payments, i.e., sales proceeds plus refund	Outstanding balance
Cocoa Board	2233.9	2275.9	2275.9	0
Palm Produce Board	662.2	853.9	325.1	528.8
Cotton Board	359.7	449.7	289.3	160.4
Rubber Board	257.9	309.4	154.5	154.9
Grains Board	184.0	212.5	58.1	154.4
Groundnut Board	42.2	53.4	38.2	15.2
Total	3739.5	4154.8	3141.8	1013.7

Source: Idachaba and Ayoola (1991).