DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS
DIVISION OF AGRICULTURE AND NATURAL RESOURCES
UNIVERSITY OF CALIFORNIA AT BERKELEY

WORKING PAPER NO. 814

THE ROLE OF AGRICULTURE IN ECONOMIC DEVELOPMENT: VISIBLE AND INVISIBLE SURPLUS TRANSFERS

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GIANNINI FOUNDATION OF AGRICULTURAL ECONOMICS
APRIL, 1997

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Abstract

The financial surplus of agriculture has been central to theories of the role of agriculture in economic development. Morrisson and Thorbecke (MT) have used a constant-price social accounting matrix (SAM) framework to rigorously measure the financial surplus of agriculture and decompose the mechanisms of surplus extraction. History and theory have, however, stressed the role of prices as an invisible transfer mechanism in addition to the visible transfers identified in the SAM framework. We extend the MT approach by defining and measuring the real surplus of agriculture and decomposing the mechanisms of surplus extraction between visible and invisible financial transfers. Using an archetype computable general equilibrium model for poor African nations, we trace the generation, transfer, and use of an agricultural surplus created by a productivity gain in agriculture. This shows that prices indeed play an overwhelmingly important role in transferring a surplus from agriculture to the benefit of the rest of the economy.

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I. Role of an agricultural resource surplus for industrial development

Characterizing the role of agriculture in economic development and identifying ways in which this role can be enhanced have been classical themes in development economics (Mellor, 1966 and 1986). More specifically, for countries that want to industrialize, agriculture is commonly the main source of resources that can be captured for investment in the emerging activities. Hence, successful industrialization requires a solution to the problems associated with the generation, transfer, and use of an agricultural resource surplus. Generation of a growing surplus demands a rising productivity of resource use in agriculture. This is achieved by successful agricultural and rural development, most particularly through total factor productivity enhancing technological and institutional changes (Hayami and Ruttan, 1985). In physical terms, the net quantity of resources transferred includes goods (consumer goods, intermediate inputs, and investment goods) and primary factors (labor and capital services). To this net surplus of products and factors correspond compensatory financial flows into agriculture that constitute the net savings of agriculture. These net savings can be accrued either in domestic currency, constituting the domestic agricultural surplus, or in foreign currency, constituting the foreign agricultural surplus. These net savings can in turn be extracted from agriculture through a variety of visible and invisible transfer mechanisms. Visible transfers include taxes, payment of rents to urban landlords, voluntary transfers from agricultural to non-agricultural households, savings of agriculture invested in non-agriculture, and net transfer of the balance of current accounts of agriculture. Invisible transfers occur through the terms of trade for agriculture. Deterioration of the terms of trade against agriculture can be the result of successful diffusion of agricultural innovations in front of an inelastic demand, inducing the famous "agricultural treadmill" of falling costs, rising aggregate supply, falling prices, and further inducement to seek cost reducing new technological and institutional options (Owen, 1966). Direct invisible transfers can also occur through government intervention using price controls, export taxes, and import subsidies. Indirect invisible transfers occur through overvalued or appreciated real exchange rates which depress the domestic price of tradable agricultural goods (Krueger, Valdés, and Schiff, 1988). Prices have thus been a major, if not the major, instrument of surplus extraction from agriculture. And, with one instrument serving more than one function, there is a difficult balance to be stricken between incentive and extraction effects in using policy interventions to influence the terms of trade for agriculture. As Kuznets put it in his classical study of the role of agriculture: "One of the crucial problems of modern economic growth is how to extract from the product of agriculture a surplus for the financing of capital formation necessary for industrial growth without at the same time blighting the growth of agriculture" (Kuznets, 1964). Finally, successful industrialization requires efficient use of the surplus transferred. Availability to industry of a surplus of agricultural resources effectively transferred is only a necessary condition, not a sufficient one. Industrialization strategies that make effective use of this surplus still have to be devised and implemented, and this has occurred highly unevenly across countries, with many countries taxing their agricultures of a surplus without industrializing successfully for that matter.

In spite of this fundamental importance of the role of an agricultural surplus for industrialization, the very concept of agricultural surplus has remained ill defined and rarely quantified. This has prevented, among other things, a more systematic comparative analysis of how this surplus can be generated, extracted, and used for industrialization. In a recent article, Morrisson and Thorbecke (1990) used the framework of a country's social accounting matrix (SAM) to propose a rigorous definition and quantification of the domestic and foreign agricultural surplus. Their methodology allows establishment of a clear correspondence between net intersectoral quantity transfers between agriculture and the rest of the economy, the domestic and foreign net savings of agriculture, and the patterns of transfer of these savings. However, because SAMs are fixed price accounting schemes, this approach cannot account for the role of prices as instruments of surplus extraction, even though we know from historical experience that invisible transfers have been far larger than direct transfers, at least in market economies.

In this paper, we remedy this deficiency by proposing a rigorous measure of the agricultural surplus and its visible and invisible components in the context of SAM-based computable general equilibrium (CGE) modeling. This allows us to extend the Morrisson-Thorbecke analysis in two directions: one is to track changes in the agricultural surplus associated with particular sources of growth or policy interventions; the other is to measure not only visible but also invisible transfers and thus to assess the relative importance of these two mechanisms. This is illustrated using a SAM and a CGE to identify the impact of a productivity gain in agriculture on the agricultural surplus in an archetype net food-importing African country.

II. The role of an agricultural surplus for industrialization in history and theory

Throughout the literature on the role of agriculture in economic development, three themes dominate: (1) the determinants of generation of an agricultural surplus through productivity enhancing innovations and investments; (2) the mechanisms of extraction of this surplus through visible and invisible transfers; and (3) the use of this surplus for industrial development, particularly to increase public investment in support of industry if the transfer is via tax and to lower nominal wages in industry if the transfer is via price. The Physiocrats thus argued that the size and disposition of an agricultural surplus were key to the state of public finances and the level of economic activity. In 1767, at the dawn of the industrial revolution in England, John Steuart Mill argued that it is the productivity of the farmer that limits the size of the industrial sector. Historians of the industrial revolution have observed the recurrence of a sequence whereby agricultural revolutions predated successful industrial revolutions by long lags of some fifty to sixty years. Thus Toynbee (1884) described how technical and institutional change in agriculture helped lower the price of food for industry and cheapen labor for industrial employment in eighteenth century England. This virtuous sequence was repeated as the industrial revolution spread to France in the 1820s, Germany in the 1850s, and the United States in the 1860s (Bairoch, 1973). In Japan, previous productivity gains in agriculture were essential to support a heavy land tax that was invested by the Meiji state in the 1880s in forced pace industrialization (Ohkawa and Rosovsky, 1964). Following a lull in successful industrialization after the 1880s, emergence of the newly industrialized countries (NICs) in the 1950s further confirmed this pattern. As described by analysts of the role of agriculture such as Lee and Chen (1979), Ban (1979), Johnston and Kilby (1975), and Timmer (1988), high productivity growth in agriculture was fundamental in generating an agricultural surplus in Taiwan and South Korea that could be taxed to finance industry and helped lower the price of food and cheapen nominal wages for industrial employment. Achievements of the Green Revolution in the mid-1960s helped support import substitution industrialization in India (Ahluwalia, 1991). By contraposition, difficulties to industrialize in Africa have been associated to failure of the Green Revolution to take root on most of that continent (Mellor, 1986).

It is clear that prices have played an important role in extracting a surplus from agriculture, either in response to market forces or in response to government interventions. On the world market, there has been a secular decline in the price of agricultural goods relative to other goods of 0.5 to 0.7 percent a year since 1900, implying that the relative price for agriculture has been halved since the beginning of the century (Mundlak, 1990). At the national level, extraction of the benefits of technological change through falling prices has been analyzed in a partial equilibrium framework by Pinstrup-Andersen, Ruiz de Londoño, and Hoover (1976), in multimarkets by Quizon and Binswanger (1986), and in CGEs by Adelman and Robinson (1978). Schuh (1974) stressed the role of an overvalued exchange rate as a mechanism of surplus extraction from agriculture, transferring to consumers the benefits from technological change. Many governments have tried to manipulate prices to accelerate surplus extraction, either directly through trade policy interventions or indirectly through overvalued exchange rates. Ample empirical evidence on this bias against agriculture has been provided by Krueger, Valdés, and Schiff (1988).

Using history as a source of evidence, growth theorists have attempted to formalize the mechanisms through which an agricultural surplus plays a role in industrialization. In his classical model of the dual economy, Lewis (1955) established a link between cheap surplus labor in agriculture and the level of industrial wages through the operation of the labor market. Low nominal wages in industry in turn induce high rates of investment and growth. Assuming, by contrast, full employment, Jorgenson (1961) showed that the possibility of extracting labor from agriculture for industrial employment without putting upward pressure on the price of food and raising nominal wages for industry required technological change in agriculture to raise the productivity of labor in that sector. These two features of industrialization in the less developed economy -- surplus labor and a role for technological change in agriculture -- were brought together in dual economy models developed by Fei and Ranis (1964) and Lele and Mellor (1981). In the first model, with surplus labor in agriculture and constant real wages in that sector, nominal wages for industry can be lowered by technological change in agriculture that reduces the price of food. In the second model, surplus labor and a constant real wage apply to the urban informal sector while there is full employment in agriculture. Again, technological change in agriculture helps lower the price of food and the nominal wage for industrial employment. Other aspects of the role of agriculture -- beyond cheap food, low nominal wages for industry, and the transfer of domestic agricultural savings -- have been used to formulate industrial growth models. de Janvry and Sadoulet (1989) show how the growth of agriculture can constrain industrial growth in a two-gaps model if agricultural exports are the main source of foreign exchange and industry uses intermediate and capital goods with an import component.

III. Measurement of the agricultural surplus

3.1. A social accounting matrix framework

In defining the agricultural surplus, Morrisson and Thorbecke begin with a general SAM in which all accounts, with the exception of government, are separated into agriculture (indexed *a*) and non-agriculture (indexed *n*). This disaggregation allows an explicit representation of the flows between these two sectors for a given period of time. Since the SAM only represents the present, future flows, such as returns on savings, are not incorporated. Following this methodology, Table 1 presents the general structure of a SAM. Creating such a SAM requires a clear definition of agriculture and non-agriculture. For activities this is straightforward since agricultural commodities are easily identified. Institutional distinction between agriculture and non-agriculture is more difficult since households/firms are likely to be involved in a combination of both activities. In the archetype SAM, rural households and firms receive most of their income from agriculture and urban households and firms from non-agriculture. The institutional distinction between agriculture and non-agriculture is then synonymous with rural and urban. Correspondingly, factors owned by rural households are considered agricultural and similarly for non-agriculture. Agricultural (rural) labor and capital may receive wages from nonagricultural activities (VL_{an} and VK_{an}), but by definition the distribution of returns all go to agricultural (rural) institutions (L_{aa} and K_{aa}). The rest of the world (ROW) accounts (indexed *r*) are divided into agriculture and non-agriculture according to the corresponding account. For example, agricultural exports, E_{ar} , are under the agricultural ROW account and industrial imports, X_{rn} , are in the non-agricultural ROW account. In the SAM used in this study, agricultural exports are significantly larger than imports, and correspondingly, non-agricultural imports are larger than exports. For the ROW accounts to balance, a transfer of foreign exchange from ROW non-agriculture to ROW agriculture must occur. This is measured by the term TF_{an} .

By definition, total income (row) and total expenditure (column) for each account of the SAM must equate. With the government sector indexed *g*, the identities that concern the agricultural sector in the SAM presented in Table 1 are the following:

Agricultural activities

$$X_{aa} + X_{an} + C_{aa} + C_{an} + I_{aa} + C_{ag} + E_{ar} = X_{aa} + X_{na} + VL_{aa} + VL_{na} + VK_{aa} + VK_{na} + TI_{ga} + X_{ra}. \quad (1)$$

Agricultural labor

$$VL_{aa} + VL_{an} = L_{aa}. \quad (2)$$

Agricultural capital

$$VK_{aa} + VK_{an} = K_{aa} + K_{ra}. \quad (3)$$

Agricultural households/firms

$$L_{aa} + K_{aa} + TR_{aa} + TR_{an} + TR_{ag} + TR_{ar} = C_{aa} + C_{na} + TR_{aa} + TR_{na} + S_{aa} + S_{na} + TD_{ga} + C_{ra}. \quad (4)$$

Agricultural investment/savings

$$S_{aa} + S_{an} + S_{ag} + S_{ar} = I_{aa} + I_{na} + I_{ra}. \quad (5)$$

Rest of the World, Agriculture

$$X_{ra} + K_{ra} + C_{ra} + I_{ra} + TF_{an} = E_{ar} + TR_{ar} + S_{ar}. \quad (6)$$

Following the methodology in Morrisson and Thorbecke, we can add these equations to get the following identity:

$$\left(X_{an} + C_{an} + C_{ag}\right) - \left(X_{na} + C_{na} + I_{na}\right) + \left(VL_{an} + VK_{an}\right) - \left(VL_{na} + VK_{na}\right) = \left(TR_{na} - TR_{an}\right) + \left(S_{na} - S_{an}\right) + \left[\left(TD_{ga} + TI_{ga}\right) - \left(TR_{ag} + S_{ag}\right)\right] - TF_{an}. \quad (7)$$

The left-hand side of equation (7) is the value of the net surplus of products and factors from agriculture to non-agriculture, while the right-hand side represents the compensatory monetary and capital flows.

The domestic agricultural surplus, SU_d, can then be defined as the monetary value of the net surplus of products and factors which flow from agriculture to non-agriculture:

$$SU_d = \left(G_{an} - G_{na}\right) + \left(F_{an} - F_{na}\right) \quad (8)$$

where:

$G_{an} = X_{an} + C_{an} + C_{ag}$, $G_{na} = X_{na} + C_{na} + I_{na}$, and $G_{an} - G_{na}$ is the net flow of consumer goods, intermediate inputs, and investment goods from agriculture to non-agriculture, and
$F_{an} = VL_{an} + VK_{an}$, $F_{na} = VL_{na} + VK_{na}$, and $F_{an} - F_{na}$ is the net flow of primary factors of production from agriculture to non-agriculture.

Using the right-hand side of equation (7), the domestic agricultural surplus can also be written in terms of the financial mechanisms of surplus extraction from agriculture as:

$$SU_d = C_d + D_d + E_d - TF_{an}$$

where:

$C_d = TR_{na} - TR_{an}$ is the net private monetary transfers from agricultural to non-agricultural households/firms;

$D_d = S_{na} - S_{an}$ is the net savings from agriculture directed to non-agriculture;

$E_d = \left(TD_{ga} + TI_{ga}\right) - \left(TR_{ag} + S_{ag}\right)$ is the net monetary transfer from agriculture to the government extracted through direct and indirect taxes, net of government monetary transfers to agricultural households and of the government surplus on current account vis-a-vis agriculture which is available to agriculture for investment; and

TF_{an} is the transfer of foreign exchange from ROW non-agriculture to ROW agriculture, which corresponds to the foreign exchange surplus of the domestic agricultural sector.

Corresponding to the domestic agricultural surplus, there is an external or foreign agricultural surplus, SU_f, defined as the monetary value of the net export surplus of agriculture:

$$SU_f = E_{ar} - M_{ra}, \qquad (9)$$

where:

$$M_{ra} = C_{ra} + X_{ra} + K_{ra} + I_{ra}.$$

This surplus generates an equivalent foreign savings available to agriculture.

Using identity (6), the foreign agricultural surplus can also be written in terms of the financial instruments that are used to extract this surplus from agriculture as:

$$SU_f = -TR_{ar} - S_{ar} + TF_{an}, \qquad (10)$$

where

TR_{ar} is the private remittances from ROW to agricultural households/firms, and

S_{ar} is the deficit on the current account of the balance of payments of the agricultural sector to the ROW.

Total agricultural surplus, SU_T, in the SAM framework is the sum of the domestic and foreign components,

$$SU_T = SU_d + SU_f = \left(G_{an} - G_{na}\right) + \left(F_{an} - F_{na}\right) + \left(E_{ar} - M_{ra}\right).[1] \qquad (11)$$

Given this definition, the agricultural surplus may be calculated from a SAM for the particular period represented. In their 1990 paper, Morrisson and Thorbecke thus made three important contributions to the analysis of the agricultural surplus: (1) they showed rigorously how the net savings of agriculture, or the "financial surplus of agriculture", is the counterpart image of the net physical flows of goods and services from agriculture to non-agriculture; (2) they identified the mechanisms of extraction of this

[1] Recognizing that government and foreign transfers to the agricultural sector often occur through freely provided goods and services, two additional terms representing these transfers could be included in the calculation of agricultural surplus (see Morrisson and Thorbecke). In the next section, changes in agricultural surplus are examined when the economy changes due to productivity growth in agriculture. As the economy changes, these transfers drop out of the calculation of agricultural surplus since there is no justification for changing their values. They are therefore not included in this analysis.

financial surplus to the benefit of the non-agricultural sector; and (3) they gave us a rigorous accounting framework, based on a country's SAM, to identify and measure each of these flows.

3.2. Surplus transfers via prices

A SAM is a static accounting framework where prices are fixed. We know from history and theory that the most powerful mechanism of extraction of a financial surplus from agriculture in market economies is via prices, the source of invisible transfers. In accounting for the contributions of agriculture, we would consequently like to distinguish between visible financial transfers and invisible transfers via price effects. In the SAM, the visible financial transfers are readily identifiable, but price effects are absent. To distinguish visible from invisible contributions, a time dimension is required, with accompanying financial flow and price effects as values in the SAM change. This allows to distinguish between the real agricultural surplus and the financial agricultural surplus. The change in the real agricultural surplus is defined as the change in the physical flows at a given price. The change in financial surplus (*SU*), defined as the compensatory monetary flows, combines financial flows and price changes. In what follows, we show how this can be done.

Consider a SAM in an initial period 0 and a SAM for the same economy after an exogenous change in the following period 1. In each period, the agricultural surplus can be measured following the equations defined previously. The change in total monetary flows between the two periods, ΔSU_T, can then be calculated as:

$$\Delta SU_T = SU_{T1} - SU_{T0}, \tag{12}$$

where:

SU_{T1} is the total agricultural surplus in period 1, and
SU_{T0} is the total agricultural surplus in period 0.

Using equations (11) and (12), we can derive the following:

$$\Delta SU_T = \Delta SU_d + \Delta SU_f = \Delta(G_{an} - G_{na}) + \Delta(F_{an} - F_{na}) + \Delta(E_{ar} - M_{ra}), \tag{13}$$

where Δ corresponds to a change in that variable between periods 1 and 0.

Since social accounting matrices are monetary flows, each component of the change in agricultural financial surplus represents a value. These values, in the right-hand side of equation (13), correspond to both prices and quantities that can be separated. Let V_i represent the *i-th* of the *N* elements that make up the decomposition of total financial surplus. The value of V_i is positive if it represents a flow from agriculture to non-agriculture and negative if it is a flow from non-agriculture to agriculture. The change in financial surplus can be calculated as:

$$\Delta SU_T = \sum_{i=1}^{N} \Delta V_i = \sum_{i=1}^{N} (V_{i1} - V_{i0}) . \tag{14}$$

Let p_i and V_i^* represent the corresponding price and volume breakdown for element V_i.[2] The change in agricultural surplus for the SAM can then be expressed as:

[2] The volume

$$\Delta SU_T = \sum_{i=1}^{N} \left(p_{i1} V_{i1}^* - p_{i0} V_{i0}^* \right). \tag{15}$$

Using equation (15), price and quantity effects can be separated as follows:

$$\Delta SU_T = \sum_{i=1}^{N} \left(p_{i0} \Delta V_i^* + V_{i0}^* \Delta p_i + \Delta p_i \Delta V_i^* \right). \tag{16}$$

The change in total financial surplus is equal to the sum of quantity effects, price effects, and the interaction between quantity and price effects. Since this last term is relatively small, it can be aggregated with the price effect to get the following:

$$\Delta SU_T = \sum_{i=1}^{N} p_{i0} \Delta V_i^* + \sum_{i=1}^{N} \Delta p_i V_{i1}^*, \tag{17}$$

where the first term on the right-hand side is the fixed price real surplus effect and the second term is the price effect. From equation (17), the change in real agricultural surplus can thus be decomposed in a change in monetary flows extracted through private remittances, savings, taxes, and foreign exchange contributions, i.e., the visible transfers measured through the SAM, and surplus extraction through changes in prices, the invisible transfers, as follows:

$$\Delta \text{ real agricultural surplus} = \sum_{i=1}^{N} p_{i0} \Delta V_i^* = \Delta SU_T - \sum_{i=1}^{N} \Delta p_i V_{i1}^*. \tag{18}$$

Applying this decomposition to the concepts of agricultural surplus derived from the SAM in equation (11) gives:

$$\begin{aligned} & p_{a0} \Delta G_{an}^* - p_{n0} \Delta G_{na}^* + w_{a0} \Delta VL_{an}^* - w_{n0} \Delta VL_{na}^* + r_{a0} \Delta VK_{an}^* - r_{n0} \Delta VK_{na}^* + e_0 \left(\Delta E_{ar}^* - \Delta M_{ra}^* \right) \\ &= \Delta SU_d + \Delta SU_f - \Delta p_a G_{an1} + \Delta p_n G_{na1} - \Delta w_a VL_{an1} + \Delta w_n VL_{na1} - \Delta r_a VK_{an1} + \Delta r_n VK_{na1} + \Delta e \left(-E_{ar1} + M_{ra1} \right) \end{aligned} \tag{19}$$

where:

p_a is the price of the agricultural commodity,
p_n is the price of the non-agricultural commodity,
w_a is the wage rate for agricultural labor,
w_n is the wage rate for non-agricultural labor,
r_a is the rental rate for agricultural capital,
r_n is the rental rate for non-agricultural capital,
e is the exchange rate, and
X^* is the volume corresponding to the value X in the SAM, with $X = G, VL, VK, E$, and M.

The left-hand side of equation (19) indicates physical flows and the right-hand side the compensatory monetary flows. From this characterization it is possible to identify the importance of changes in commodity prices, wage rates, capital rents, and the exchange rate as invisible mechanisms of surplus extraction, in addition to the visible domestic and foreign agricultural financial surpluses of agriculture which can, in turn, be identified with specific mechanisms of surplus extraction such as voluntary transfers and taxation.

IV. Determining the role of agriculture in archetype economies

4.1. Agricultural surplus in the SAM framework

To illustrate the measurement and decomposition of a change in agricultural surplus, we use an archetype economy representing net cereal-importing countries in Africa.[3] This archetype economy is not designed to represent an entire region or to be a sample of countries in the region, but rather to characterize a set of countries in the region with similar structural characteristics. The SAM presented in Table 1 was constructed from accounts developed by Sadoulet, Subramanian, and de Janvry (1992), with flows reported in 1985 US$ per capita. Each account was divided between agriculture and non-agriculture. The accounts from this SAM are used to calculate the most relevant macroeconomic aggregates and the domestic and foreign agricultural surpluses in Table 2.

In Africa, the share of agriculture in GDP is large (36.6%), implying that a productivity gain in agriculture could have large aggregate effects. However, the level of interaction between agricultural and non-agricultural sectors is weak, as agricultural activities use neither non-agricultural labor nor capital (i.e., negligible amounts rounded off to zero). Agricultural exports far exceed agricultural imports, which means that agriculture is a supplier of foreign exchange to the economy to the tune of $22 per capita. Agricultural households spend a large portion of their income on non-agricultural commodities (54.7%) suggesting a strong flow of goods from non-agriculture to agriculture. Finally, purchase of non-agricultural investment goods by agriculture also represents a significant flow of resources equal to $7.3 per capita.

The net foreign surplus is largely positive due to the surplus of exports over imports ($SU_f = E_{ar} - M_{ra} = 22$). The foreign exchange earned by agriculture (E_{ar}) is changed into local currency units as it is transferred to non-agriculture in exchange of domestic expenditures by agriculture. This foreign exchange is in turn used by non-agriculture to import (X_{rn}), creating a foreign exchange entry into the ROW non-agriculture account. Because ROW is a net importer of agricultural goods from Africa, this foreign exchange surplus is ultimately transferred from ROW non-agriculture to ROW agriculture under the form of TF_{an}. Hence, this foreign exchange is part of the foreign agricultural surplus extracted from agriculture.

By contrast, the domestic agricultural surplus is largely negative (-20.8). This originates in the net flow of goods from agriculture to non-agriculture which is negative since the net consumption of goods and services strongly favors agriculture ($G_{an} - G_{na} = -61.2$) and exceeds factor payments from non-agriculture ($VL_{an} - VL_{na} = 40.4$) derived from rural households earning wages in non-agriculture in excess of the wages earned by non-agricultural households working in agriculture. Part of the domestic agricultural surplus is extracted via taxes paid to government (3.4), but there is a much larger influx of foreign exchange from ROW agriculture to ROW non-agriculture (-24.2) that corresponds to the foreign exchange earned by agriculture and spent by agriculture.

The net effect is a total agricultural surplus that is positive but small, representing 1.3% of agricultural GDP. This reveals the low productivity of African agriculture and the weakness of extraction

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[3] The following countries are represented by the Africa archetype: Benin, Burkina Faso, Central African Republic, Ethiopia, Ghana, Guinea, Kenya, Lesotho, Liberia, Madagascar, Mali, Mauritania, Mozambique, Rwanda, Senegal, Sierra Leone, Somalia, Sudan, Tanzania, Togo, and Zaire.

mechanisms through taxation or through private transfers to non-agricultural institutions and activities. However, the role of the price mechanism as a source of extraction needs to also be added to have a full accounting of the transfer of an agricultural surplus.

4.2. Visible and invisible transfers in the CGE framework

To evaluate the role of agriculture in the African economy, we use a positive total factor productivity shock to agricultural production. From an initial SAM, the change in the economy due to the agricultural shock is simulated using a CGE model. The simulation creates a final SAM which differs from the base values only as a consequence of the productivity gain in agriculture. Additionally, the simulation provides all the price and quantity changes associated with the productivity shock. The results show how an increase in agricultural productivity impacts the economy and changes the relationship between agriculture and non-agriculture.

The main structural features of the CGE model are given in the lower part of Table 2. The degree of openness is characterized by the elasticity of substitution in consumption of agricultural commodities between domestically produced and imported goods. The African economy is nearly closed, with an elasticity of 0.3, due to the fact that food imports (mainly wheat and rice) are very different from domestically produced food (tubers and coarse grains). Because of low per capita income, the price elasticity of demand for cereals is high, with a value of –0.54. On the supply side, the price elasticity is also low, with a value of 0.2. Initially, the labor market closure assumes a fixed real wage in all sectors of the economy, due to surplus labor among unskilled workers and an efficiency wage among skilled workers.[4] The foreign trade closure assumes fixed foreign capital inflows and hence a flexible exchange rate. Sensitivity analysis will be applied to both the degree of openness of the economy and the labor market closure rule.

The impact on the economy of a 10% increase in agricultural productivity is presented in Table 3.[5] With a relatively closed economy and fixed real wages, the increase in agricultural production is equal to the 10% productivity increase (as we will see, this is the resultant of the productivity gain inducing an increase in output but also a fall in agricultural prices, creating a disincentive on production, compensated by income growth and falling wage costs, creating positive incentives on production). As domestic output increases in a relatively closed economy, the terms of trade for agriculture deteriorate by 6.2%, a fall due to the inelastic demand for food, but that is mitigated by the strong GDP per capita growth effect created by the productivity gain in agriculture. This fall in price reduces the consumer price of agricultural commodities by 6.3%. With real wages fixed, a fall in consumer price drives down the nominal rural wage by 1.9%. With product prices falling less than output growth, the nominal value of gross output rises. In addition, with a falling consumer price for agricultural commodities, real rural household income rises by 7.6%.

As domestic agricultural prices decline, demand for imported agriculture should fall since the world price is now higher than the domestic price. However, because it is difficult to substitute between domestic and imported foods, imports actually increase (6.4%) as a consequence of the income effect in demand. The rise in agricultural production augments the availability of agricultural exports by 12.1%. Thus, both imports and exports increase, pushing the exchange rate in opposite directions. As the import demand effect dominates, the net effect is a 1.1% appreciation of the exchange rate.

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[4] The real wage is calculated using a consumer price index that is specific to agricultural labor.

[5] This is modeled as a 10% increase in the total factor productivity parameter in the production function of all agricultural sectors.

Through the nominal wage effect (urban nominal wages fall by 1.8% as domestic prices fall), productivity growth in agriculture induces non-agricultural output growth (4.7%). This is the classical source of growth for non-agriculture identified by Lewis in a fixed real wage economy. This output growth in turn raises real urban household incomes by 4.4%. Combining the growth effect of a productivity gain in agriculture and the transmission to non-agricultural growth through cheap labor results in an overall GDP growth effect of 6.8%.

How was the agricultural surplus created by productivity growth transferred to non-agriculture? Table 4 shows the visible and invisible transfers of the change in agricultural surplus (equation 19). To help interpret the results, the monetary flows are presented in percent of GDP per capita.

The most important observation is that the invisible transfer of a financial surplus from agriculture (1.07) far exceeds the visible transfer (0.18). The invisible transfer comes principally from two sources: a fall in agricultural prices (creating a transfer of 0.66) and a fall in nominal wages in agriculture (creating a transfer of 0.35). There is a small invisible transfer into agriculture as non-agriculture prices also fall, benefiting agriculture, but this is a minute amount (–0.05). A third source of invisible transfer is through the exchange rate contribution. The negative change in exchange that multiplies a negative balance of imports over exports results is a positive contribution to invisible transfer of 0.11.

By contrast, the visible transfer is quite small. Net monetary transfers flow in the direction of non-agriculture. The change in domestic surplus is an inflow into agriculture of 0.99 while the change in foreign surplus is a transfer to non-agriculture of 1.17. The change in foreign surplus corresponds to a small increase in the value of remittances that follow movements in the nominal exchange rate and to a large increase in the transfer of foreign exchange from ROW non-agriculture to ROW agriculture. Clearly, not taking into account invisible transfers would give a highly misleading picture of the role of agriculture in transferring resources to non-agriculture.

Similar calculations of the relative roles of visible and invisible transfers were done using Latin American and Asian archetypes (see the specification of these archetypes in Subramanian, Sadoulet, and de Janvry). The results give the following shares of total financial transfers originating in invisible transfers for the three archetypes:

Africa	86%
Latin America	100%
Asia	123%.

In all cases, the invisible transfers far outweigh the visible transfers, which are zero in Latin America and negative in Asia, reinforcing the conclusion reached for Africa.

Looking at the net physical flows out of agriculture in the lower half of Table 4 shows that the main positive contributions are through an increase in the factor contribution from agricultural labor working in non-agriculture ($w_a \Delta VL_{an}$ = 1.48), increased exports (1.47), and an increase in agricultural goods absorbed by non-agriculture (0.61). These flows overwhelm the large increase in inflows of non-agricultural goods into agriculture (–2.12), resulting in a net positive combined factor and product contribution of 1.25.

In conclusion, the relative magnitudes of visible and invisible transfers shows the enormous importance of the latter in the way agriculture contributes resources to non-agriculture. While visible transfers are small, invisible transfers are large, particularly through falling product prices, and also secondarily through falling rural nominal wages.

4.3. Sensitivity analysis

The results in the previous section are dependent on parameters specifying the degree of openness of the economy and on assumptions about the labor market closure rule. In this section, we examine the sensitivity of the results to alterations of these two specifications of the CGE model.

Tables 3 and 4 present the results of sensitivity to the elasticity of substitution between domestic and imported food. This elasticity measures the ability of an economy to shift consumption from imported food to domestic food as economic conditions change. A low elasticity implies a relatively closed economy, as in the base run specification, and a high elasticity indicates an open economy. As productivity gains occur in agriculture, a high elasticity of substitution gives greater scope for import substitution, and agricultural imports fall (Table 3). This leads to a larger appreciation of the exchange rate, creating disincentives for agricultural exports and non-agricultural trade. Due to import substitution, the domestic terms of trade for agriculture fall less than in a closed economy. This dampening of food price reduction drives the rest of the results: the real income of rural households rise more while the nominal wage received by the urban population falls less. However, with greater benefits retained by agriculture and less transmission to non-agriculture, real GDP per capita growth is also dampened.

The impact on the transfer of a financial surplus from agriculture is analyzed in Table 4. The greater degree of openness reduces the financial transfers out of agriculture. This occurs principally as a consequence of greater price stability, and hence lower invisible transfers. As the economy opens, price effects become relatively less important and quantity effects relatively more important. Thus, while the total financial contribution of agriculture declines from 1.25 to 1.00, this is due to a reduced surplus extraction by invisible transfers (from 1.07 to 0.85), while visible transfers hardly change (from 0.16 to 0.14).

In development theory, assumptions about the rural labor market are fundamental to the contributions of agriculture to manufacturing growth. Dual economy models that give a strong role to productivity gains in agriculture in lowering nominal wages for industry specify surplus labor and constant real wages (Lele and Mellor; Fei and Ranis). In the base run, the labor market was closed via fixed real wages for all labor categories. To explore alternatives to the surplus labor model, we analyze in Tables 3 and 4 how the contribution of agriculture would change if full employment were achieved in the unskilled labor market, with wage adjusting to equate supply and demand, while skilled labor keeps an efficiency wage, retaining the base run's largely closed economy status. From Table 3, we see that there is less GDP per capita growth as nominal wages rise in agriculture and fall less in non-agriculture than in the base run, limiting output growth. Slower growth implies less import increase than in the base run, increasing appreciation of the exchange rate. Less growth creates smaller income effects and hence a greater deterioration of the terms of trade for agriculture and of the consumer price of food. Rural households' incomes do not rise as much due to the sharp decline in price, while non-agricultural incomes also do not rise as much due to lower growth. Full employment thus dampens the benefits of productivity growth in agriculture on growth and welfare.

In Table 4, the financial transfer out of agriculture is lower under a full employment labor market clearing rule than under a fixed real wage rule. This happens in spite of the larger transfer of an invisible surplus via falling agricultural prices ($-\Delta p_a G_{an}$ = 0.98): rrising agricultural wages and falling prices of non-agricultural commodities consumed by agriculture thwart this effect, and the financial transfer out of agriculture is less than in the base run. Looking at the value of net physical flows out of agriculture shows that lower income growth in agriculture and a greater decline in the terms of trade for agriculture imply a lower demand of agriculture for non-agricultural commodities ($-p_n \Delta G_{na} = -1.69$), increasing the product contribution of agriculture to 0.21. However, lower non-agricultural production growth and lower employment opportunities in non-agriculture reduce the factor contribution of agriculture under the form of a labor contribution to non-agriculture ($w_a \Delta VL_{an} = 0.84$). The net effect is a lower monetary value of net physical flows out of agriculture than under a fixed real wage.

V. Conclusions

Identifying the role of an agricultural surplus in support of industrialization has been a fundamental theme in development economics, both in a historical and theoretical perspective, as well as in terms of current policy issues. A majority of countries have no alternative source of resources for investment in industry than those that are present or can be created in their agricultural sectors. Successful industrial development thus requires the generation, transfer, and use of an agricultural financial surplus. History and theory have stressed the role of the price mechanism as a key instrument for the transfer of a surplus, either as an endogenous outcome of market forces or as a policy instrument via trade and exchange rate interventions. Yet, the recent important contribution of Morrisson and Thorbecke giving a rigorous definition and quantification of the agricultural surplus was done in the context of a SAM with fixed prices. In this paper, we develop a method to identify and quantify the transfer of a change in agricultural surplus using a SAM accounting framework in conjunction with CGE modeling. The compensatory monetary flows that match the change in net physical flows of goods and services between sectors are decomposed in visible and invisible transfers, where the former occur via voluntary transfers and taxation, while the latter occur through the terms of trade between agriculture and non-agriculture.

An archetype CGE model for low income African economies was used to simulate the impact of a total factor productivity gain in agriculture on the generation, transfer, and use of an agricultural surplus. The African economy, since it is largely agrarian, receives a large aggregate benefit from a positive technological shock in agriculture. We found that prices play a very important role in financial transfers and that these transfers are much larger in value than the net effects of foreign exchange and domestic savings. As suggested by theory, we have also noted the sensitivity of results to the openness of the economy and the labor market clearing rule. A more open economy is found to allow the agricultural sector to retain more of the benefits of an agricultural productivity increase as agricultural prices are more stable, benefiting rural households more but also reducing the transfer of a financial surplus and thus decreasing the overall GDP growth effect. Progress toward full employment dampens the growth effect of productivity in agriculture as it allows wages to rise in agriculture and fall less in non-agriculture. It thus shift the contribution of a real agricultural surplus toward products and away from factors. And while the transfer via falling prices is largest due to lower growth in farm incomes, the factor price contribution of agriculture is reduced, and so is the transfer of a financial surplus.

As suggested by the classical dual economy models, productivity growth in agriculture is thus a particularly important source of non-agricultural growth at the early stages of economic development, when economies are relatively closed, there is surplus labor on the unskilled labor market, and the agricultural sector is a large share of the economy. The financial surplus created by productivity growth is extracted from agriculture principally through invisible transfers, particularly via falling nominal agricultural wages and falling agricultural prices. However, even when the economy becomes more open and when labor markets tighten up toward full employment, the form of transfer of an agricultural surplus remains overwhelmingly achieved through invisible transfers, stressing the fundamental role of flexible product and factor prices to transfer to non-agriculture the benefits of productivity growth in agriculture.

With transfer of an agricultural surplus key for industrialization, and the price mechanism identified as the main instrument of surplus transfer, the much debated question of "getting the prices right" for agriculture is rightly recognized as a central policy question (Timmer, 1986). The difficulty is to weight carefully the incentive and extractive effects of the terms of trade for agriculture. This is one of the oldest issues in development economics. In addressing again this theme in the context of modern growth accounting, this paper has suggested a rigorous quantitative approach to this classical policy debate.

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Table 1 - Social Accounting Matrix for an archetype African economy distinguishing between agriculture and non-agriculture

In US$ of 1985

Incomes (rows)	Activities		Labor		Capital		Households/Firms		Investment		Gov't	Rest of World		Total
Expenditures (columns)	Ag.	Non-ag.	Ag.	Non-ag.	Ag.	Non-ag.	Ag.	Non-ag.	Ag.	Non-ag.		Ag.	Non-ag.	incomes
Activities														
Agriculture	Xaa 7.0	Xan 16.3					Caa 52.7	Can 7.8	Iaa 4.6		Cag 0.0	Ear 29.4		117.8
Non-agriculture	Xna 14.5	Xnn 143.5					Cna 63.5	Cnn 63.7	Ina 7.3	Inn 21.9	Cng 37.0		Enr 13.2	364.6
Labor														
Agriculture	VLaa 8.9	VLan 40.4												49.3
Non-agriculture	VLna 0.0	VLnn 54.7												54.7
Capital														
Agriculture	VKaa 77.2	VKan 0.0												77.2
Non-agriculture	VKna 0.0	VKnn 32.2												32.2
Households/Firms														
Agriculture			Laa 49.28		Kaa 77.16		TRaa 0.0	TRan 0.0			TRag 1.1	TRar 2.2		129.8
Non-agriculture				Lnn 54.7		Knn 32.2	TRna 0.0	TRnn 0.0			TRng 1.6		TRnr 3.8	92.3
Savings														
Agriculture							Saa 11.9	San 0.0			Sag 0.0	Sar 0.0		11.9
Non-agriculture							Sna 0.0	Snn 16.8			Sng 5.1		Snr 0.0	21.9
Government	TIga 2.78	TIgn 26.9					TDga 1.74	TDgn 2.79					TRgr 15.2	49.4
Rest of the World														
Agriculture	Xra 7.38				Kra 0.0		Cra 0.0		Ira 0.0				TFan 24.2	31.6
Non-agriculture		Xrn 50.65				Krn 0.0		Crn 1.2		Irn 0.0	Crg 4.6			56.5
Total expenditures	117.7	364.6	49.3	54.7	77.2	32.2	129.8	92.3	11.9	21.9	49.4	31.6	56.5	

Table 2. Main elements of the African archetype SAM and CGE

Main features of archetype SAM	
Macroeconomic aggregates	
GDP per capita ($VL_{aa}+VL_{an}+VL_{nn}+VK_{aa}+VK_{nn}+TI_{ga}+TI_{gn}$, US$ of 1985)	243
Agriculture as a share of GDP (($VL_{aa}+VK_{aa}+TI_{ga}$)/GDP, %)	36.6
Balance of agricultural trade (E_{ar}-X_{ra}, $ per capita)	22
Agricultural households' budget share for non-agriculture ($C_{na}/(C_{aa}+C_{na})$, %)	54.7
Purchase of non-agricultural investment goods by agriculture (I_{na}, $ per capita)	7.3
Domestic agricultural surplus ($ per capita)	
Generation	
Net flow of goods from agriculture to non-agriculture (G_{an} - G_{na})	-61.2
Net flow of factors from agriculture to non-agriculture (F_{an} - F_{na})	
Labor (VL_{an} - VL_{na})	40.4
Capital (VK_{an} - VK_{na})	0
Domestic agricultural surplus ($SU_d = (G_{an} - G_{na}) + (F_{an} - F_{na})$)	-20.8
Extraction	
Net private transfers from agricultural to non-agricultural institutions ($C_d = TR_{na} - TR_{an}$)	0
Net monetary tax transfers from agriculture to government ($E_d = TD_{ga} + TI_{ga} - TR_{ag}$)	3.4
Negative transfer of foreign exchange from ROW non-agriculture to ROW agriculture ($-TF_{an}$)	-24.2
Domestic agricultural surplus ($SU_d = C_d + E_d - TF_{an}$))	-20.8
Foreign agricultural surplus ($ per capita)	
Generation	
Exports of agriculture (E_{ar})	29.4
Imports of agriculture ($M_{ra} = C_{ra} + X_{ra} + K_{ra} + I_{ra}$)	7.4
Foreign agricultural surplus ($SU_f = E_{ar} - M_{ra}$)	22
Extraction	
Negative private remittances from overseas to agricultural households ($-TR_{ar}$)	-2.2
Transfer of foreign exchange from ROW non-agriculture to ROW agriculture (TF_{an})	24.2
Foreign agricultural surplus ($SU_f = -TR_{ar} + TF_{an}$)	22
Total agricultural surplus ($SU = SU_d + SU_f$, $ per capita)	1.2
Main features of archetype CGE	
Degree of openness: elasticity of substitution in consumption between domestic and foreign agricultural goods	0.3
Price elasticity of demand for cereals	-0.54
Elasticity of supply response of cereals	0.2

Table 3. Impact of a 10% increase in agricultural productivity: CGE results.
Percentage changes

	Base run†	**Sensitivity analysis°**	
Degree of openness	Fairly closed (0.3)	Open (30)	Fairly closed (0.3)
Labor market condition	Fixed real wage	Fixed real wage	Full employment
GDP per capita	6.8	6.5	6.1
Exchange rate (e/p^p_n)	-1.1	-3.2	-3.3
Agriculture			
Production	10.0	10.0	9.7
Imports	6.4	-5.9	5.8
Exports	12.1	10.5	12.2
Real rural household income	7.6	7.7	6.9
Consumer price of agricultural commodity	-6.3	-4.3	-9.4
Wage received by rural population	-1.9	-1.5	1.1
Taxes/tariffs paid by rural population	8.9	6.5	6.6
Savings by rural population	4.8	5.4	2.4
Non-Agriculture			
Production	4.7	4.1	3.2
Imports	7.1	7.3	6.5
Exports	3.9	1.8	1.0
Real urban household income	4.4	4.2	4.3
Consumer price of non-agricultural commodity	-0.1	-0.6	-0.6
Wage received by urban population	-1.8	-1.3	-1.4
Taxes/tariffs paid by urban population	5.9	4.8	3.6
Savings by urban population	6.0	5.4	4.9
Terms of trade for agriculture	-6.2	-3.7	-8.8
Government expenditures	5.0	3.3	2.6

† Base run:
Degree of openness. Fairly closed: elasticity of substitution in consumption between domestic and imported food = 0.3
Labor market condition: fixed real wage all labor categories.
° Sensitivity analysis:
Degree of openness. Open: elasticity of substitution in consumption between domestic and imported food = 30
Labor market condition: full employment of unskilled labor, fixed real wage skilled labor.
Numeraire: Producer price on non-agricultural goods (p^p_n).

Table 4. Visible and invisible transfers of a financial surplus from agriculture

In percent of GDP per capita

Normalisation with producer price of non-agricultural goods

	Base run†	**Sensitivity analysis°**	
Degree of openness	Fairly closed (0.3)	Open (30)	Fairly closed (0.3)
Labor market condition	Fixed real wage	Fixed real wage	Full employment
Financial transfers out of agriculture	**1.25**	**1.00**	**1.05**
Visible transfer of a financial surplus: net savings from agriculture	**0.18**	**0.16**	**0.16**
Net domestic savings (ΔSU_d)	-0.99	-0.96	-0.79
Net foreign exchange savings (ΔSU_f)	1.17	1.12	0.95
Invisible transfer of a financial surplus: extraction via prices	**1.07**	**0.85**	**0.89**
Commodity price contribution: change in relative product prices			
$\Delta p_n G_{na}$	-0.05	-0.21	-0.24
$- \Delta p_a G_{an}$	0.66	0.45	0.98
Factor price contribution: change in wages and rents			
$- \Delta w_a VL_{an}$	0.35	0.27	-0.20
Exchange rate contribution: change in the exchange rate			
Δe (imports - exports)	0.11	0.34	0.34
Corresponding monetary value of net physical flows out of agriculture	**1.25**	**1.00**	**1.05**
Product contribution	**-0.23**	**-0.30**	**0.21**
Net supply of commodities to domestic market			
$p_a \Delta G_{an}$	0.61	0.57	0.60
$- p_n \Delta G_{na}$	-2.12	-2.32	-1.69
Net supply of commodities to foreign market			
$e\ \Delta$exports	1.47	1.28	1.47
$- e\ \Delta$imports	-0.20	0.18	-0.18
Factor contribution ($w_a \Delta VL_{an}$)	**1.48**	**1.30**	**0.84**

† ° See Table 3