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An extended cross-country database for agricultural investment and capital

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An Extended Cross-country Database for Agricultural Investment and Capital

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Abstract

This paper presents a database of investment and capital in agriculture, an essential input for cross-country macro analysis of the primary sector of the economy. Our work stems from the innovative research undertaken by Larson et al. (2000). With respect to these authors, we extend country coverage and time span. Further we introduce some refinements to the methodology used to construct the series of fixed capital stock by changing how the agricultural GDP and investment is forecasted. Finally we document in details our data sources and the STATA program used to implement all the methods.

Keywords: agriculture, fixed capital stock, investment

JEL Codes: E22, O16, Q10

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1. Introduction

The objective of this paper is to present a new database of investment and capital in agriculture. Measures of sectoral investment and capital stocks are essential in applied economics research, particularly in cross-country studies. In fact, when data are aggregated at national level, a wide and representative spectrum of countries is needed, both in terms of demographic composition and economic development, in order to get meaningful production function estimates and consequently make sound policy suggestions.

Starting from Bhattacharjee (1955) analysis, a number of studies postulated a global production function, while seeking to explore the causes of cross-country differences in agricultural productivity.¹ Knowledge of the production structure is indeed crucial in the discussion of several key topics such as the contribution of inputs to output and, in a dynamic context, to growth. Most studies in the past, and even more recent studies², have suffered from lack of sectoral capital data, due to its intrinsic demanding requirements, which no existing source or compilation of data comes close to satisfying. Even if comprehensive data on components of the agricultural capital stock (ACS) were readily available for a representative sample of countries, difficult issues of allocation/attribution would remain to be solved.³

To date, two main approaches to measuring the ACS and investments in agriculture have been employed. One is based on national accounts and captures a relatively broad set of ACS components. The other is based on physical inventories contained in the FAOSTAT database, which only covers a relatively narrow set of fixed assets in farming. Following the former methodology, Larson et al. (2000) used information on gross fixed capital formation in national accounts to construct estimates of sector-level capital stocks for 57 countries between 1967 and 1992. As an alternative, the FAO Statistics Division in 1995 first compiled estimates of the ACS based on the physical stocks of various types of agricultural assets (see Von Cramon-Taubadel et al. (2009) for a good review of this method of computing ACS). National accounts-based estimates of the ACS provide a noticeably broader coverage of fixed capital in agriculture than the estimates based on FAOSTAT physical inventories. Moreover, their use of the permanent inventory method coupled with consistent national accounts data on investments provides theoretically better estimates of the value of the ACS in each year than the FAOSTAT approach. Finally, the use of constant prices in the FAOSTAT approach implies a volume index that does not account for the age of assets or quality improvements in assets over time.⁴ On the other hand, the main disadvantage of the national accounts-based estimates is that they are only available for some countries; particularly OECD and other

¹ See, for instance, Hayami (1969, 1970) and Hayami and Ruttan (1970).

² See Fuglie (2008), for example.

³ For example, machinery might be used for farm and non-farm purposes.

⁴ E.g. the fact that the average tractor made in 2005 can do more than the average tractor made in 1975, or that there have been genetic improvements in livestock over the same period.

industrialized economies are well represented, but this is not the case for developing countries.

In this document we develop national accounts-based estimates of ACS building upon the seminal work undertaken by Larson et al. (2000), extending both country coverage and time span. This paper develops as follows: in the following section we briefly discuss how we estimate national-accounts based series of ACS, following and adapting the Larson et al. method. We critically review the assumptions made by the above-mentioned authors to derive national ACS series and show how we modified the methodology for integrating investments, focusing on both agricultural GDP and the investment forecasting. Further, we describe some economic characteristics of the dataset and describe the main trends in the evolution of capital in agriculture. Finally, in two appendices we document in detail our data sources and the STATA program used to implement all the methods.

2. Estimating the agricultural capital stock with national accounts data

The method followed to estimate agricultural capital stocks in this paper borrows heavily from the excellent work conducted at the World Bank by Larson, Butzer, Crego, and Mundlak (Larson et al. (2000), cited as LBMC below).

As described in the United Nations System of National Accounts, fixed capital investment does not include direct investment in livestock or trees, even though also the latter two components should be included in the computation of ACS. Therefore, following LBMC this dataset is also generated based on the assumption that agricultural capital is composed of three elements that must be computed separately: 1) livestock, 2) physical capital, and 3) orchard stock, which represents the value of the planted permanent crops. For the first element of the ACS we followed the same approach suggested by LBMC (see also Crego et al. (1998) for further details), so here we briefly sketch the routine to estimate the value of livestock in the country. Further details are given for the procedures for estimating the latter two elements of the ACS, because they are estimated differently.

According to the United Nation's accounting practices, animal additions that are not used for slaughter should be included as fixed-capital investments. However, as LBMC also pointed out, upon deeper inspection it seems this is not the case for many countries, and should therefore be accounted. Following LBMC, in this paper the value of livestock is calculated using the stock numbers reported by FAOSTAT for different types of animals. Heads of livestock are valued using dollar prices which are estimated as regional 5-year moving averages (weighted by quantity) of implicit unit export/import prices, also obtained from FAOSTAT.

2.1 Estimating Physical Capital

The physical capital series is constructed using time series of gross fixed capital formation in agriculture as published in national account statistics, and in a few instances using case studies that attempt to calculate these same series⁵. The method used to estimate physical capital stocks is a variation of the perpetual inventory method (PIM). The PIM estimates capital stocks changes through additions of new assets (investment) and through scrapping (discards) of assets which have reached the end of their useful service life. Let I_t be the investment made during year t , K_t be the capital stock at the end of year t , L be the lifetime of the capital good and s_j be the productivity of investment of age j . Then the capital stock is given by:

$$\begin{aligned} K_t &= s_0 I_t + s_1 I_{t-1} + \dots + s_L I_{t-L} \\ K_t &= s_0 I_t + s_1 I_{t-1} + \dots + s_L I_{t-L} + K_{t-T-1}, \text{ for } T < L \end{aligned} \quad (1)$$

where T is the length of the series, $0 < s_j < 1$ for $0 < j < L$; $s_0 = 1$ and $s_j = 0$ for $j \geq L$. In order to construct the series K_t we need, data on investment, I_t , the productivity coefficients s_j and the initial capital stock, K_{t-T-1} , if the series is not sufficiently long. Traditionally, the productivity of past investments is valued according to an exponential decay function:

$$s_j = (1 - \delta)^{t-j},$$

where $\delta \in (0,1)$ represents a fixed depreciation rate. In this study, however, the path of the relative productivity at age j , s_j , we follow Ball et al. (1993) who postulated the following family of hyperbolic efficiency functions

$$\begin{aligned} s_j &= \frac{L-j}{L-\beta j} & 0 \leq j < L \\ s_j &= 0 & j \geq L \end{aligned} \quad (2)$$

where β is a curvature parameter describing the form of depreciation. In this study we follow LBCM assumptions and propose that the lifetime of each investment is normally distributed with a mean of 20 years and a standard error of 8 years. Further, we assume a concave productivity curve, by setting $\beta = 0.7$. This means that with 95 percent probability each agricultural investment has a service lifetime between 4 and 36 years.⁶

To apply this methodology a long time series on gross investment is required. Where this was not available, instead of attempting to seed an initial value of capital, we back-cast gross investment levels and generated a lengthier series. LBCM did this by regressing the logarithm of the investment to output ratio on time for the study period. They then used this regression to estimate past values of the investment-output ratio and applied them to the published output data to generate the needed missing investment values. If the output values were not available, they estimated them from a regression of output on time. However, this approach has an inconvenient feature: it automatically assumes that the investment-output ratio is a

⁵ Sources for all time series used in this study are identified in Appendix 4.

⁶ LBCM showed that final results of fixed-capital stocks were robust to several parameters' set specification.

trend-stationary (TS) process. Therefore depending on the estimated coefficients, predicted values for the ratio may well fall outside the possible interval $[0,1]$. Further, if the estimated coefficient on time is negative and large, estimates of the capital stock in the past may become implausibly high, as we show below.

In this study we generate lengthier investment series by adopting a more robust econometric framework, which is described in details in the following sections. Our procedure is not ideal, since we make the same set of assumptions for subgroups of countries in constructing the series, depending on data availability. In fact, for some countries we have very few observations and it becomes quite hard to make meaningful and reliable predictions. Finally, for the purpose of predicting agricultural GDP, we take into account the so-called retransformation problem, when the dependent variable in a regression is expressed in logarithmic terms.⁷

Predicting agricultural output

It is hard to select a specific process to model the series of value-added in agriculture (referred to as agricultural GDP below). Choice among the existing wide array of models available in the literature is complicated by several factors, like the degree of persistence of the process, the existence of structural breaks, the forecast horizon of interest and the sample size among others. The main consequence is that the best forecasting model is not necessarily the true data-generating process.

One ideal, albeit mechanical, approach would be to adopt a sequential procedure *à la* Box-Jenkins (1976). In the context of non-stationary time series more updated versions have been suggested, among others by Culver and Papell (1997), Ayat and Burridge (2000), Diebold and Kilian (2000) and Kejriwal and Perron (2010). In the context of a univariate time-series like the agricultural GDP, this would amount to run a sequential battery of tests. As a first step we would determine if the series is a unit root. Then, we would determine if the stationary process is trend stationary or not, followed by a battery of tests to determine if there are structural breaks in the underlying parameters. Forecasting would hence be case/model-specific.

However, it has been largely shown in the literature that unit root tests with small samples like ours generally have very low power,⁸ which is further reduced when a redundant trend term is incorporated in the model. On the other hand, West (1987) demonstrated that rejection probabilities are very small if a fixed trend is erroneously omitted. In our case, given that a long-term agricultural GDP growth rate should exist, the data-generating process should include a trend. Not surprisingly, when we implemented some augmented Dickey-Fuller (ADF) tests, the null hypothesis of a unit root has been rejected for 5 countries out of 79 at a

⁷ See Wooldridge (2000), p. 202.

⁸ See, for instance, Agiaklogou and Newbold (1992) or De Jong et al. (1992).

conventional 5 percent significance level, which become 8 if we add a trend in the test.⁹ We also performed a Philipps-Perron test which gave slightly comparable results, in that for 11 out of 79 countries the null hypothesis was rejected, and this increased to 24 countries when a trend was added. Given the well-documented power problem, the true amount of unit root processes is less than 55, but we cannot know how many.

The presence of a structural change in the slope and/or the intercept may create additional difficulties in determining whether a stochastic process is stationary or not, as shown by Perron (1989), who assumed the break point was known *a priori*, and by Zivot and Andrews (1992), Perron (1997) and Vogelsang and Perron (1998), who treat the break point as endogenous in their proposed tests. The bottom line is that with reduced samples, as annual time series generally are, it is too taxing on the statistical test to differentiate a structural break in the data-generating process, from a random walk.

Our primary interest is in back-casting the series for a long number of years. Multiple-step backward predictions are generally more difficult than back-casting only one period behind. The problem is that the prediction variance grows without bound as the horizon increases.¹⁰ Therefore, given the large forecast horizon, the limited amount of data for most countries, and the certain presence of structural breaks in the series, we decided to be “conservative” in our choice and stick to the simpler TS process to predict values of agricultural GDP. In order to keep some flexibility in the model, we allowed for structural breaks when we deemed to have enough degrees of freedom to identify them. Below we recap analytically the procedure undertaken.

For countries with fewer than 30 observations, we assume that the agricultural GDP series (y_t), expressed in logarithms, is trend stationary (TS) and then for the predictions we correct for the log- bias, that is:

I) we run the country-specific regression

$$\ln(y_t) = \alpha + \beta t + \varepsilon_t \quad (3)$$

II) we compute the “smearing” factor

$$\hat{\sigma}_\varepsilon = \frac{\sum_{t=1}^T (\exp(\hat{\varepsilon}_t))}{T} \quad (4)$$

III) we forecast (back-cast) agricultural GDP

$$\hat{y}_t = \exp(\hat{\alpha} + \hat{\beta}t) \times \hat{\sigma}_\varepsilon \quad (5)$$

⁹ For the ADF tests we selected the number of lags based on Schwert criterion. Similar results are obtained with Newey-West lags. When the optimal lag is not selected, i.e. when there is only one lag in the augmented regression, rejection rates are higher, 9 and 25 depending on the respective exclusion or inclusion of the trend.

¹⁰ See chapter 18 in Woolridge (2000).

For countries with more than 30 observations we tested for the existence of structural change. Evaluating whether a break in the series happened and setting the break date is a complex task, in that several methods exist for estimating it and the results may differ. As there is no general rule, we decided to run a CUSUM test to identify the presence of structural breaks¹¹. When there is no break, again, we assume that agricultural output is TS and make predictions using the log-bias correction as described in equations (3)-(5). The CUSUM test for structural breaks is consistent and has good local asymptotic properties for given fixed values in the relevant set of alternative hypotheses (Ploberger and Kramer, 1990). However in finite samples, it has serious power problems, overall when the alternative considered is further away from the null value. Therefore, whenever a break in the series is detected with the CUSUM, we determine the break date with the maximal F_T statistics coming from a set of general Chow tests for a break at a fraction r/T of the sample, i.e.

$$F_T\left(\frac{r}{T}\right) = \frac{SSR_{1,T} - (SSR_{1,r} + SSR_{r+1,T})}{(SSR_{1,r} + SSR_{r+1,T})/(T - 2k)} \quad (6)$$

where $SSR_{1,r}$ is the sum of squared residuals from the estimation of (3) up to year r . The maximal F_T statistics have an asymptotic distribution which is described in Andrews (1993). Further, we run a country-specific regression with breaks in both intercept and trend (“Model II” of Vogelsang and Perron, 1998), i.e.

$$y_t = \alpha + \beta t + \theta DU_t^c + \gamma DT_t^c + u_t \quad (7)$$

Where $DU_t^c = 1(t > T_b^c)$, $DT_t^c = 1(t > T_b^c)(t - T_b^c)$, T_b^c is the date of the break and $1(.)$ is the indicator function. We then compute the “smearing” factor

$$\hat{\sigma}_u = \frac{\sum_{t=1}^T (\exp(\hat{u}_t))}{T} \quad (8)$$

Finally, we forecast (back-cast) agricultural GDP

$$\hat{y}_t = \exp(\hat{\alpha} + \hat{\beta}t + \hat{\theta}DU_t^c + \hat{\gamma}DT_t^c) \times \hat{\sigma}_u \quad (9)$$

In order to decide on a forecasting method, we need a criterion to choose among the competing options. Generally, we can decide between in-sample criteria and out-of-sample criteria. For fore/back-casting, it is better to use out-of-sample criteria, as forecasting is essentially an out-of-sample problem. An out-of-sample comparison involves using the first part of a sample to estimate the parameters of the model and putting aside the latter part of the sample to determine its forecasting properties. This mimics what we would have to do in practice if we did not yet know the future values of the variables. Two methods are commonly used to evaluate how well our model forecasts y when it is out of sample: i) the root mean square error (RMSE) and ii) the mean absolute error (MAE), defined as

¹¹ See Greene (2008), p. 135.

$$RMSE = \sqrt{\frac{1}{NT} \sum_{i=1}^N \sum_{t=1}^T \left(1 - \frac{\hat{y}_i}{y_i}\right)^2}$$

$$MAE = \frac{1}{NT} \sum_{i=1}^N \sum_{t=1}^T \left|1 - \frac{\hat{y}_i}{y_i}\right|$$

where N is the total number of available observations and, and T is the amount of years of data trimming; we explored cuts between one and 6 years. For both RMSE and MAE, we prefer the model with the smallest value. In Table 1 we report the results for our proposed method, model (1), and Larson et al. methodology, model (2). As shown there, our model performs better both in terms of RMSE and MAE, at any level of the trimming and independently of the number of available observations per country. It should also be noted that most of the gains in terms of better predictions come from allowing for structural breaks, as the advantages from the log-bias corrections are minor.

Predicting agricultural investment

Selecting a data-generating process for the ratio of investment in agriculture to agricultural value-added (I_t/y_t) is not as straightforward as assuming a TS process for agricultural GDP itself, as theory does not immediately suggest or reject a TS process. What can be assumed though is that on the long-run this ratio cannot follow a TS process, as LBCM assumed, because as described in the previous section, this risks predicting ratios outside the unit interval (which is unlikely for ratios above 1 and unfeasible for negative ratios).

For this investment to output ratio we also implemented the ADF and Phillips-Perron unit root battery of tests, with and without a trend. At 5 percent significance level, results are in the same line of the agricultural GDP series, with a higher rejection rate for the test with the trend, as expected. However, given the low power of the test, the limited amount of data and the extended forecast horizon, we decided not to base predictions on a difference stationary process. Therefore, in order to simplify the prediction process with a parsimonious data-generating process, consistent with both the long term stability of this ratio, and its response to noise in agricultural output, we assume that the ratio of investment to agriculture is constant, with fluctuations driven by the performance of the agricultural sector relative to its long-term potential.

This means that the ratio responds to the deviations of agricultural GDP from its long-term trend. As output deviates from its potential level, this is also reflected in the level of the gross fixed capital formation which has been predicted only after purging for the output gap. The implicit working hypothesis is that the investment series is also TS (but not the share of investments). This model has two different advantages: i) it is easily estimable with OLS and ii) it has inherently some policy implications. In fact, if the coefficient is negative, which is the expected sign, when the country's GDP is above its potential level, the residual is positive and the country invests a lower share; equivalently, when there is a negative shock gross fixed-capital formation is sustained by investing a higher share of output. Consistently with

these predictions, we find a negative β for the deviations in long term agricultural GDP in 52 of the 79 countries considered. As in the previous case of GDP predictions, when we were not constrained by data, we keep model flexibility, by allowing for structural breaks as described below.

For countries with fewer than 30 observations or with gaps in the agricultural investment series we do the following steps:

- I) We grab the GDP residuals ($\hat{\epsilon}$) coming from equations (3) or (7).
- II) We assume that the ratio, q , of investment in agriculture to agricultural GDP is constant, with fluctuations driven by agricultural output residuals, i.e.

$$q_t = \alpha + \beta \hat{\epsilon}_t + z_t \quad (10)$$

- III) We forecast (back-cast) investment in agriculture as

$$\hat{I}_t = \hat{\alpha} \times \hat{y}_t \text{ or } \hat{I}_t = \hat{\alpha} \times y_t, \quad (11)$$

depending on data availability.

For countries with at least 30 observations, we run a CUSUM test for structural break. When there is no break, we assume again (10) and (11). Whenever a break in the series is detected, we undertake the following steps for each country:

- I) We implement Chow tests for a break at a fraction r/T and select break date based on F_T statistics.
- II) We run a country-specific regression with break in the intercept

$$q_t = \alpha + \beta \hat{\epsilon}_t + \gamma DU_t + z_t \quad (12)$$

where $DU_t^c = 1(t > T_b^c)$

- III) We forecast (back-cast) investment in agriculture as

$$\hat{I}_t = (\hat{\alpha} + \hat{\gamma}_t DU_t) \times \hat{y}_t \text{ or } \hat{I}_t = (\hat{\alpha} + \hat{\gamma}_t DU_t) \times y_t. \quad (13)$$

In order to check the validity of our methodology, we evaluate how much predictions from the agricultural investment equation deviate from real data. RMSE and MAE are now defined as

$$RMSE = \sqrt{\frac{1}{NT} \sum_{i=1}^N \sum_{t=1}^T \left(1 - \frac{\hat{I}_{it}}{I_{it}}\right)^2}$$

$$MAE = \frac{1}{NT} \sum_{i=1}^N \sum_{t=1}^T \left|1 - \frac{\hat{I}_{it}}{I_{it}}\right|$$

As it can be seen from Table 2, our complete model shows overall the lowest error with respect to the competing approach, at any level of the trimming, except in the case when we drop out just the first available year and only for the RMSE. Also the model without breaks, i.e. when we have fewer than thirty data points per country, performs better than the LBMC predictions.

With our data we created the ACS series by using both the LBMC method and our approach. In Figure 1 we show a comparison of the estimated ACS for a set of countries with the lowest coefficient on the trend in the investment-to-output estimation, using the LBCM method. The figure clearly indicates that a negative coefficient leads the authors to estimate implausibly high ACS at earlier periods. Obviously the problem also extends to forecasting in later periods; in fact, when we do not have recent updates of the agricultural gross fixed capital formation series, like for instance in Venezuela (VEN) or Madagascar (MDG), the two different estimates tend to diverge. In order to have a more general graphical evaluation of the soundness of our approach, in Figure 2 we add a third comparison model, where we do not consider structural breaks. With the previous set of countries this assessment is not possible, since for all of them we hold fewer than thirty observations per country. Predictions in the past improved markedly in both cases with respect to the LBMC methodology, avoiding the problem of the ACS drop (i.e. unrealistically high initial ACS). For some countries, like Guatemala (GTM) and Iran (IRN), we do not observe any difference by modelling structural change, while for New Zealand (NZL) and Sri Lanka (LKA) the difference is non-trivial.

2.2 Estimating Treestocks

Treestocks, i.e. the intrinsic value of permanent crop trees and plants in the fields, are valued following LBMC as the present value of discounted future net revenues. In their estimations LBCM assumed that net revenues were equal to 80 percent of gross revenues which, in turn, are calculated per permanent crop as the product of yields and prevailing prices. Yields are calculated using area and total output data from FAOSTAT (i.e. the simplifying assumption that all fields produce at average yields is made), while the prices used correspond to 5-year moving averages of actual producer prices reported by FAOSTAT for each country.¹² One simplifying assumption was made: all permanent crops are at half of their productive life-spans. The authors also assumed that the lifespan of all permanent crops is 26 years. Future revenues are discounted using a ‘real’ rate of return defined as the difference between the yields of 10-year US bonds and the inflation of the US GDP deflator for each period.

In our estimates we followed essentially the same approach. In these calculations, however, to dampen jumps in the treestock series driven by financial shocks we use 5-year moving averages of the ‘real’ rate of return. Also, we estimated separately the economic half-life of

¹² Yields obviously vary by the age of the treestock, but we cannot improve those estimates because we do not know: *i*) the age of the trees, or *ii*) the yield curves by crop.

all tree crops included in FAOSTAT, numbers presented in Appendix 3.¹³ The concept of economic life is different than the lifespan of a tree; it refers to the number of years trees are usually productive in an economic environment; that is, the years during which the tree is yielding fruit up to when it is cut because yields have become too low. For example a walnut tree in ideal conditions can live up to 400 years, but in commercial agriculture, groves are exploited for 60-100 years. Similarly ginger is a perennial plant, but it is cultivated in economic environments as an annual crop. Chestnuts, olives, and many other crops, have an expected economic life that goes well beyond the human planning horizon. In order not to over-value some specific treestocks, we capped the maximum economic life-span at 50 years in our calculations.

We also change the assumption of 20 percent profit margin, which seems exaggerated for several reasons. First, it is a fact of agricultural activity that in some years tree farms are operated at a loss, and in some years the output/labour price ratio makes the harvesting of trees uneconomical and fruits remain unpicked. Furthermore, the net present value of treestock revenues, which should be roughly equivalent to the market price of the farm, does not only reward the value of the treecrop, but also the land where they stand. Obviously, choosing the profit margin is an *ad hoc* and consequential choice. Figure 3 shows the sensitivity, at the aggregate levels, of the treestock estimates relative to physical assets, to different assumptions regarding the maximum (cut-off) economic life-span of trees, and different assumptions about net revenues. The figure shows that the imposing an arbitrary cutoff at 50 years for treecrops does not have a major impact at the aggregate level. However, as expected, the profit rate at which tree farms are assumed to operate has a very large impact on the overall estimates of ACS, particularly in low- and middle-income countries, and the impact at the country level can be even larger. The steep curve of the ratio of treestock in ACS (left pane in the figure) shows that between 1 and 15 percent figures are very sensitive to the net revenue rate assumed. In these calculations we assumed a profit rate of 5 percent.

2.3 Achieving International Comparability

Our internationally comparable measures of ACS suffer from the same problems that plague all internationally comparable macroeconomic indicators. In the first place, countries with hyper-inflationary episodes are difficult to value accurately, because during these episodes the annual figures can vary notoriously with the choice of exchange rate used, and deflators become unreliable. Also, deflating old values becomes unreliable, because it is easy to lose significance of 12 to 18 digits, not only in our numerical computations, but also in the available data sources.¹⁴ Also, the exchange rate for countries that are essentially closed and not trading are unreliable; think of countries like Iran or the republics of the former Soviet Union. For this type of closed economy, we used estimated black market exchange rates from different sources, as identified in Appendix 4. However, even these may not be the ideal

¹³ In their update Butzer et al. (2010) inserted differentiated lifespans, however these are not crop specific, but rather by group of crops. In any case it is a welcome improvement.

¹⁴ For example, the IMF series of exchange rates for Argentina available in the *International Financial Statistics* as of 12/2010 is wrong, and we had to use national sources to reconstruct a correct series.

choice, as the black market premium also captures the risk in the illegal activity. Nevertheless they still represent a better choice than the official exchange rates.

3. Major Trends in Agricultural Capital Accumulation

In this section we briefly review the most salient features in capital accumulation at a global level, which are distilled from the new dataset. There are important messages that can be extracted from global trends and cross-country averages; however, many important trends occur at country and regional level, and require a more careful and in-depth analysis not provided here.

The country coverage of the new dataset is limited mostly by data on gross investments in agriculture. Figure 4 shows the availability of information for the three components of the ACS. Thanks to FAOSTAT data, the data on livestock has almost full world coverage, starting from 1960. Data on treestocks are available for most countries, certainly most of the planet in terms of population and area. What constrains the availability of data on ACS, as the figure shows, is the data on gross fixed capital formation. Nonetheless, the complete ACS is calculated for 80 countries, representing an expansion of 23 countries from the original LBCM dataset of 57. Unfortunately, being in this ACS sample is not a random outcome; wealthier countries have in place better statistical institutions which allow them to produce data on gross fixed capital formation in agriculture among other more sophisticated statistics. Overall, the complete ACS covers countries which represent up to 65 percent of the world agricultural GDP. As explained above this representativity is unevenly distributed between a coverage of up to 95 percent of high-income countries agricultural GDP, and up to 45 percent of the agricultural GDP of middle- and low-income countries. We advise users of this dataset to account for this potential selection bias in their analysis. The complete set of 80 countries included in this dataset is described in Table 3. Also included in the table are the ratios of livestock to physical capital and treestock to physical capital, and their evolution across decades.

Figure 5 describes the evolution of the ACS over time for countries grouped by major income groups. Several stories are conveyed by this figure. First, the share of livestock in ACS has been falling both in high-income as well as developing countries, but more noticeably in high-income countries, as can also be seen in Table 4. There was a fall in agricultural stocks across the board during the early 1980s, some of which can be explained by changing valuation of stocks as a result of the financial crisis that followed the debt crisis of 1981/2, but there was also a slow-down in gross investment. Overall and in the long-run, developed countries show a clearly positive net investment trend, but in low- and middle-income countries this trend is not very clear. Although on average there is (slow) net investment in physical capital, that is countervailed in developing countries by falling livestock and slow-growing treestocks.

The asymmetry between developed and developing countries gets amplified when we look at the ACS per agricultural worker, Figure 6. This is because developed countries have reduced their agricultural labour force as they move forward in the agricultural transition increasing the capital-intensity of their agricultural sector. In contrast, in developing countries, the overall agricultural labour force has remained relatively constant. This is an artifact of low-income countries which have just started or have yet to start their agricultural transition and hence have growing agricultural labour forces, and middle income countries where there is a net decline in the agricultural workforce, see also Table 5. Given the overall stagnant agricultural workforce, in terms of ACS per worker there has been a falling ACS in the long run and stagnant since the mid-1980s.

An inspection by region, as done in Table 5, reveals that capital accumulation has followed very heterogeneous paths. Among developing countries important capitalization has taken place in East Asia and the Middle East and North Africa (MENA) regions. In South Asia there has been on average negative net investment as a result of falling livestock and very slow growth in physical and tree stocks. The value of treestocks has grown very fast in East Asia, Latin America and MENA regions; while livestock has been, on average, falling in most regions except for North America and East Asia. In terms of physical capital accumulation East Asia, MENA, and Europe and Central Asia (which does not include high-income countries) display the fastest rates of capitalization. These asymmetries become more pronounced if we look at ACS per worker, precisely because the regions with fastest-growing agricultural workforce are those with lowest rates of capitalization, namely South Asia and sub-Saharan Africa. In contrast, in East Asia, a relative small decline in the agricultural workforce re-enforces the capitalization that has occurred in the region in terms of ACS per worker.

Net investment is the real change in capital stocks, net of depreciation of those stocks, and it reveals the trend of the capital stocks available to the economy. In Figure 7, net investment in agriculture is shown as 5-year period averages by major income groups. The figure unveils some very clear trends. First, as described above, the first half of the 1980s caused major disinvestment in agriculture both in developed and developing countries. This sharp decline in ACS was reversed during the second half of that decade with strong accumulation in developed countries; however, in developing countries there was on average only weak growth in capital stocks, a trend consistent with what has been called in Latin America the “lost decade”. During the 1990s high-income countries decapitalized throughout the decade, while developing countries on average displayed low net investment during the early 1990s and net disinvestment during the last 5-year period of the century. At the turn of the century, there is a big turn-around with high positive average net investment across the board. However, it is likely that the notable decapitalization of agriculture that occurred during the last decade of the past century is partially responsible for the inability of agriculture to meet growing demand as expressed by two high food and agricultural prices events in 2007/8 and 2010/11.

Figure 8 shows that, as expected, there is a strong correlation between agricultural output per worker and agricultural fixed capital per worker. Countries that successfully amass positive net investment over time have higher levels of agricultural output. However, a more relevant relationship is shown in Figure 9, where it is shown that net investment is positively correlated with growth in output. This is a relationship that needs to be explored in further detail, but the preliminary evidence described in the figure suggests that investing in agriculture not only increases agricultural output, but it also fosters growth and development by promoting higher agricultural output growth rates.

4. Conclusions

There are growing concerns (a returning theme since the times of Malthus) both in the popular media as well as in academic circles about the capacity of the agriculture sector to feed a growing population given also diet transformations and newly developed demand from the energy sector.¹⁵ Obviously these fears have been fueled by two events of international food prices spikes in 2007/8 and 2010/11. An evaluation of the food and agriculture sector needs an understanding of what is happening with technology. Has technology grown, or total factor productivity TFP of the sector slowed down in the last years, as some have claimed? Are developing countries lagging in technology growth and is there divergence between developed and developing countries in terms of agricultural output? In spite of the obvious fundamental nature of these questions, they cannot be answered if we do not have an adequate accounting of all the key resources involved in the agricultural activity, namely: labour, land, and capital. Regardless of the methodology used, understanding and evaluating the evolution of technology and TFP requires an accounting of the evolution of the factors in production, including capital.

This paper thus covers an enormous hole in our measuring of basic economic aggregates necessary to carry meaningful analysis of the evolution of agricultural output. We place this dataset in the hands of the general public with the expectations of seeding meaningful analysis that will help us understand better the determinants of agricultural output and growth. We also share with as much detail as possible, all of its raw inputs, in order to facilitate the update and improvement of this global public good. Additionally, we hope to promote policy advocacy and help with policy formulation by identifying the hot spots where an agricultural investment push is sorely needed.

¹⁵ For an example of this concern in the media, see *The Economist*, 24 February 2011, special edition on feeding the world, and in academic circles see FAO's international event "How to Feed the World in 2050".

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Tables

Table 1: RMSE and MAE for agricultural GDP

		Number of observations per country							
		>= 30				< 30			
		Model (1)		Model (2)		Model (1)		Model (2)	
Trimming		RMSE	MAE	RMSE	MAE	RMSE	MAE	RMSE	MAE
1		0.1068	0.0797	0.1914	0.1423	0.2830	0.2464	0.2897	0.2517
2		0.1293	0.0936	0.2062	0.1542	0.3173	0.2759	0.3213	0.2794
3		0.1359	0.1032	0.2244	0.1590	0.3166	0.2631	0.3192	0.2657
4		0.1634	0.1144	0.2371	0.1619	0.3188	0.2606	0.3205	0.2628
5		0.1766	0.1219	0.2432	0.1617	0.3063	0.2466	0.3077	0.2484
6		0.1786	0.1245	0.2445	0.1630	0.2987	0.2360	0.3000	0.2376

Notes: Model (1) is our proposal as described by equations from 3 to 9. Model (2) is Larson et al. (2000) model.

Table 2: RMSE and MAE for investment to GDP ratio

		Number of observations per country							
		>=30				<30			
		Model (1)		Model (2)		Model (1)		Model (2)	
Trimming		RMSE	MAE	RMSE	MAE	RMSE	MAE	RMSE	MAE
1		2.1060	1.2096	2.0028	1.3362	1.4167	0.8729	1.8685	0.9400
2		2.1590	1.1827	2.2220	1.3289	1.3472	0.8315	1.7780	0.9383
3		1.9190	1.0641	1.9847	1.2220	1.2849	0.8120	1.7928	1.0378
4		1.7586	0.9588	1.8316	1.1195	1.2089	0.7695	1.8171	1.0890
5		1.6733	0.8813	1.7097	1.0283	1.3018	0.7888	1.8555	1.1195
6		1.6227	0.8431	1.7807	1.0042	1.2543	0.7611	1.9684	1.1858
7		1.5510	0.8051	1.7512	0.9623	1.2169	0.7357	2.0574	1.2031
8		1.5044	0.7787	1.7135	0.9294	1.1993	0.7305	2.3043	1.3021
9		1.4659	0.7717	1.6960	0.9043	1.1827	0.7162	2.7231	1.4458
10		1.4193	0.7403	1.7860	0.8952	1.2011	0.7158	4.0043	1.7523

Notes: Model (1) is our proposal as described by equations from 10 to 13. Model (2) is Larson et al. (2000) model.

Table 3: Ratio of livestock and orchard stock to Agricultural Fixed Capital (averages over sub-periods)

Country/ Territory	1961-1980	1981-1994	1995-2006	Country/ Territory	1961-1980	1981-1994	1995-2006	Country/ Territory	1961-1980	1981-1994	1995-2006	Country/ Territory	1961-1980	1981-1994	1995-2006
ANT		0.062	0.101	DOM	3.849	1.520	1.663	JOR		0.759	0.745	PER	1.660	0.685	0.712
ARG	2.140	1.061	0.915	EGY	5.480	3.404	2.880	JPN	0.018	0.009	0.007	PHL	1.832	1.576	2.577
ARM	0.194	0.368	0.414	ESP	0.843	1.320	1.179	KEN	0.291	0.161	0.133	POL	10.046	11.461	14.638
AUS		2.723	0.728	EST	0.187	0.149	0.157	KOR	3.821	3.944	2.786	PRT	1.748	0.458	0.319
AUT		0.615	0.399	FIN	0.004	0.015	2.516	LKA	3.920	5.047	7.257	SLV	0.025	0.040	0.083
AZE	0.802	0.534	0.286	FJI		0.277	0.150	LTM	0.169	0.044	0.032	SVK	0.413	0.484	0.216
BLR	0.246	0.197	0.177	FRA	0.149	0.055	0.053	LVA	0.388	0.422	0.331	SVN	1.893	3.068	2.448
BLX	0.122	0.115	0.077	GBR	0.007	0.004	0.002	MAR	2.694	2.347	0.225	SYR	3.130	1.346	1.359
BOL	0.026	0.147	0.165	GRC	0.454	1.095	1.766	MDA	28.308	24.213	20.119	TTO	14.749	6.128	4.248
BRA		6.316	1.827	GTM				MDG			0.334	SVK		0.529	0.253
BWA		1.486	1.471	HND	0.299	0.195	0.148	MEX			0.022	SVN		0.337	0.200
CAN		7.249	0.982	IDN	0.379	0.330	0.343	MLT	3.532	1.824	1.597	SWE	0.154	0.090	0.087
CHL	0.414	0.344	0.206	IRL	0.087	0.045	0.028	MUS	3.613	8.427	6.537	TUN		0.010	0.004
COL	0.118	0.138	0.128	IRN	0.287	0.225	0.116	NAM		5.257	2.750	TUR	0.668	0.909	0.361
CRI		6.087	9.296	IRQ	1.223	11.547	17.816	NLD		4.868	2.817	URY	4.793	6.327	7.636
CSK		1.790	2.623	ISL	1.201	0.979	1.213	NOR	49.432	69.814	40.485	VEN	0.199	0.119	0.077
CYP		1.716	1.951	ISR	1.263	1.479	1.344	NZL	32.040	59.421	40.977	ZAF		0.655	0.546
CZE	21.372	14.503	5.686	ITA	1.589	2.536	3.797	PAK	6.409	4.031	3.237	ZWE	0.538	0.265	0.410
DEU	0.237	0.219	0.235	JAM	1.423	1.120	1.182		3.635	3.524	3.489		4.077	2.865	4.939
DNK	0.023	0.019	0.028		13.676	8.522	6.101		0.259	0.973	0.540		4.495	4.196	4.664
		0.690	0.671		3.172	1.460	0.321		0.156	0.064	0.032				
		1.108	1.032		1.496	1.257	1.362		0.865	0.392	0.161				1.579
	3.454	3.040	2.419		1.016	0.556	0.439		1.628	1.624	1.427		3.925	3.925	1.652
	2.636	3.684	2.389		0.007	0.006	0.005		3.524	2.676	3.692				
	0.983	0.758	0.300		1.542	1.892	1.040			1.490	1.431			1.401	0.843
	3.026	2.841	3.705		1.988	4.614	6.379			0.056	0.117			0.201	0.233
	0.231	0.243			0.616	0.564	0.777		2.308	3.904	6.231		10.068	7.407	9.659
	0.042	0.083			0.129	0.168	0.263		0.345	0.171	0.101		0.198	1.306	2.097
	0.273	0.137	0.099						0.002	0.018	0.038		0.428	0.392	0.291
	4.649	1.976	1.620		0.093	0.041	0.057		0.002	0.011	0.006		0.214	0.207	0.246
			0.168		1.944	1.350	1.221		0.117	0.057	0.056		0.631	0.583	0.710
	0.302	0.203	0.131		0.161	0.062	0.045		0.002	0.011	0.006		0.449	0.390	0.486
	0.039	0.101	0.096		2.417	1.574	1.419		0.057	0.260	0.405		0.349	0.456	0.896
	0.433	0.175	0.141		0.694	1.188	0.893		1.921	1.808	0.679		1.686	1.571	1.179
		0.011	0.011		2.494	8.865	10.971		1.279	1.355	1.144		0.268	0.538	0.425

Note: Ratio of livestock to agricultural fixed capital in bold. Standard country/territory abbreviations used here are defined in Appendix 1.

Table 4: Component shares in Total Agricultural Capital (%)

Income groups	1970	1975	1980	1985	1990	1995	2000	2005
<u>Middle and low-income</u>								
Fixed capital	26.46	27.95	29.48	28.97	28.63	34.11	35.96	39.62
Livestock	37.59	34.14	31.38	30.50	30.41	29.15	28.58	29.99
Treestock	35.96	37.91	39.14	40.53	40.97	36.74	35.47	30.40
<u>High-income</u>								
Fixed capital	63.12	63.58	69.49	66.13	68.36	69.2	68.10	69.89
Livestock	19.76	20.36	15.40	16.80	13.92	11.95	12.50	11.68
Treestock	17.11	16.06	15.11	17.08	17.72	18.86	19.4	18.43

Table 5: Average annual rates of growth in ACS components by income groups (1980-2005, in percent)

	TOT	FIX	LIV	TREE	POP	TOTPW
<u>Income groups</u>						
Middle and low-income	0.388	1.533	-2.322	2.214	0.263	0.125
High-income	0.532	0.644	-1.821	4.558	-2.743	3.275
<u>World Bank Region</u>						
East Asia & Pacific	1.983	2.126	3.303	1.801	-0.787	2.770
Europe & Central Asia	0.458	2.699	-2.425	5.384	-2.852	3.310
Latin America & Caribbean	0.112	-0.018	-0.956	1.904	0.385	-0.273
Middle East & North Africa	2.553	1.598	-4.693	3.774	0.158	2.395
South Asia	-0.633	1.640	-11.259	1.114	1.587	-2.220
Sub-Saharan Africa	-1.660	-2.443	-2.523	-0.129	1.381	-3.040
North America	-0.302	-0.475	0.178	0.606	-2.212	1.910

Notes: TOT- total agricultural capital, FIX – fixed capital, LIV-livestock, TREE-tree stock, POP – total economically active population in agriculture, TOTPW – total agricultural capital per worker.

Figures

Figure 1: Agricultural Capital Stock – models' comparison across countries with lowest coefficient on trend stationary investment to output ratio

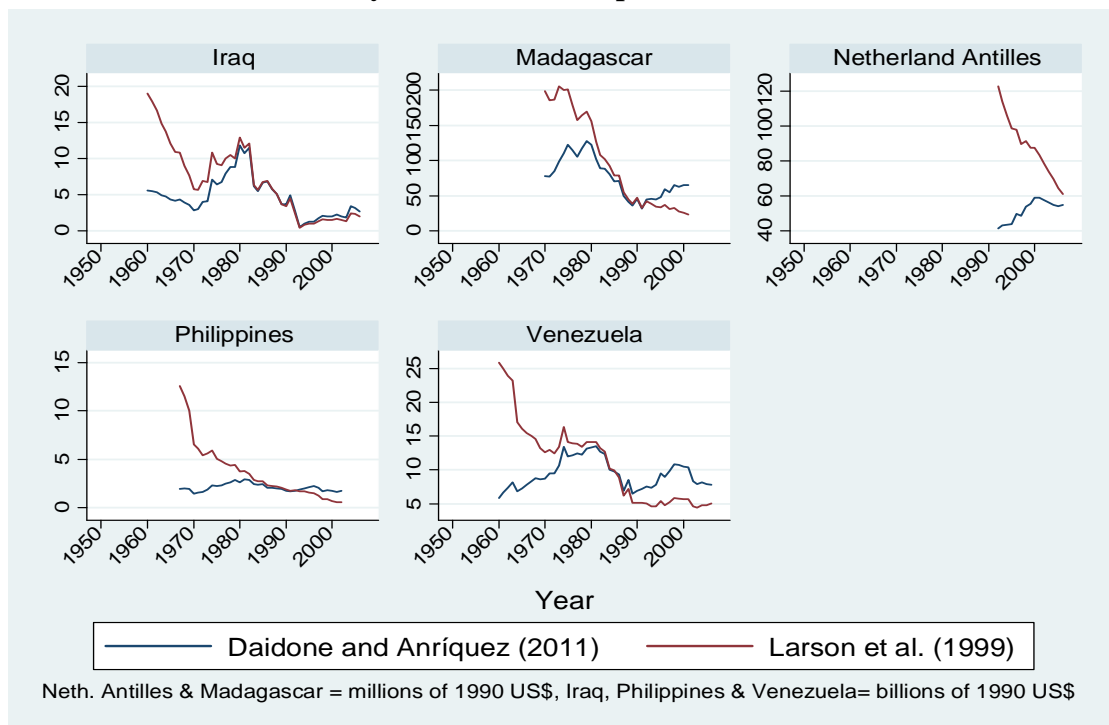


Figure 2: Agricultural Capital Stock – models' comparison across countries with negative coefficient on trend stationary investment to output ratio and structural break

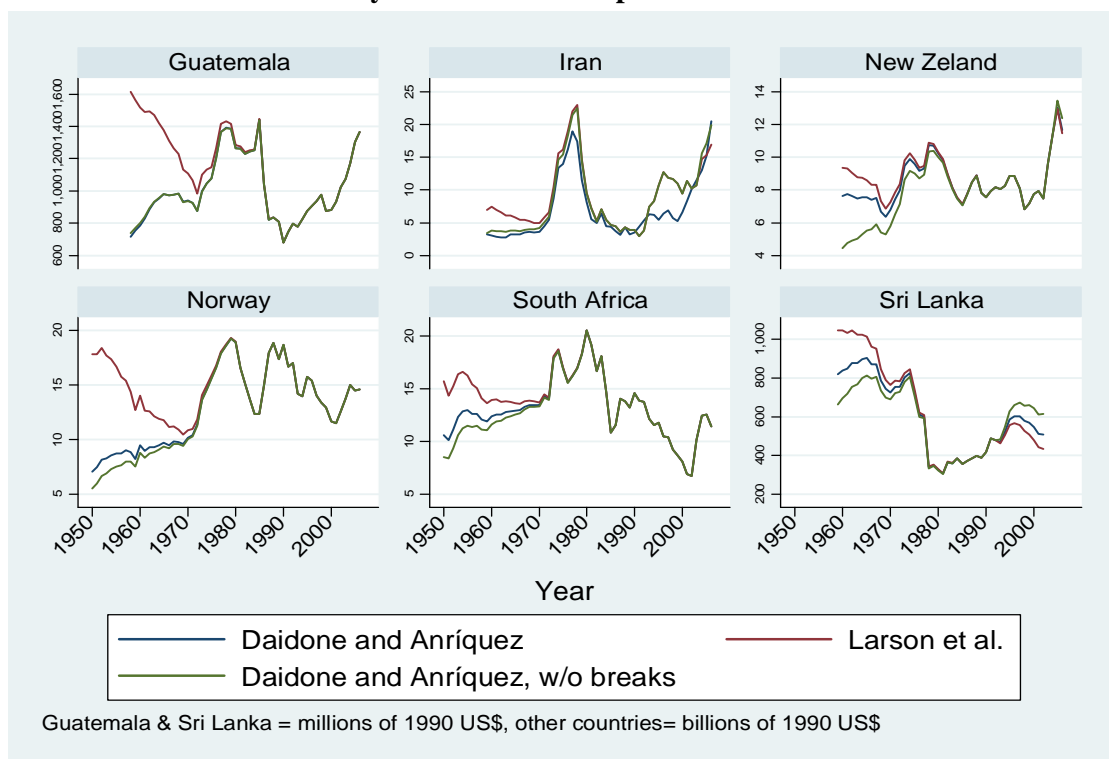


Figure 3: Sensitivity of tree stock measure to profit assumptions and tree lifetime

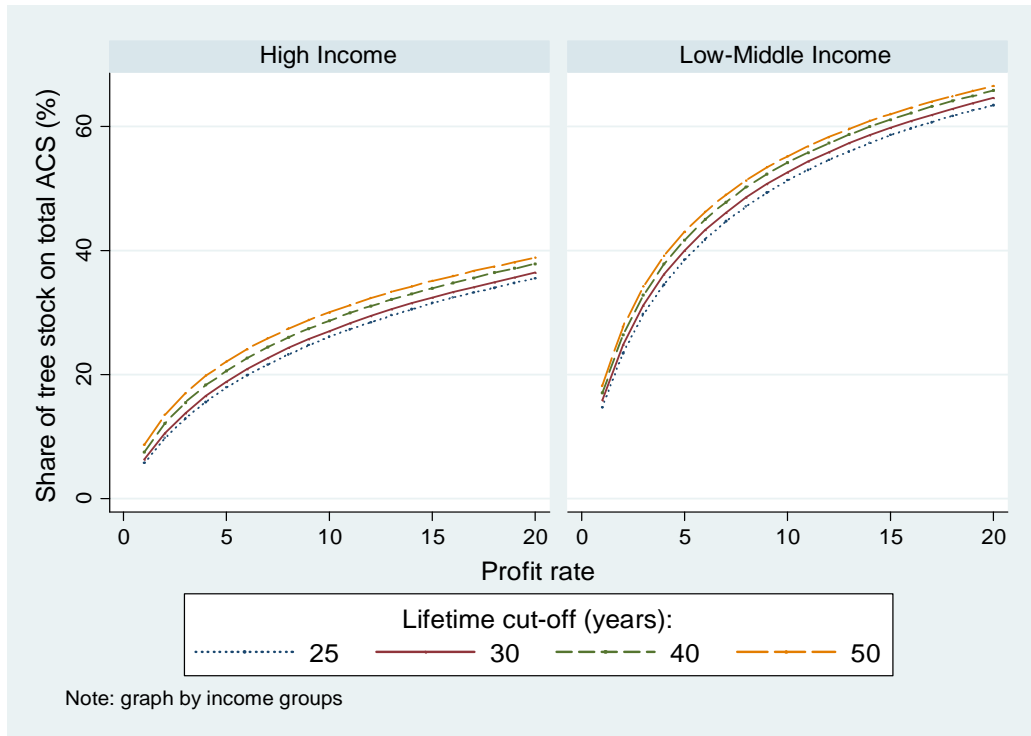


Figure 4: Data availability. Number of countries in capital stock estimates, by year and component

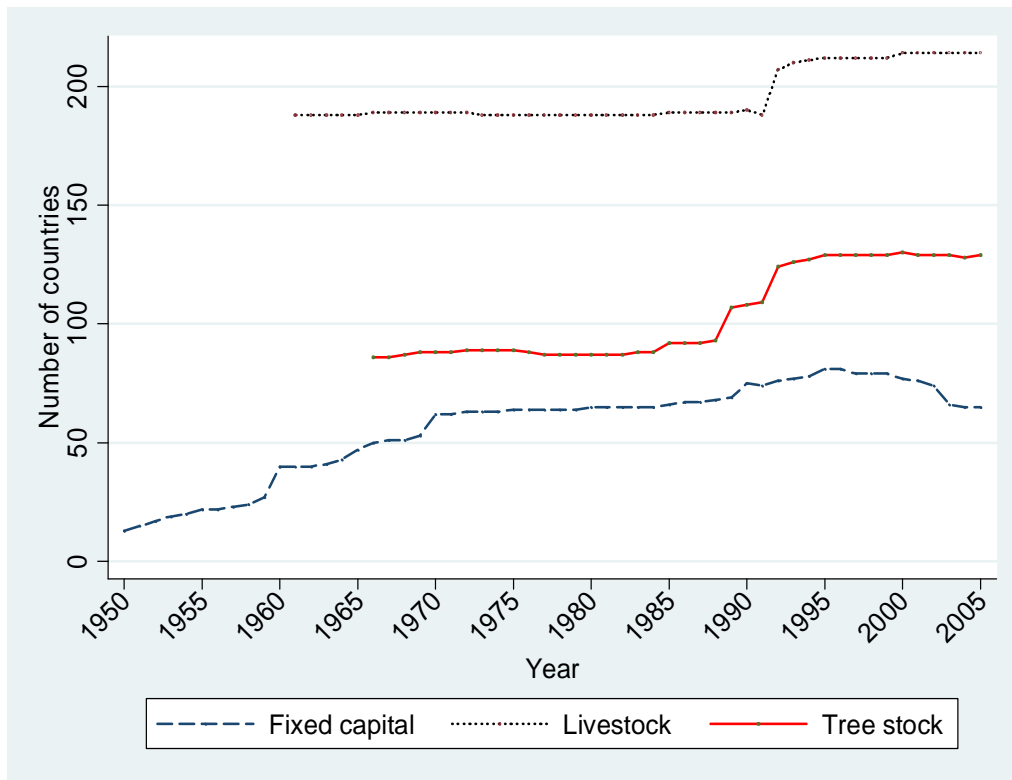


Figure 5: Components of agricultural capital

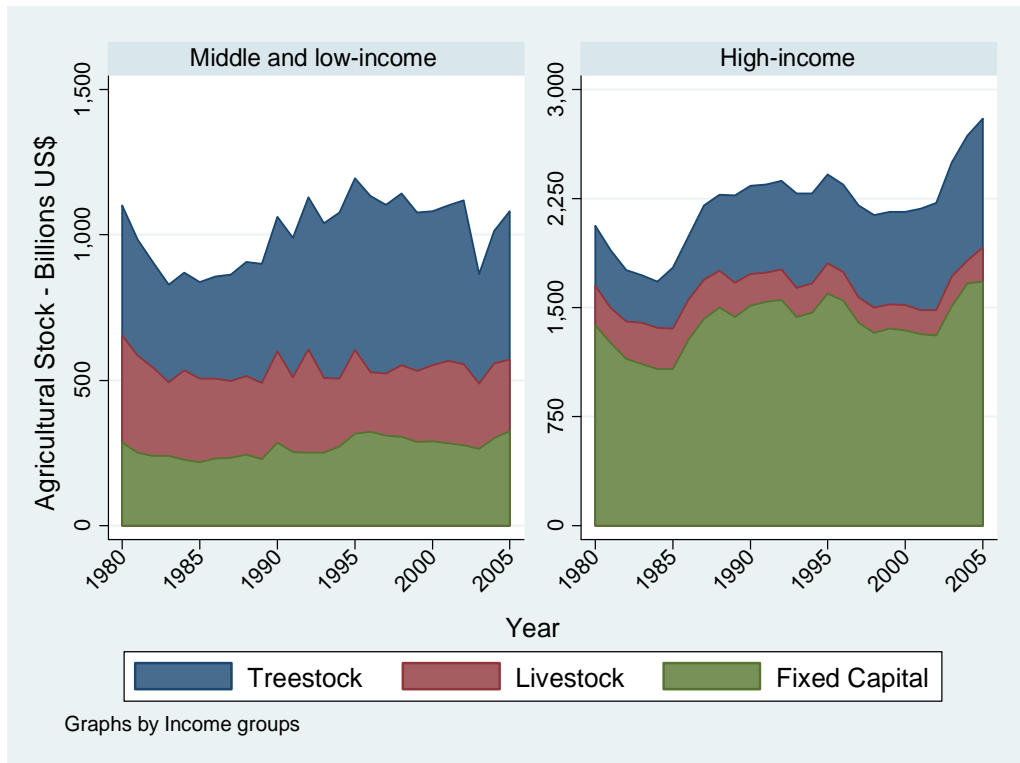


Figure 6: Components of ACS per agricultural worker

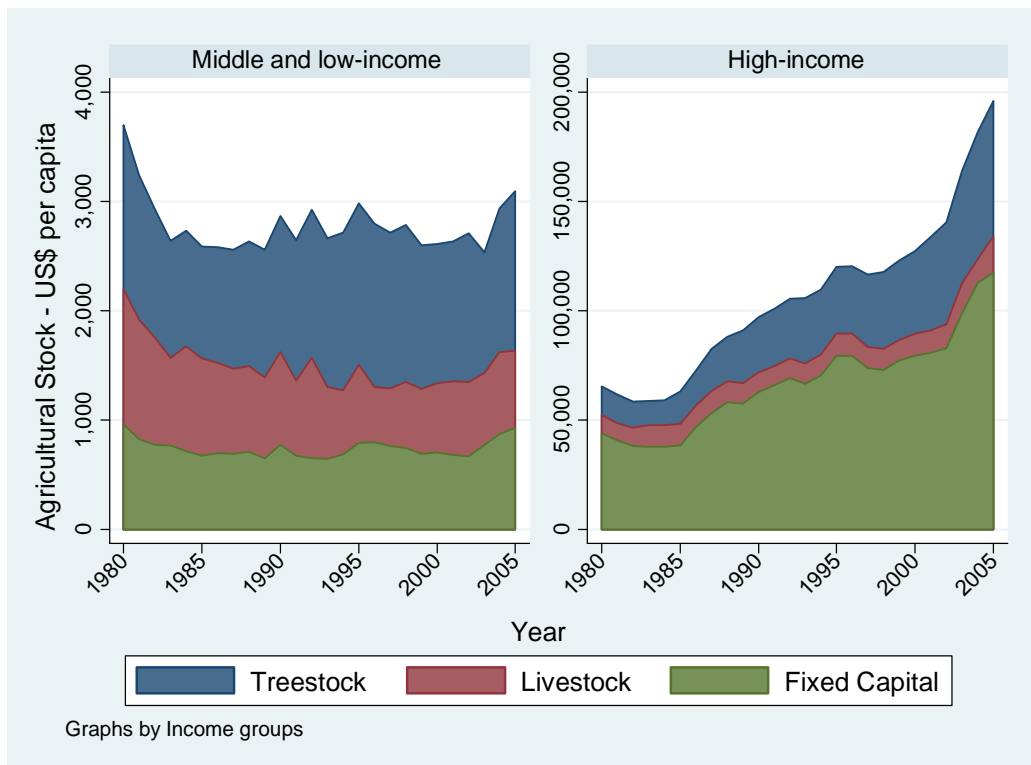


Figure 7: Average annual growth rates in global ACS components (five-year periods since 1970, in percent) by income groups

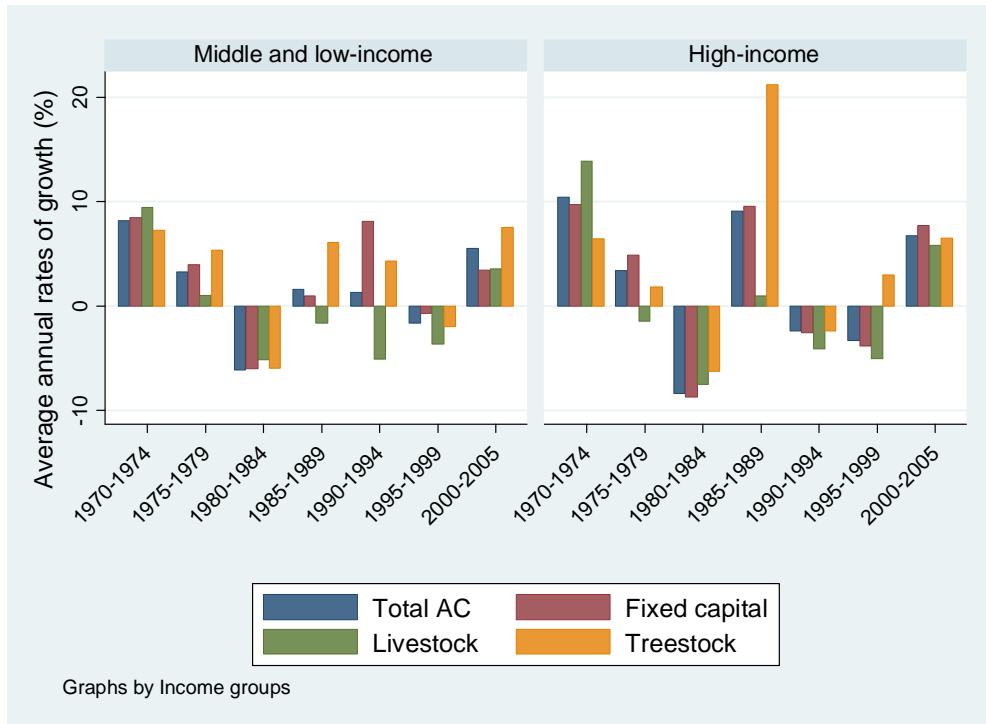


Figure 8: GDP per worker versus fixed capital per worker in agriculture, 1970-2005

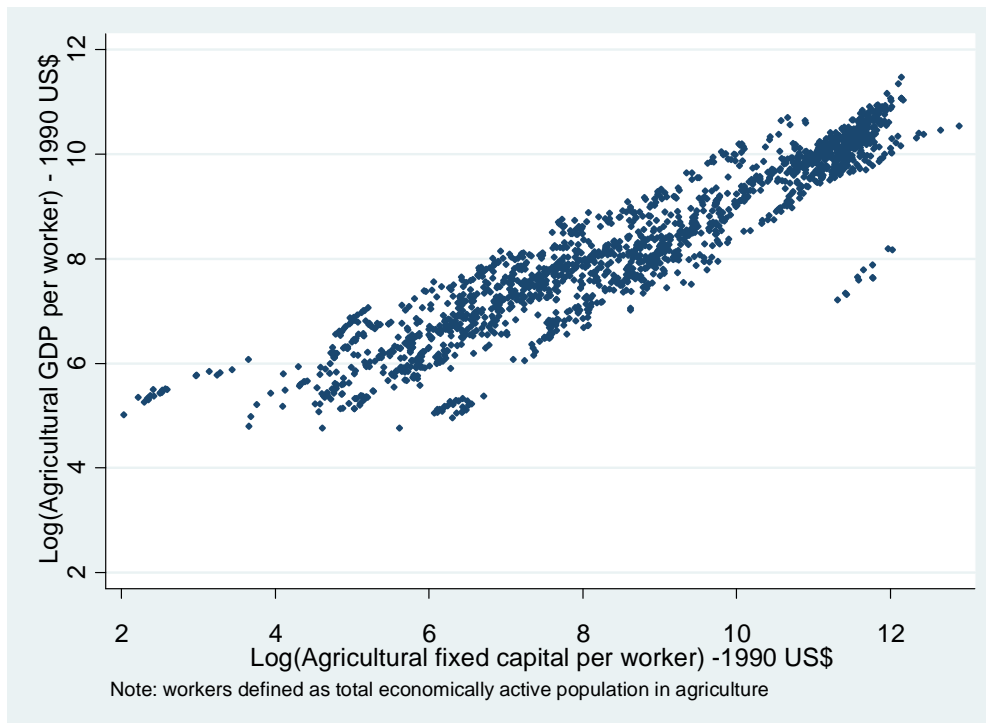
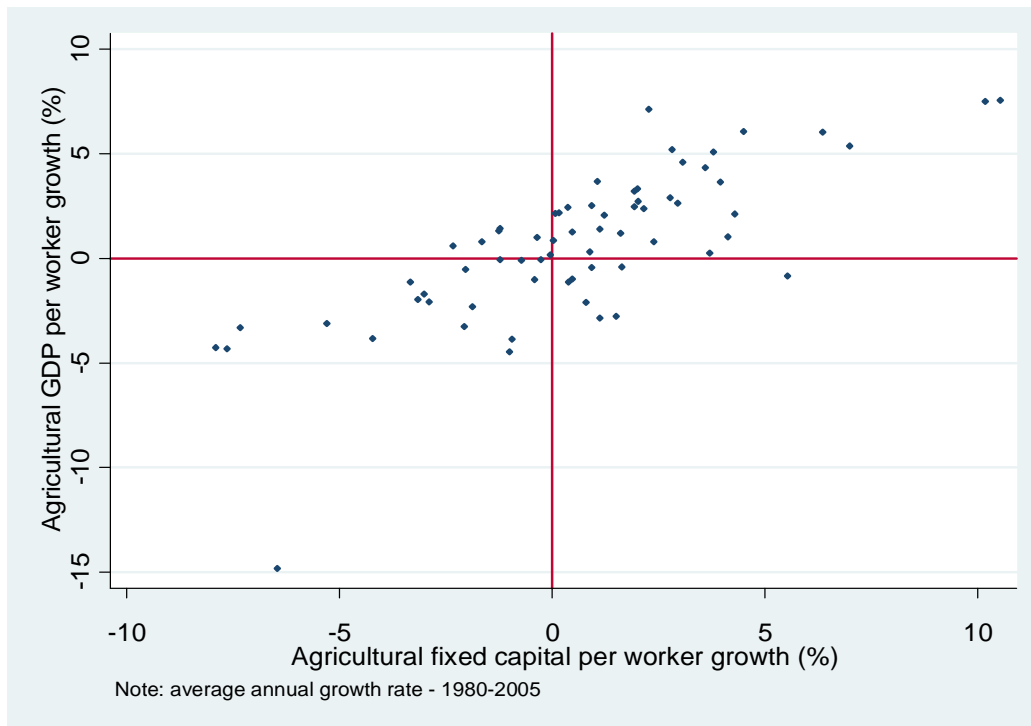


Figure 9: Growth of GDP per worker versus growth of fixed capital per worker in agriculture, 1980-2005



Appendix 1: Abbreviations for names of countries/territories

Abbreviation	Country name	Abbreviation	Country name
ANT	Netherlands Antilles	JOR	Jordan
ARG	Argentina	JPN	Japan
ARM	Armenia	KEN	Kenya
AUS	Australia	KOR	Korea, Rep. of
AUT	Austria	LKA	Sri Lanka
AZE	Azerbaijan	LTU	Lithuania
BLR	Belarus	LVA	Latvia
BLX	Belgium-Luxembourg	MAR	Morocco
BOL	Bolivia	MDA	Moldova
BRA	Brazil	MDG	Madagascar
BWA	Botswana	MEX	Mexico
CAN	Canada	MLT	Malta
CHL	Chile	MUS	Mauritius
COL	Colombia	MWI	Malawi
CRI	Costa Rica	NAM	Namibia
CSK	Czechoslovakia	NER	Niger
CYP	Cyprus	NLD	Netherlands
CZE	Czech Republic	NOR	Norway
DEU	Germany	NZL	New Zealand
DNK	Denmark	PAK	Pakistan
DOM	Dominican Republic	PER	Peru
EGY	Egypt	PHL	Philippines
ESP	Spain	POL	Poland
EST	Estonia	PRT	Portugal
FIN	Finland	SLV	El Salvador
FJI	Fiji Islands	SVK	Slovakia
FRA	France	SVN	Slovenia
GBR	United Kingdom	SWE	Sweden
GRC	Greece	SYR	Syrian Arab Republic
GTM	Guatemala	TTO	Trinidad and Tobago
HND	Honduras	TUN	Tunisia
IDN	Indonesia	TUR	Turkey
IND	India	TWN	Taiwan Province of China
IRL	Ireland	TZA	United Republic of Tanzania
IRN	Iran	UKR	Ukraine
IRQ	Iraq	URY	Uruguay
ISL	Iceland	USA	United States of America
ISR	Israel	VEN	Venezuela
ITA	Italy	ZAF	South Africa
JAM	Jamaica	ZWE	Zimbabwe

Appendix 2: STATA program to calculate agricultural capital stock

```

***** Set working directories *****
clear all
set more off
gl RAW ...\RawData
gl TEMP ...\TempData

*****

***** STEP 1: COMPUTE PRODUCTIVITY COEFFICIENTS *****

clear
set obs 199
gen year=1850+_n if _n<158

mac def mu=20
mac def sigma=8
mac def beta=.7

gen lifetime=20-(100-_n)
local zmin=((mu-2*sigma-.5)-mu)/sigma
local zmax=((mu+2*sigma+.5)-mu)/sigma
mac def denom=normal($zmax)-normal($zmin)

gen sub = 20-_n+.5 if _n<100
gen subpr = (normal((sub[_n]-mu)/sigma) - ///
             normal((sub[_n]-mu)/sigma))/denom if _n>1 & _n<100
replace subpr = (normal((mu-mu)/sigma) - normal((sub[_n]-mu)/sigma))/denom in 1
replace subpr = 0 if sub<3
gen freq=.
forvalues l=2/99 {
    local place = $l+99
    qui replace freq = subpr[$l] in $place
    local inv=100-$l+1
    qui replace freq=subpr[$inv] in $l
}
replace freq=subpr[1]*2 in 100
replace freq=0 if freq==.

qui sum year
local dimss=r(N)
qui sum lifetime
local dimlt=r(N)

mat SERV=J($dimss,$dimss,.)

forvalues i=1/$dimss {
    local rows=$dimss-$i+1
    mat SERV[$i,$i]=J($rows,1,0)
    forvalues j=1/$dimlt {
        if (freq[$j] > 0) {
            local lp=min(lifetime[$j],$rows)
            forvalues k=1/$lp {
                local r=$i+$k-1
                mat SERV[$r,$i] = SERV[$r,$i] + freq[$j]*(lifetime[$j] -///
                ($k-1))/(lifetime[$j] - $beta*($k-1))
            }
        }
    }
}

svmat SERV
local j = 1851
forvalues i = 1/157 {
    rename SERV`i' SERV`j'
    local j = `j'+1
}

```

```

drop lifetime sub subpr freq
keep if year>1947
drop SERV1851-SERV1912
drop if year == .

drop SERV1949- SERV2007
#delimit;
global SERV "SERV1913 SERV1914 SERV1915 SERV1916 SERV1917 SERV1918 SERV1919 SERV1920
SERV1921 SERV1922 SERV1923 SERV1924 SERV1925 SERV1926 SERV1927 SERV1928
SERV1929 SERV1930 SERV1931 SERV1932 SERV1933 SERV1934 SERV1935 SERV1936
SERV1937 SERV1938 SERV1939 SERV1940 SERV1941 SERV1942 SERV1943 SERV1944
SERV1945 SERV1946 SERV1947 SERV1948";
#delimit cr

local i = 35
foreach k of global SERV {
    replace `k'=. in 2/59
    egen SERV_back`i'=total(`k')
    drop `k'
    local i = `i'-1
}
sort year
lab data "Productivity Coefficients"
save $TEMP\Weights, replace

***** STEP 2: COMPUTE AGRICULTURAL FIXED CAPITAL STOCK *****

/* The file AgInvest.dta is stored in the RawData folder and contains:
a) the gross fixed capital formation series;
b) the deflator series.
The AgGdp.dta contains the Agricultural GDP series */

use "$RAW\AgInvest", clear
reshape wide AgSEInv Def, i(imf_id) j(year)

*** Loop needed to create longer series
forvalues i=1915/1949 {
    cap gen AgSEInv`i' = .
    cap gen Def`i' = .
}
qui reshape long AgSEInv Def, i(imf_id) j(year)
merge 1:1 imf_id year using "$RAW\AgGdp"
drop if _m == 2
drop _m

tsset imf_id year
gen AgSEInv_copy = AgSEInv
gen AgGdp_copy = AgGdp
gen LnAgGdp = ln(AgGdp)
gen AgGdpRes = .

bys iccode: egen count1 = count(LnAgGdp)

*** ASSUME TREND STATIONARITY FOR COUNTRIES WITH LESS THAN 30 OBSERVATIONS
preserve
keep if count1 < 30
drop count1
encode wbcc, gen(id_AGC)
qui su id_AGC
local IDAGC = r(max)
forvalues i=1/'IDAGC' {
    cap qui regress LnAgGdp year if id_AGC==`i'
    cap qui predict LnAgGdp_hat`i' if id_AGC==`i' , xb
    cap qui predict LnAgGdp_res`i' if id_AGC==`i' , res
    cap qui egen Dsmear`i' = mean(exp(LnAgGdp_res`i')) if id_AGC==`i'
    cap qui gen AgGdp_hat`i' = exp(LnAgGdp_hat`i')* Dsmear`i' if id_AGC==`i'
    cap qui replace AgGdpRes = LnAgGdp_res`i' if id_AGC==`i'
    cap qui replace AgGdp_copy = AgGdp_hat`i' if id_AGC==`i' & AgGdp_copy == .
}

```

```

        cap qui replace AgGdpHat = AgGdp_hat`i' if id_AG==`i'
        cap drop Dsmear`i' LnAgGdp_hat`i' AgGdp_hat`i' LnAgGdp_res`i'
    }
    drop id_AG
    sort iccode year
    save "$TEMP/count1.dta", replace
    restore

    drop if count1 < 30
    drop count1
    encode wbcc, gen(id_AG)

    *** IMPLEMENTING CUSUM TEST TO CHECK FOR THE PRESENCE OF STRUCTURAL BREAKS
    qui su id_AG
    local MAX = r(max)

    forvalues k=1/`MAX' {
        preserve
        qui keep if id_AG == `k'
        qui tsset year
        qui cusum6 LnAgGdp year, cs(cusum) lw(lower) uw(upper) noplot
        qui g du = (cusum > upper)
        qui g dl = (cusum < lower)
        qui egen up = max(du)
        qui egen low = max(dl)
        qui gen break = (up==1 | low==1)
        qui gen duL1 = l1.du
        qui gen dlL1 = l1.dl
        qui gen year_c = year if ( du==1 & duL1==0 ) | ( dl==1 & dlL1==0 )
        qui egen year_cusum = max(year_c)
        qui keep id_AG break year_cusum
        qui duplicates drop
        qui compress
        tempfile cusum`k'
        qui save `cusum`k'', replace
        restore
    }

    preserve
    use `cusum1', clear
    forvalues h=2/`MAX' {
        qui append using `cusum`h''
    }
    sort id_AG
    tempfile cusum
    save `cusum', replace
    restore

    sort id_AG
    merge id_AG using `cusum'
    drop _m id_AG

    *** IF NO STRUCTURAL BREAK, SIMPLE REGRESSION
    preserve
    keep if break == 0
    drop break
    encode wbcc, gen(id_AG_break)
    qui su id_AG_break
    local MAXBREAK = r(max)
    forvalues i=1/`MAXBREAK' {
        cap qui regress LnAgGdp year if id_AG_break==`i'
        cap qui predict LnAgGdp_hat`i' if id_AG_break==`i' , xb
        cap qui predict LnAgGdp_res`i' if id_AG_break==`i' , res
        cap qui egen Dsmear`i' = mean(exp(LnAgGdp_res`i')) if id_AG_break==`i'
        cap qui gen AgGdp_hat`i' = exp(LnAgGdp_hat`i')*Dsmear`i' if id_AG_break==`i'
        cap qui replace AgGdpRes=LnAgGdp_res`i' if id_AG_break==`i'
        cap qui replace AgGdp_copy=AgGdp_hat`i' if id_AG_break==`i' & AgGdp_copy==.
        cap qui replace AgGdpHat = AgGdp_hat`i' if id_AG_break==`i'
        cap drop Dsmear`i' LnAgGdp_hat`i' AgGdp_hat`i' LnAgGdp_res`i'
    }

```

```

}
drop id_AG_break year_cusum
sort iccode year
save "$TEMP/break.dta", replace
restore

drop if break == 0
drop break

encode wbcc, gen(id_LNAG)
bys id_LNAG: egen miny_AG = min(year) if LnAgGdp !=.
bys id_LNAG: egen maxy_AG = max(year) if LnAgGdp !=.

preserve
keep if LnAgGdp !=.
duplicates drop wbcc, force
keep maxy_AG miny_AG id_LNAG
tempfile minmaxy
save `minmaxy', replace
restore

bys id_LNAG: egen count1 = count(LnAgGdp)

*** Set the trimming periods for the maximum F-stat
gen nperiods = count1 + 2 - int(count1 *.5)
qui su nperiods
local maxp = r(max)
forvalues j = 1/`maxp' {
    cap qui gen period`j' = .
}
bys id_LNAG: g trim = int(count1 *.25)-1

*** IF THERE IS A BREAK, TAKE THE MAXIMUM OF THE CHOW F-TEST ...
qui su id_LNAG
local MAXLNAG = r(max)
di `MAXLNAG'
forvalues k=1/`MAXLNAG' {
    qui su miny_AG if id_LNAG== `k'
    local miny_AG = r(mean)
    qui su nperiods if id_LNAG== `k'
    local period = r(mean)
    qui su trim if id_LNAG== `k'
    local trim = r(mean)
    mat F`k' = J(`period',3,.)
    matrix colnames F`k' = id_LNAG year F
    forvalues i = 1/`period' {
        cap qui replace period`i'=0 if year<(miny_AG+`trim'+`i') & LnAgGdp !=. &
        id_LNAG==`k'
        cap qui replace period`i'=1 if year>=(miny_AG+`trim'+`i') & LnAgGdp!=. &
        year!=. & id_LNAG==`k'
        cap qui regress LnAgGdp year if id_LNAG==`k' & period`i'==1
        scalar SSE1 = e(rss)
        cap qui regress LnAgGdp year if id_LNAG==`k' & period`i'==0
        scalar SSE0 = e(rss)
        cap qui regress LnAgGdp year if id_LNAG== `k'
        scalar SSEc = e(rss)
        scalar dfN = e(df_m)+1
        scalar dfD = e(N)-2*(e(df_m))-2
        mat F`k'[`i',1 ] = `k'
        mat F`k'[`i',2 ] = `miny_AG'+ `trim' + `i'
        mat F`k'[`i',3 ] = (SSEc-SSE0-SSE1)/((SSE0+SSE1)/(e(N)-2*(e(df_m))))
    }
}
drop period*

preserve
clear
forvalues h=1/`MAXLNAG' {
    qui svmat F`h', names(col)

```

```

        tempfile F`h'
        qui save `F`h'', replace
        clear
    }
    use `F1', clear
    forvalues h=2/\MAXLNAG' {
        qui append using `F`h''
    }
    sort id_LNAG year
    bys id_LNAG: egen maxF = max(F)
    drop if F<maxF
    merge 1:1 id_LNAG using `minmaxy'
    drop _m
    gen critical = 11.48 /* 5% significance level given in Andrews (1993) */
    gen break = (maxF>critical)

    *** Correct Critical values
    ren year year_chow_F
    keep year_chow_F F id_LNAG
    sort id_LNAG
    save "$TEMP\chow_LNAG1.dta", replace
    restore

    merge n:1 id_LNAG using "$TEMP\chow_LNAG1.dta"
    drop _m

    *** GENERATE LONGER GDP SERIES, TAKING INTO ACCOUNT OF STRUCTURAL CHANGE
    gen t = year-1909
    gen tb = year_chow-1909
    bys id_LNAG: gen DUt = (t>tb)
    bys id_LNAG: gen DTtstar = t-tb if t>tb
    bys id_LNAG: replace DTtstar = 0 if DTtstar == .

    qui su id_LNAG
    local MAXLNAG = r(max)
    forvalues i=1/\MAXLNAG' {
        cap qui regress LnAgGdp t DUt DTtstar if id_LNAG ==`i'
        cap qui predict LnAgGdp_hat`i' if id_LNAG ==`i' , xb
        cap qui predict LnAgGdp_res`i' if id_LNAG ==`i' , res
        cap qui egen Dsmear`i' = mean(exp(LnAgGdp_res`i')) if id_LNAG ==`i'
        cap qui gen AgGdp_hat`i' = exp(LnAgGdp_hat`i')* Dsmear`i' if id_LNAG ==`i'
        cap qui replace AgGdpRes = LnAgGdp_res`i' if id_LNAG ==`i'
        cap qui replace AgGdp_copy=AgGdp_hat`i' if id_LNAG==`i' & AgGdp_copy==.
        cap qui replace AgGdpHat = AgGdp_hat`i' if id_LNAG ==`i'
        cap drop Dsmear`i' LnAgGdp_hat`i' AgGdp_hat`i' LnAgGdp_res`i'
    }

    append using "$TEMP/count1.dta"
    append using "$TEMP/break.dta"
    ren year_chow year_chow_AG

    drop year_cusum-DTtstar
    drop LnAgGdp
    gen Ia = (AgSEInv/AgGdp_copy)

    ***** 2ND STEP - PREDICT INVESTMENT IN AGRICULTURE
    bys iccode: egen count2 = count(AgSEInv)
    bys iccode: gen missing = missing(AgSEInv) if year >= miny & year <= maxy
    bys iccode: egen miss = mean(missing)

    /* ASSUME CONSTANT INVESTMENT TO GDP RATIO (IA) WITH FLUCTUATIONS DRIVEN BY GDP RESIDUALS
    FOR SERIES:
    1) WITH LESS THAN 30 OBSERVATIONS
    2) WITH GAPS IN THE SERIES */

    preserve
    keep if count2 < 30 | miss != 0
    drop count2 miss
    encode wbcc, gen(id_INVC)

```



```

qui su id_INVC
local IDINVC = r(max)
gen Iahat = .
forvalues i=1/\`IDINVC' {
    cap qui gen Iahat`i' = .
    cap qui replace Iahat`i' = Ia
    cap qui regress Ia AgGdpRes if id_INVC == `i'
    cap qui replace Iahat`i' = _b[_cons] if id_INVC == `i' & Iahat`i' == .
    cap qui replace AgInvHat = AgGdp_copy*_b[_cons] if id_INVC == `i'
    cap qui replace Iahat = Iahat`i' if id_INVC == `i'
}
renvars Iahat, u
drop Iahat*

forvalues i=1/\`IDINVC' {
    qui replace AgSEInv_copy=AgGdp_copy*IAHAT if AgSEInv_copy==. & id_INVC==`i'
}

drop id_INVC AgGdpRes LnAgGdp missing
sort iccode year
save "$TEMP/count2.dta", replace
restore

drop if count2 < 30 | miss != 0
drop count2 miss
encode wbcc, gen(id_INV)

*** IMPLEMENTING CUSUM TEST TO CHECK FOR THE PRESENCE OF STRUCTURAL BREAK IN IA
qui su id_INV
local MAX = r(max)

forvalues k=1/\`MAX' {
    preserve
    qui keep if id_INV == `k'
    qui tsset year
    qui cusum6 Ia AgGdpRes, cs(cusum) lw(lower) uw(upper) noplot
    qui g du = (cusum > upper)
    qui g dl = (cusum < lower)
    qui egen up = max(du)
    qui egen low = max(dl)
    qui gen break = (up==1 | low==1)
    qui gen duL1 = l1.du
    qui gen dlL1 = l1.dl
    qui gen year_c = year if ( du==1 & duL1==0) | ( dl==1 & dlL1==0)
    qui egen year_cusum = max(year_c)
    qui keep id_INV break year_cusum
    qui duplicates drop
    qui compress
    tempfile cusum`k'
    qui save `cusum`k'', replace
    restore
}

preserve
use `cusum1', clear
forvalues h=2/\`MAX' {
    qui append using `cusum`h''
}
sort id_INV
tempfile cusum
save `cusum', replace
restore

merge n:1 id_INV using `cusum'
drop _m id_INV missing year_cusum

*** IF NO BREAK IN IA, SIMPLE REGRESSION
preserve
keep if break == 0

```

```

drop break
encode wbcc, gen(id_INV_break)
qui su id_INV_break
local MAXBREAK = r(max)
gen Iahat = .
forvalues i=1/\`MAXBREAK' {
    cap qui gen Iahat`i' = .
    cap qui replace Iahat`i' = Ia
    cap qui regress Ia AgGdpRes if id_INV_break == `i'
    cap qui replace Iahat`i' = _b[_cons] if id_INV_break == `i' & Iahat`i' == .
    cap qui replace AgInvHat = AgGdp_copy*_b[_cons] if id_INV_break == `i'
    cap qui replace Iahat = Iahat`i' if id_INV_break == `i'
}
renvars Iahat, u
drop Iahat*

forvalues i=1/\`MAXBREAK' {
    qui replace AgSEInv_copy=AgGdp_copy*IAHAT if AgSEInv_copy==. & id_INV_break==`i'
}

drop id_INV_break AgGdpRes LnAgGdp
sort iccode year
save "$TEMP/break_INV.dta", replace
restore

drop if break == 0
drop break
encode wbcc, gen(id_LNINV)

preserve
keep if AgSEInv !=.
duplicates drop wbcc, force
keep maxy miny id_LNINV
sort id_LNINV
tempfile minmaxy
save `minmaxy', replace
restore

bys id_LNINV: egen count1 = count(AgSEInv)
gen nperiods = count1 + 2 - int(count1 *.5)
qui su nperiods
local maxp = r(max)
forvalues j = 1/\`maxp' {
    cap qui gen period`j' = .
}

bys id_LNINV: g trim = int(count1 *.25)-1

*** IF THERE IS A BREAK, TAKE THE MAXIMUM OF THE CHOW F-TEST
qui su id_LNINV
local MAXLNINV = r(max)
forvalues k=1/\`MAXLNINV' {
    qui su miny if id_LNINV== `k'
    local miny = r(mean)
    qui su nperiods if id_LNINV== `k'
    local period = r(mean)
    qui su trim if id_LNINV== `k'
    local trim = r(mean)
    mat F`k' = J(`period',3,..)
    matrix colnames F`k' = id_LNINV year F
    forvalues i = 1/\`period' {
        cap qui replace period`i'=0 if year<(miny+`trim'+`i') & AgSEInv !=. & id_LNINV==`k'
        cap qui replace period`i'=1 if year>=(miny+`trim'+`i') & AgSEInv !=. & year !=. & id_LNINV==`k'
        cap qui regress Ia AgGdpRes if id_LNINV == `k' & period`i' == 1
        scalar SSE1 = e(rss)
        cap qui regress Ia AgGdpRes if id_LNINV== `k' & period`i' == 0
        scalar SSE0 = e(rss)
    }
}

```

```

        cap qui regress Ia AgGdpRes if id_LNINV== `k'
        scalar SSec = e(rss)
        scalar dfN = e(df_m)+1
        scalar dfD = e(N)-2*(e(df_m))-2
        mat F`k'[`i',1 ] = `k'
        mat F`k'[`i',2 ] = `miny'+ `trim' + `i'
        mat F`k'[`i',3 ] = (SSec-SSE0-SSE1)/((SSE0+SSE1)/(e(N)-2*(e(df_m))))
    }
}
drop period*

preserve
clear
forvalues h=1/\MAXLNINV' {
    svmat F`h', names(col)
    tempfile F`h'
    qui save `F`h'', replace
    clear
}
use `F1', clear
forvalues h=2/\MAXLNINV' {
    qui append using `F`h''
}
sort id_LNINV year
drop if F == .
bys id_LNINV: egen maxF = max(F)
drop if F<maxF
merge 1:1 id_LNINV using `minmaxy'
drop _m
gen critical = 11.48
gen break = (maxF>critical)

*** Correct Critical values
ren year year_chow_F
keep year_chow_F F id_LNINV break
sort id_LNINV
save "$TEMP\chow_LNINV1.dta", replace
restore

merge n:1 id_LNINV using "$TEMP\chow_LNINV1.dta"
drop _m
sort id_LNINV year
drop count1 nperiods trim F id_LNINV

*** IF THE CHOW-TEST REJECTED STRUCTURAL BREAK (OPPOSITE TO CUSUM TEST)
preserve
keep if break == 0
drop break
encode wbcc, gen(id_INV_break2)
qui su id_INV_break2
local MAXBREAK2 = r(max)
gen Iahat = .
forvalues i=1/\MAXBREAK2' {
    cap qui gen Iahat`i' = .
    cap qui replace Iahat`i' = Ia
    cap qui regress Ia AgGdpRes if id_INV_break2==`i'
    cap qui replace Iahat`i' = _b[_cons] if id_INV_break2==`i' & Iahat`i' == .
    cap qui replace AgInvHat = AgGdp_copy*_b[_cons] if id_INV_break2 == `i'
    cap qui replace Iahat = Iahat`i' if id_INV_break2 ==`i'
}
renvars Iahat, u
drop Iahat*

forvalues i=1/\MAXBREAK2' {
    qui replace AgSEInv_copy=AgGdp_copy*IAHAT if AgSEInv_copy==. & id_INV_break2==`i'
}

drop id_INV_break2 AgGdpRes LnAgGdp year_chow_F
sort iccode year

```

```

save "$TEMP/break_INV2.dta", replace
restore

drop if break == 0
drop break

*** GENERATE LONGER INVESTMENT SERIES, TAKING INTO ACCOUNT OF STRUCTURAL CHANGE
encode wbcc, gen(id_IA)
gen t = year-1909
gen tb = year_chow-1909
bys id_IA: gen DUt = (t>tb)

qui su id_IA
local IDIA = r(max)
gen Iahat = .
forvalues i=1/'IDIA' {
    cap qui gen Iahat`i' = .
    cap qui replace Iahat`i' = Ia
    cap qui regress Ia AgGdpRes DUt if id_IA == `i'
    cap qui replace Iahat`i'=_b[_cons]+_b[DUt]*DUt if id_IA==`i' & Iahat`i'==.
    cap qui replace AgInvHat=AgGdp_copy*_b[_cons]+_b[DUt]*DUt if id_IA == `i'
    cap qui replace Iahat = Iahat`i' if id_IA == `i'
}
renvars Iahat, u
drop Iahat*

forvalues i=1/'IDIA' {
    qui replace AgSEInv_copy=AgGdp_copy*IAHAT if AgSEInv_copy==. & id_IA==`i'
}

drop id_IA AgGdpRes LnAgGdp year_chow_F- DUt

append using "$TEMP/count2.dta"
append using "$TEMP/break_INV.dta"
append using "$TEMP/break_INV2.dta"

tsset imf_id year
forvalues i=0/35 {
    g AgSEInv_L`i'=L`i'.AgSEInv_copy
}
merge n:1 year using "$TEMP/weights"
drop if _m == 2
drop _m
merge n:1 year using "$RAW\US_AgInvDef"
drop _m
merge n:1 year using "$RAW\US_TotInvDef"
drop _m
merge 1:1 imf_id year using "$RAW\exrates"
drop if _m == 2
drop _m

forvalues i = 0/35 {
    g Add`i'= (AgSEInv_L`i'*SERV_back`i')
}

/*-----
      AGRICULTURAL FIXED CAPITAL STOCK
-----*/

*** Compute Agricultural Capital Stock in 1990 Local Currency Unit
egen AgSECap_LCU90 = rsum(Add0-Add34)

*** Compute Agricultural Capital Stock in current Local Currency Unit
gen AGSECap_LCUcurr = (AgSECap_LCU90*Def)/100

*** Compute Agricultural Capital Stock in current US$
gen AGSECap_UScurr = AGSECap_LCUcurr/Ex_Rate

```

```

*** Compute Agricultural Capital Stock in 1990 US$
gen AgSECap_US90 = (AGSECap_UScurr/AgInvDefUS)*100
replace AgSECap_US90 = (AGSECap_UScurr/TotInvDefUS)*100 if AgSECap_US90 == .

drop Add* SERV_back* AgSEInv_L* Ia IAHA
compress
sort imf_id year
save "$TEMP\AgSECap", replace

***** STEP 3: COMPUTE LIVESTOCK *****

/* The files livestock_id - livestock_stock - livestock_EQ - livestock_EV - livestock_IQ
- livestock_IV are stored in the RawData folder and contain respectively the animal
identifier, the number of heads by each animal id, the number of exported heads, the
value of exported heads, the number of imported heads, the value of imported heads */

*** Set the livestock quantity
use "$RAW\livestock_id", clear
merge 1:n liv_id using "$RAW\livestock_stock"
drop _m
reshape long livestock, i(imf_id liv_id) j(year)
compress
merge n:1 imf_id using "$RAW\country_id"
drop if _m == 2
drop _m country_name ccode incgrp
label var year "Year"
label var livestock "Livestock Quantity (Heads)"
label var regwb "World Bank Regional Grouping"
sort year regwb liv_id
save "$TEMP\livestock_stock", replace

/*----- EXPORT QUANTITIES -----*/
use $RAW\livestock_id, clear
merge 1:n liv_id using "$RAW\livestock_EQ"
keep if _m == 3
drop _m
reshape long eq, i(imf_id liv_id) j(year)
label var eq "Exported Livestock Units"
drop if eq == . | eq == 0
tempfile expq
save `expq', replace

/*----- EXPORT VALUES -----*/
use "$RAW\livestock_id", clear
merge 1:n liv_id using "$RAW\livestock_EV"
keep if _m == 3
drop _m
reshape long ev, i(imf_id liv_id) j(year)
label var ev "Value of Exported Livestock, Current US $"
drop if ev == . | ev == 0

/*----- COMPUTE EXPORT PRICES -----*/
merge 1:1 imf_id year liv_id using `expq'
keep if _m == 3
drop _m
merge n:1 imf_id using "$RAW\country_id"
drop if _merge == 2
drop _m ccode incgrp country_name
bys year regwb liv_id: egen reg_ev = total(ev)
bys year liv_id: egen wd_ev = total(ev)
label var reg_ev "Value of Region Exported Livestock, Current US $"
label var wd_ev "Value of World Exported Livestock, Current US $"
bys year regwb liv_id: egen reg_eq = total(eq)
bys year liv_id: egen wd_eq = total(eq)
label var reg_eq "Region Exported Livestock Quantity"

```

```

label var wd_eq "World Exported Livestock Quantity"

gen reg_exprice = reg_ev / reg_eq
label var reg_exprice "Regional Export Price, Current US $"
gen wd_exprice = wd_ev / wd_eq
label var wd_exprice "World Export Price, Current US $"

keep liv_id year regwb reg_exprice wd_exprice
duplicates drop
lab var year "Year"
sort year regwb liv_id
compress
save "$TEMP\liv_exprice", replace

/*----- IMPORT QUANTITIES -----*/
use "$RAW\livestock_id", clear
merge 1:n liv_id using "$RAW\livestock_IQ"
keep if _m == 3
drop _m
reshape long iq, i(imf_id liv_id) j(year)
label var iq "Imported Livestock Units"
drop if iq == . | iq == 0
tempfile impq
save `impq', replace

/*----- IMPORT VALUES -----*/
use $RAW\livestock_id, clear
merge 1:n liv_id using $RAW\livestock_IV.dta
keep if _m == 3
drop _m
reshape long iv, i(imf_id liv_id) j(year)
label var iv "Value of Imported Livestock, Current US $"
drop if iv == . | iv == 0

/*----- COMPUTE IMPORT PRICES -----*/
merge 1:1 imf_id year liv_id using `impq'
keep if _m == 3
drop _m
merge n:1 imf_id using $RAW\country_id
drop if _merge == 2
drop _m ccode incgrp country_name
bys year regwb liv_id: egen reg_iv = total(iv)
bys year liv_id: egen wd_iv = total(iv)
label var reg_iv "Value of Region Imported Livestock, Current US $"
label var wd_iv "Value of World Imported Livestock, Current US $"
bys year regwb liv_id: egen reg_iq = total(iq)
bys year liv_id: egen wd_iq = total(iq)
label var reg_iq "Region Imported Livestock Quantity"
label var wd_iq "World Imported Livestock Quantity"

gen reg_imprice = reg_iv / reg_iq
label var reg_imprice "Regional Import Price, Current US $"
gen wd_imprice = wd_iv / wd_iq
label var wd_imprice "World Import Price, Current US $"

keep liv_id year regwb reg_imprice wd_imprice
duplicates drop
lab var year "Year"
sort year regwb liv_id
compress
save "$TEMP\liv_imprice", replace

use "$TEMP\livestock_stock", clear
merge n:1 year regwb liv_id using "$TEMP\liv_exprice"
drop _m
merge n:1 year regwb liv_id using "$TEMP\liv_imprice"
drop _m

drop if fao_id == .

```

```

drop wbcc imf_id country_id
preserve
use "$RAW\country_id", clear
sort fao_id
tempfile id
save `id`, replace
restore
merge n:1 fao_id using `id`
drop if _m == 2
drop country_name - _m
order year imf_id fao_id wbcc country_id liv_id livestock

drop if livestock==. & reg_exprice==. & reg_imprice==. & wd_exprice==. & wd_imprice==.
drop if livestock==0 & reg_exprice==. & reg_imprice==. & wd_exprice==. & wd_imprice==.
drop if reg_exprice==. & reg_imprice==. & wd_exprice==. & wd_imprice==.
drop if livestock==.

/*-----
LIVESTOCK VALUE
-----*/
gen liv_value = livestock* reg_exprice
replace liv_value = livestock* reg_imprice if liv_value == .
replace liv_value = livestock*wd_exprice if liv_value == .
replace liv_value = livestock*wd_imprice if liv_value == .

bys year imf_id: egen livestock = total(liv_value)
drop if livestock == .
drop if livestock == 0
drop livestock reg_exprice wd_exprice reg_imprice wd_imprice liv_id liv_value
duplicates drop
merge n:1 year using "$RAW\US_AgInvDef"
keep if _m == 3
drop _m
gen Livestock = (livestock/AgInvDefUS)*100
label var Livestock "Value of Livestock Capital, Constant 1990 US $"
label var livestock "Value of Livestock Capital, current US$"
drop AgInvDefUS regwb
compress
sort imf_id year
save "$TEMP\livestock", replace

***** STEP 4: COMPUTE TREESTOCK *****

/* The files orchard_area - orchard_prices - orchard_prices_SLC - orchard_yield are
stored in the RawData folder and contain respectively the animal identifier, the number
of heads by each animal id, the number of exported heads, the value of exported heads,
the number of imported heads, the value of imported heads */

use "$RAW\orchard_area", clear
drop if imf_id == .
reshape long area, i(imf_id orch_id) j(year)
drop if area == .
rename area area_k
sort imf_id
label var year "Year"
label var area_k "Area harvested by crop, hectares"
sort imf_id orch_id year
compress
save "$TEMPORCH\orchard_area", replace

/*-----
INPUT DATA ON ORCHARD PRICES BY COMMODITY FOR EACH
COUNTRY. ORCHARDS PRICES FROM FAOSTAT
-----*/
use "$RAW\orchard_prices", clear

```

```

*** Convert prices in euro for eurozone (imf exrates are set in euros at parity date).
French territories outside France included
forvalues i = 1966/2001 {
    replace price`i' = price`i'/6.55957 if imf_id == 696
    replace price`i' = price`i'/6.55957 if imf_id == 333
    replace price`i' = price`i'/6.55957 if imf_id == 329
    replace price`i' = price`i'/6.55957 if imf_id == 349
    replace price`i' = price`i'/13.7603 if imf_id == 122
    replace price`i' = price`i'/40.3399 if imf_id == 124
    replace price`i' = price`i'/5.94573 if imf_id == 172
    replace price`i' = price`i'/6.55957 if imf_id == 132
    replace price`i' = price`i'/1.95583 if imf_id == 134
    replace price`i' = price`i'/0.787564 if imf_id == 178
    replace price`i' = price`i'/1936.27 if imf_id == 136
    replace price`i' = price`i'/40.3399 if imf_id == 137
    replace price`i' = price`i'/2.20371 if imf_id == 138
    replace price`i' = price`i'/200.482 if imf_id == 182
    replace price`i' = price`i'/166.386 if imf_id == 184
    replace price`i' = price`i'/6.55957 if imf_id == 363
    replace price`i' = price`i'/40.3399 if imf_id == 126
    replace price`i' = price`i'/340.750 if imf_id == 174
}
drop pricel1991-price2006
compress
tempfile prices_ante
save `prices_ante', replace

use "$RAW\orchard_prices_SLC", clear
forvalues i = 1991/2001 {
    replace priceLCU`i' = priceLCU`i'/6.55957 if imf_id == 696
    replace priceLCU`i' = priceLCU`i'/6.55957 if imf_id == 333
    replace priceLCU`i' = priceLCU`i'/6.55957 if imf_id == 329
    replace priceLCU`i' = priceLCU`i'/6.55957 if imf_id == 349
    replace priceLCU`i' = priceLCU`i'/13.7603 if imf_id == 122
    replace priceLCU`i' = priceLCU`i'/40.3399 if imf_id == 124
    replace priceLCU`i' = priceLCU`i'/5.94573 if imf_id == 172
    replace priceLCU`i' = priceLCU`i'/6.55957 if imf_id == 132
    replace priceLCU`i' = priceLCU`i'/1.95583 if imf_id == 134
    replace priceLCU`i' = priceLCU`i'/0.787564 if imf_id == 178
    replace priceLCU`i' = priceLCU`i'/1936.27 if imf_id == 136
    replace priceLCU`i' = priceLCU`i'/40.3399 if imf_id == 137
    replace priceLCU`i' = priceLCU`i'/2.20371 if imf_id == 138
    replace priceLCU`i' = priceLCU`i'/200.482 if imf_id == 182
    replace priceLCU`i' = priceLCU`i'/166.386 if imf_id == 184
    replace priceLCU`i' = priceLCU`i'/6.55957 if imf_id == 363
    replace priceLCU`i' = priceLCU`i'/40.3399 if imf_id == 126
    replace priceLCU`i' = priceLCU`i'/340.750 if imf_id == 174
}
gen ratio = priceSLC1991/ priceLCU1991
replace ratio = 1 if ratio>.99 & ratio<1.01
bys imf_id : egen mratio = mean(ratio)
gen ratio2= priceSLC1992/ priceLCU1992
replace ratio2 = 1 if ratio>.99 & ratio<1.01
bys imf_id : egen mratio2 = mean(ratio2)
drop ratio ratio2
gen ratio = mratio
replace ratio = mratio2 if ratio == .
replace ratio = 1 if ratio == .
drop mratio mratio2 priceLCU*
merge 1:1 imf_id orch_id using `prices_ante'
drop _m
replace ratio = 1 if ratio == .
forvalues i=1966/1990 {
    replace price`i' = price`i'*ratio
}
forvalues i=1991/2006 {
    ren priceSLC`i' price`i'
}

```



```

/*-----
Adjust value for peruvian sol
-----*/
forvalues i = 1966/1985 {
    replace price`i' = price`i'/1000000000 if wbcc == "PER"
}
forvalues i = 1986/1991 {
    replace price`i' = price`i'/1000000 if wbcc == "PER"
}
/*-----
Adjust value for Zimbabwean Dollar
-----*/
forvalues i = 1966/2006 {
    replace price`i' = price`i'/1000 if wbcc == "ZWE"
}
/*-----
Adjust value for New Venezuela Bolivar
-----*/
forvalues i = 1966/2006 {
    replace price`i' = price`i'/1000 if wbcc == "VEN"
}
/*-----
Adjust value for bolivianos
-----*/
forvalues i = 1966/1986 {
    replace price`i' = price`i'/1000000 if wbcc == "BOL"
}

/*-----
Adjust value for mexican peso
-----*/
forvalues i = 1966/1981 {
    replace price`i' = price`i'/1000 if wbcc == "MEX"
}
/*-----
Adjust value for argentinian peso
-----*/
forvalues i = 1966/1977 {
    replace price`i' = price`i'/100 if wbcc == "ARG"
}
forvalues i = 1983/1985 {
    replace price`i' = price`i'/10000 if wbcc == "ARG"
}
/*-----
Adjust value for Malagasy Franc
-----*/
forvalues i = 1966/2006 {
    replace price`i' = price`i'/5 if wbcc == "MDG"
}

drop ratio
reshape long price, i(imf_id orch_id) j(year)
compress

/*-----
INPUT DATA ON NOMINAL EXCHANGE RATES SINCE PRICES
ARE EXPRESSED IN NOMINAL LOCAL CURRENCIES
-----*/
merge 1:1 imf_id year using "$RAW\exrates"
drop _merge

*** CONVERT PRICES TO NOMINAL US$
gen price_lcu = price
drop price
gen price = price_lcu/Ex_Rate
label var price_lcu "Price per metric ton in current local currency"
label var price "Price per metric ton, nominal US$"
drop if orch_id == .
drop price_lcu

```

```

*** COMPUTE 5-YEARS MOVING AVERAGES OF PRICES
reshape wide price, i(imf_id year) j(orch_id)
tsset imf_id year
forvalues i = 216/836 {
    forvalues j=1/2 {
        capture generate price`i'F`j' = F`j'.price`i'
        capture generate price`i'L`j' = L`j'.price`i'
    }
    capture order price`i'L2 price`i'L1 price`i' price`i'F1 price`i'F2
    capture egen avgp`i' = rmean(price`i'L2 - price`i'F2)
    capture drop price`i'L2 price`i'L1 price`i' price`i'F1 price`i'F2
}
compress
reshape long avgp, i(imf_id year) j(orch_id)
drop if avgp == .
label var imf_id "IMF Country Code"
label var country_id "Country identifier"
label var year "Year"
label var orch_id "Orchard identifier"
label var avgp "Price per metric ton, nominal US$, 5-years moving average"
order year imf_id fao_id wbcc country_id orch_id avgp Ex_Rate
sort imf_id orch_id year
save "$TEMP\orchard_prices", replace

/*-----
INPUT DATA ON ORCHARD YIELDS BY COMMODITY FOR EACH
COUNTRY. ORCHARDS YIELDS FROM FAOSTAT
-----*/
use "$RAW\orchard_yield.dta", clear
sort imf_id orch_id
drop if imf_id == .
reshape long yield, i(imf_id orch_id) j(year)
merge m:1 imf_id using "$RAW\country_id", keep(wbcc fao_id)
drop if _merge == 2
drop _merge

/*-----
COMPUTE MOVING AVERAGES OF YIELDS
5-YEAR MA ASSUMED, ALTERNATIVELY
3-YEAR MA ASSUMED OR CURRENT YEAR YIELD
-----*/
drop if orch_id == .
reshape wide yield, i(imf_id year) j(orch_id)
tsset imf_id year
forvalues i = 216/836 {
    forvalues j=1/2 {
        capture generate yield`i'F`j' = F`j'.yield`i'
        capture generate yield`i'L`j' = L`j'.yield`i'
    }
    capture order yield`i'L2 yield`i'L1 yield`i' yield`i'F1 yield`i'F2
    capture egen avgy`i' = rmean(yield`i'L2 - yield`i'F2)
    capture drop yield`i'L2 yield`i'L1 yield`i' yield`i'F1 yield`i'F2
}
compress
reshape long avgy, i(imf_id year) j(orch_id)
drop if avgy == .
label var imf_id "IMF Country Code"
label var year "Year"
label var orch_id "Orchard identifier"
label var avgy "Hectograms 5-years Moving Average per hectare of harvested area"
replace avgy = avgy/10000
label var avgy "Tons 5-years Moving Average per hectare of harvested area"
sort imf_id orch_id year
save "$TEMPORCH\orchard_yield", replace

/*-----
COMPUTE THE DOLLAR VALUE PER HECTARE FOR A SPECIFIC PERIOD USING THE ASSUMPTION
THAT PROFITS FROM TREE CROPS ARE 5% OF REVENUES
-----*/

```

```

-----*/
merge 1:1 imf_id orch_id year using "$TEMPORCH\orchard_prices"
drop _merge
drop if imf_id == .
compress
gen dollha = avgp*avgy*0.05
label var dollha "Orchard Value per Hectar (profits=0.2*revenues)"
drop avgy avgp Ex_Rate
compress
sort year
save "$TEMP\orchard_dollha", replace

*** INPUT DATA ON US NOMINAL INTEREST RATES, US GDP DEFLATORS AND COMPUTE INFLATION
use "$RAW\US_BondRate.dta", clear
merge 1:1 year using "$RAW\US_GDPDef.dta"
drop if _merge == 2
drop _merge
tsset year
gen GDPDefUSF1 = F1.GDPDefUS
gen infrate = (( GDPDefUSF1 - GDPDefUS) / GDPDefUS) * 100
drop GDPDefUS GDPDefUSF1
label var infrate "US Inflation rate (from GDP deflator)"

*** CONVERT NOMINAL INTEREST RATES TO REAL INTEREST RATES
gen realint = (bondrate - infrate)/100
drop bondrate infrate
forvalues j=1/2 {
    cap gen realintF`j' = F`j'.realint
    cap gen realintL`j' = L`j'.realint
}
cap order realintL2 realintL1 realint realintF1 realintF2
cap egen avgrealint = rmean(realintL2 - realintF2)
cap drop realintL2 realintL1 realintF1 realintF2 realint
label var avgrealint "Real interest rate - 5 years moving average"
compress
merge 1:m year using "$TEMPORCH\orchard_dollha.dta"
keep if _merge == 3
drop _merge
order year imf_id fao_id wbcc country_id orch_id dollha avgrealint

/*-----
COMPUTE THE PRESENT VALUE PER ORCHARD HECTARE AS THE DISCOUNTED
STREAM OF FUTURE PROFITS. LIFETIME ASSUMED CROP SPECIFIC
-----*/
reshape wide dollha avgrealint, i(imf_id orch_id) j(year)
egen dolzero = rsum(dollha*)
drop if dolzero == 0
drop dolzero
merge m:1 orch_id using "$RAW\orchard_lifetime.dta"
keep if _merge == 3
drop _merge
replace lifetime = 50 if lifetime>50
forvalue i=1961/1965 {
    capture drop dollha`i' realint`i'
}
drop dollha2006 avgrealint2006 dollha2007 avgrealint2007
forvalues i=1966/2005 {
    gen presvalu_k`i' = 0
}

quietly {

qui su orch_id
local prod = r(max)
forvalues x = 1/'prod' {
    preserve
    keep if orch_id == `x'
    local lifetime = lifetime
    restore
}

```

```

forvalues i=1966/2005 {
    forvalues j=1/'lifetime' {
        replace presvalu_k`i' = presvalu_k`i' + dollha`i' * (exp(-avgrealint`i') * (`j'-1)) \\
        if orch_id == `x'
    }
}

}

forvalues i=1966/2005 {
    capture drop dollha`i' avgrealint`i'
}

reshape long presvalu_k, i(imf_id orch_id) j(year)
label var presvalu_k "Present value per orchard hectare, nominal US$"
merge 1:1 imf_id orch_id year using "$TEMP\orchard_area.dta"
drop if presvalu_k == .
drop _merge lifetime

*** TOTAL VALUE OF ORCHARDS IN NOMINAL US $
gen treecap_k = presvalu_k*area_k
label var treecap_k "Total present value for each tree crop, nominal US$"
bys imf_id year: egen Treecap = sum(treecap_k)
label var Treecap "Orchards total value, nominal US$"
drop orch_id presvalu_k area_k treecap_k
duplicates drop year imf_id Treecap, force
compress
merge m:1 year using "$RAW\US_AgInvDef"
drop if _merge == 2
drop _merge
gen TreeCap = (Treecap / AgInvDefUS)*100
drop Treecap AgInvDefUS*
label var year "Year"
compress
sort imf_id year
label var TreeCap "Orchard Capital, Constant 1990 US$"
drop if TreeCap == 0
format Tree* %15.0fc
save "$TEMP\Treestock.dta", replace

***** STEP 5: SUM UP STOCK COMPONENTS *****
merge 1:1 imf_id year using "$AGINVEST\AgSECap"
drop _m
merge 1:1 imf_id year using "$TEMP\livestock"
drop _m
merge 1:1 imf_id year using "$TEMP\Treestock"
drop _m
gen AgCap = AgSECapK90 + Livestock + TreeCap
lab var AgCap "Total Agricultural Capital, 1990 US$"

```

Appendix 3: Lifetime of tree crops

Orchard ID	ICC Code	Orchard Name	Orchard Group	Half Lifetime	Orchard ID	ICC Code	Orchard Name	Orchard Group	Half Lifetime
216	369	Brazil Nuts	Nuts	75.0	461	39	Carobs	Fruits & berries	13.8
217	362	Cashew Nuts	Nuts	10.0	486	312	Bananas	Fruits & berries	12.5
220	363	Chestnuts	Nuts	100.0	489	312	Plantains	Fruits & berries	12.5
221	361	Almonds	Nuts	10.0	490	323	Oranges	Fruits & berries	22.5
222	366	Walnuts	Nuts	37.5	495	324	Tang.Mand.Clement.Satsma	Fruits & berries	13.0
223	365	Pistachios	Nuts	50.0	497	322	Lemons and Limes	Fruits & berries	17.0
225	364	Hazelnuts (Filberts)	Nuts	20.0	507	321	Grapefruit and Pomelos	Fruits & berries	16.3
234	369	Nuts nes	Nuts	30.7	512	329	Citrus Fruit nes	Fruits & berries	7.2
249	441	Coconuts	Oil-Bearing Crops	30.0	515	351	Apples	Fruits & berries	16.0
254	443	Oil Palm Fruit	Oil-Bearing Crops	15.0	521	355	Pears	Fruits & berries	17.0
256	443	Palm Kernels	Oil-Bearing Crops	15.0	523	355	Quinces	Fruits & berries	12.5
260	442	Olives	Oil-Bearing Crops	100.0	526	352	Apricots	Fruits & berries	15.0
263		Karite Nuts (Sheanuts)	Oil-Bearing Crops	100.0	530	353	Sour Cherries	Fruits & berries	7.0
275	449	Tung Nuts	Oil-Bearing Crops	12.5	531	353	Cherries	Fruits & berries	8.8
305		Tallowtree Seeds	Oil-Bearing Crops	10.0	534	354	Peaches and Nectarines	Fruits & berries	4.5
339	449	Oilseeds nes	Oil-Bearing Crops	19.3	536	356	Plums and sloes	Fruits & berries	6.0
224	619	Kolanuts	Other Permanent Crops	37.5	541	359	Stone Fruit nes, Fresh	Fruits & berries	8.5
226	992	Areca Nuts	Other Permanent Crops	25.0	542	359	Pome fruit nes	Fruits & berries	11.0
310	922	Kapok Fruit	Other Permanent Crops	30.0	544	345	Strawberries	Fruits & berries	1.0
311	922	Kapokseed in shell	Other Permanent Crops	30.0	547	344	Raspberries	Fruits & berries	10.0
656	611	Coffee, green	Other Permanent Crops	17.5	549	342	Gooseberries	Fruits & berries	10.0
661	614	Cocoa Beans	Other Permanent Crops	17.5	550	341	Currants	Fruits & berries	10.0
667	612	Tea	Other Permanent Crops	25.0	552	346	Blueberries	Fruits & berries	13.5
671	613	Maté	Other Permanent Crops	13.0	554	349	Cranberries	Fruits & berries	20.0
677	619	Hop	Other Permanent Crops	15.0	558	349	Berries nes	Fruits & berries	15.5
778	922	Kapok fibre	Other Permanent Crops	30.0	560	33	Grapes	Fruits & berries	11.0
788	922	Ramie	Other Permanent Crops	5.0	569	314	Figs	Fruits & berries	50.0
789	922	Sisal	Other Permanent Crops	6.0	571	315	Mangoes	Fruits & berries	22.5
800	922	Agave Fibres nes	Other Permanent Crops	12.5	572	311	Avocados	Fruits & berries	17.5
836	94	Natural Rubber	Other Permanent Crops	15.0	574	317	Pineapples	Fruits & berries	25.0
687	6221	Pepper (Piper spp.)	Spices & Condiments	25.0	577	313	Dates	Fruits & berries	22.5
692	6226	Vanilla	Spices & Condiments	6.3	587	319	Persimmons	Fruits & berries	27.5
693	6223	Cinnamon (canella)	Spices & Condiments	5.0	592	343	Kiwi Fruit	Fruits & berries	15.0
698	6224	Cloves	Spices & Condiments	40.0	600	316	Papayas	Fruits & berries	1.5
702	6222	Nutmeg, mace and cardamoms	Spices & Condiments	25.0	603		Fruit Tropical Fresh nes	Fruits & berries	11.8
720	6225	Ginger	Spices & Condiments	0.0	619		Fruit Fresh nes	Fruits & berries	17.6
723	6229	Spices nes	Spices & Condiments	17.7					

Appendix 4: Data sources

Exchange rates

The primary source for exchange rates is the International Monetary Fund (IMF). We also use the Global Development Network Growth Database to adjust rates for the black market premium in critical countries (Argentina, Brazil, Mexico, Iran).

IMF (2010) *International Finance Statistics online*, IMF, Washington DC.

Easterly, W. (2001) “Global Development Network Growth Database” in *Macroeconomic and Economic Growth*, World Bank, Washington DC.

Agricultural Investment Data, organized by country/territory

CLBM stands for:

Crego, A., D. Larson, R. Butzer and Y Mundlak (1998) “A New Database on Investment and Capital for Agriculture and manufacturing”, Policy Research Working Paper # 2013, World Bank, Washington, D.C.

ARGENTINA

Agricultural Fixed Capital Formation

1960-1992: CLBM

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1960-1990: CLBM

1991-2006: Total investment deflator from UN Statistics Division

ARMENIA

Agricultural Fixed Capital Formation

1960-1992: UN Statistics Division

Livestock Capital

1992-2006: FAOSTAT

Orchard Capital

1992-2005: FAOSTAT

Deflators

1991-2006: Total investment deflator from UN Statistics Division

AUSTRALIA

Agricultural Fixed Capital Formation

1960-1992: CLBM

1993-2005: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1960-1990: CLBM
1991-2006: Total investment deflator from UN Statistics Division

AUSTRIA

Agricultural Fixed Capital Formation

1970-1992: CLBM
1993-2006: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1950-1990: CLBM
1991-2005: Agricultural investment deflator from EUKLEMS database
2006 : GDP deflator from UN Statistics Division

AZERBAIJAN

Agricultural Fixed Capital Formation

1990-2006: UN Statistics Division

Livestock Capital

1992-2006: FAOSTAT

Orchard Capital

1992-2005: FAOSTAT

Deflators

1991-2006: Agriculture value added deflator from UN Statistics Division

BELARUS

Agricultural Fixed Capital Formation

1990-2006: UN Statistics Division

Livestock Capital

1992-2006: FAOSTAT

Orchard Capital

1992-2005: FAOSTAT

Deflators

1990-2007: Agriculture value added deflator from UN Statistics Division

BELGIUM

Agricultural Fixed Capital Formation

1970-2006: UN Statistics Division

Livestock Capital

2000-2006: FAOSTAT

Orchard Capital

2000-2005: FAOSTAT

Deflators

1950-1990: CLBM
1991-2006: Agriculture investment deflator from Belgium Statistics

BELGIUM-LUXEMBOURG

Agricultural Fixed Capital Formation

1970-2006: UN Statistics Division

Livestock Capital

2000-2006: FAOSTAT

Orchard Capital

2000-2005: FAOSTAT

Deflators

1950-1990: CLBM

1991-2006: Total investment deflator from UN Statistics Division

BOLIVIA

Agricultural Fixed Capital Formation

1970-1986: UN Statistics Division and Pinto Aguirre, G. and G. Candia Pereira (1986) “El stock de Capital en Bolivia, un enfoque metodológico”, Revista de Análisis Económico VOL. 2, UDAPE, Banco Central de Bolivia.

1988-2002: UN Statistics Division

Livestock Capital

1970-2006: FAOSTAT

Orchard Capital

1970-2005: FAOSTAT

Deflators

1970-1986: Implicit agricultural GFCF from Pinto Aguirre and Candia Pereira (2006) and UN Statistics Division.

1991-2007: Implicit agricultural GDP deflator from Instituto Nacional de Estadística

BOSNIA AND HERZEGOVINA

Agricultural Fixed Capital Formation

2000-2007: UN Statistics Division

Livestock Capital

1992-2006: FAOSTAT

Orchard Capital

1995-2005: FAOSTAT

Deflators

1990-2007: Agriculture value added deflator from UN Statistics Division

BOTSWANA

Agricultural Fixed Capital Formation

1972-2002: UN Statistics Division

Livestock Capital

1970-2006: FAOSTAT

Deflators

1970-2007: Agriculture value added deflator from UN Statistics Division

BRAZIL

Agricultural Fixed Capital Formation

1990-2004: Instituto Brasileiro de Geografia e Estatística

Livestock Capital

1970-2006: FAOSTAT

Orchard Capital

1972-2005: FAOSTAT

Deflators

1981-2007: Implicit agricultural GDP deflator from Instituto Nacional de Estadística

BURUNDI

Agricultural Fixed Capital Formation

1970-1978: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1970-2006: Agriculture value added deflator from UN Statistics Division

CANADA

Agricultural Fixed Capital Formation

1950-2001: Statistics Canada

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1950-1990: CLBM

1990-2007: Agriculture value added deflator from UN Statistics Division

CHILE

Agricultural Fixed Capital Formation

1961-1982: CLBM

1986-2002: Vergara, R. and R. Rivero (2006) "Productividad Sectorial en Chile: 1986-2001", Cuadernos de economia, Vol. 43 (Mayo): 143-168.

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1950-1990: CLBM

1991-2007: Cuentas Nacionales Banco Central de Chile

COLOMBIA

Agricultural Fixed Capital Formation

1965-1990: CLBM

1994-2005: DANE (Departamento Administrativo Nacional de Estadística) Colombia

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1950-1990: CLBM

1994-2005: Agriculture value added deflator from UN Statistics Division

COSTA RICA

Agricultural Fixed Capital Formation

1965-1991: CLBM

1992-1993: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1950-1990: CLBM

1991-2006: Agriculture value added deflator from UN Statistics Division

CYPRUS

Agricultural Fixed Capital Formation

1953-1990: CLBM

1991-2007: Cyprus Statistical Service

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1950-1990: CLBM

1991-2006: Agriculture investment deflator from Cyprus Statistical Service

CZECHOSLOVAKIA

Agricultural Fixed Capital Formation

1960-1990: CLBM

Livestock Capital

1967-1992: FAOSTAT

Orchard Capital

1967-1992: FAOSTAT

Deflators

1960-1992: CLBM

CZECH REPUBLIC

Agricultural Fixed Capital Formation

1995-2006: Czech Statistical Office

Livestock Capital

1993-2006: FAOSTAT

Orchard Capital

1993-2005: FAOSTAT

Deflators

1995-2006: Agriculture value added deflator from UN Statistics Division

DENMARK

Agricultural Fixed Capital Formation

1950-1990: CLBM

1991-2006: Statistics Denmark

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1985-2005: FAOSTAT

Deflators

1950-1990: CLBM

1991-2006: Agriculture investment deflator from UN Statistics Denmark

DOMINICAN REPUBLIC

Agricultural Fixed Capital Formation

1960-1989: CLBM

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1960-1990: CLBM

1991-2006: Total investment deflator from UN Statistics Division

EGYPT

Agricultural Fixed Capital Formation

1960-1992: CLBM

1996-2006: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1960-1992: CLBM

1996-2006: Agriculture value added deflator from UN Statistics Division

EL SALVADOR

Agricultural Fixed Capital Formation

1965-1992: CLBM

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1960-1990: CLBM

1991-2006: Total investment deflator from UN Statistics Division

ETHIOPIA

Agricultural Fixed Capital Formation

1970-1976: UN Statistics Division

Livestock Capital

2000-2005: FAOSTAT

Orchard Capital

1993-2006: FAOSTAT

Deflators

1990-2006: Total investment deflator from UN Statistics Division

ESTONIA

Agricultural Fixed Capital Formation

1994-2006: UN Statistics Division

Livestock Capital

1992-2006: FAOSTAT

Orchard Capital

1992-2005: FAOSTAT

Deflators

1990-2006: Agriculture value added deflator from UN Statistics Division

FIJI***Agricultural Fixed Capital Formation***

1970-1972: UN Statistics Division

1977-1986: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Deflators

1990-2007: Agriculture value added deflator from UN Statistics Division

FINLAND***Agricultural Fixed Capital Formation***

1950-1990: CLBM

1991-2007: Statistics Finland

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1950-1990: CLBM

1991-2006: Agriculture investment deflator from UN Statistics Finland

FRANCE***Agricultural Fixed Capital Formation***

1950-1990: CLBM

1991-2007: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1950-1990: CLBM

1991-2006: Agriculture value added deflator from UN Statistics Division

GERMANY***Agricultural Fixed Capital Formation***

1950-1990: CLBM

1991-2006: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1950-1990: CLBM

1991-2006: Agriculture investment deflator from EUKLEMS database

GREECE***Agricultural Fixed Capital Formation***

1950-1992: CLBM

1995-2006: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1950-1990: CLBM

1991-2006: Agriculture value added deflator from UN Statistics Division

GUATEMALA

Agricultural Fixed Capital Formation

1960-1992: CLBM

1993-2006: Banco Central de Guatemala

Livestock Capital

1961-2006: FAOSTAT

Deflators

1960-1992: CLBM

1993-2006: Agriculture investment deflator from Banco Central de Guatemala

HONDURAS

Agricultural Fixed Capital Formation

1960-1990: CLBM

2000-2006: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1960-1992: CLBM

1993-2007: Agriculture value added deflator from UN Statistics Division

HUNGARY

Agricultural Fixed Capital Formation

1995-2006: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1970-2006: Agriculture value added deflator from UN Statistics Division

ICELAND

Agricultural Fixed Capital Formation

1950-1990: CLBM

1991-2005: Statistics Iceland

Livestock Capital

1961-2006: FAOSTAT

Deflators

1950-1989: CLBM

1990-2007: Agricultural investment deflator from Statistics Iceland

INDIA

Agricultural Fixed Capital Formation

1960-1992: CLBM

1996-2006: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1960-1990: CLBM

1991-2006: Agriculture value added deflator from UN Statistics Division

INDONESIA

Agricultural Fixed Capital Formation

1970-1992: CLBM

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1960-1990: CLBM

1991-2006: Total investment deflator from UN Statistics Division

IRAN

Agricultural Fixed Capital Formation

1960-2007: Central bank of the Islamic Republic of Iran

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1960-2007: Agriculture investment deflator from Central bank of the Islamic Republic of Iran

IRAQ

Agricultural Fixed Capital Formation

1960-1992: CLBM

1997-2007: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Deflators

1960-1990: CLBM

1991-2007: Agriculture value added deflator from UN Statistics Division

IRELAND

Agricultural Fixed Capital Formation

1950-1992: CLBM

1993-2006: Ireland Central Office of Statistic

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1950-1990: CLBM

1991-2006: Agriculture investment deflator from Ireland Central Office of Statistic

ISRAEL***Agricultural Fixed Capital Formation***

1952-1992: CLBM

1995-2006: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1950-1990: CLBM

1991-2006: Agriculture value added deflator from UN Statistics Division

ITALY***Agricultural Fixed Capital Formation***

1950-1992: CLBM

1993-2006: ISTAT

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1950-1990: CLBM

1991-2006: Agriculture investment deflator from ISTAT

JAMAICA***Agricultural Fixed Capital Formation***

1959-1992: CLBM

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1960-1990: CLBM

1991-2006: Total investment deflator from UN Statistics Division

JAPAN***Agricultural Fixed Capital Formation***

1952-1992: CLBM

1993-2006: Ministry of Internal Affairs and Communications, Statistics Bureau

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1950-1990: CLBM

1991-2006: Agriculture investment deflator from Ministry of Internal Affairs and Communications, Statistics Bureau

JORDAN

Agricultural Fixed Capital Formation

1985-2005: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1970-2007: Agriculture value added deflator from UN Statistics Division

KENYA

Agricultural Fixed Capital Formation

1964-1992: CLBM

1993-2003: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1964-1990: CLBM

1992-2006: Total investment deflator from UN Statistics Division

KUWAIT

Agricultural Fixed Capital Formation

1992-2002: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Deflators

1970-2007: Total investment deflator from UN Statistics Division

KYRGZSTAN

Agricultural Fixed Capital Formation

2000-2006: UN Statistics Division

Livestock Capital

1992-2006: FAOSTAT

Orchard Capital

1992-2005: FAOSTAT

Deflators

1990-2007: Agriculture value added deflator from UN Statistics Division

LATVIA

Agricultural Fixed Capital Formation

1998-2003: UN Statistics Division

Livestock Capital

1992-2006: FAOSTAT

Orchard Capital

1992-2005: FAOSTAT

Deflators

1990-2007: Agriculture value added deflator from UN Statistics Division

LESOTHO

Agricultural Fixed Capital Formation

1972-1983: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Deflators

1970-2006: Agriculture value added deflator from UN Statistics Division

LITHUANIA

Agricultural Fixed Capital Formation

1995-2007: UN Statistics Division

Livestock Capital

1992-2006: FAOSTAT

Orchard Capital

1992-2005: FAOSTAT

Deflators

1990-2007: Agriculture value added deflator from UN Statistics Division

LUXEMBOURG

Agricultural Fixed Capital Formation

1970-1991: UN Statistics Division

1996-2006: UN Statistics Division

Livestock Capital

2000-2006: FAOSTAT

Orchard Capital

2000-2005: FAOSTAT

Deflators

1950-1990: CLBM

1991-2006: Agriculture value added deflator from UN Statistics Division

MACEDONIA, FYR

Agricultural Fixed Capital Formation

2000-2006: UN Statistics Division

Livestock Capital

1992-2006: FAOSTAT

Orchard Capital

1995-2005: FAOSTAT

Deflators

1990-2007: Agriculture value added deflator from UN Statistics Division

MADAGASCAR

Agricultural Fixed Capital Formation

1970-1991: CLBM

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2006: FAOSTAT

Deflators

1950-1992: CLBM

MALAWI

Agricultural Fixed Capital Formation

1964-1986: CLBM

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2006: FAOSTAT

Deflators

1964-1992: CLBM

MALTA

Agricultural Fixed Capital Formation

1969-1990: CLBM

1991-2004: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2006: FAOSTAT

Deflators

1964-1990: CLBM

1991-2006: Total investment deflator from UN Statistics Division

MAURITIUS

Agricultural Fixed Capital Formation

1955-1992: CLBM

1993-2006: Central Statistical Office, Government of Mauritius

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2006: FAOSTAT

Deflators

1955-1990: CLBM

1990-2006: Agricultural investment deflator from Central Statistical Office, Government of Mauritius

MEXICO

Agricultural Fixed Capital Formation

1980-2004: INEGI

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2006: FAOSTAT

Deflators

1980-1987: Agriculture value added deflator from UN Statistics Division

1988-2004: Agricultural investment deflator from INEGI

MOLDOVA

Agricultural Fixed Capital Formation

1993-2006: UN Statistics Division

Livestock Capital

1992-2006: FAOSTAT

Orchard Capital

1992-2005: FAOSTAT

Deflators

1990-2007: Agriculture value added deflator from UN Statistics Division

MOROCCO

Agricultural Fixed Capital Formation

1969-1992: CLBM

1998-2007: Les Comptes de la Nation en 2007, Royaume du Maroc, Haut Commissariat au Plan.

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1960-1992: CLBM

1998-2007: Agriculture value added deflator from UN Statistics Division

MOZAMBIQUE

Agricultural Fixed Capital Formation

1996-2003: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2006: FAOSTAT

Deflators

1970-2006: Total investment deflator from UN Statistics Division

NAMIBIA

Agricultural Fixed Capital Formation

1989-2006: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1990-2006: Agriculture investment deflator from Institute for Public Policy Research (<http://www.ippr.org.na/>)

NETHERLANDS

Agricultural Fixed Capital Formation

1950-1992: CLBM

1993-2006: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1950-1990: CLBM

1991-2006: Agriculture investment deflator from EUKLEMS database

NETHERLANDS ANTILLES

Agricultural Fixed Capital Formation

1992-2004: UN Statistics Division

Livestock Capital

1970-2006: FAOSTAT

Deflators

1970-2006: Agriculture value added deflator from UN Statistics Division

NEW ZEALAND

Agricultural Fixed Capital Formation

1960-1992: CLBM

1993-2005: Statistics new Zealand

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1960-1990: CLBM

1991-2006: Agriculture value added deflator from UN Statistics Division

NIGER

Agricultural Fixed Capital Formation

1975-1977: UN Statistics Division

1998-2007: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1989-2005: FAOSTAT

Deflators

1990-2006: Agriculture value added deflator from UN Statistics Division

NORWAY

Agricultural Fixed Capital Formation

1950-1990: CLBM

1991-2008: Statistics Norway

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1950-1989: CLBM

1990-2007: Agricultural investment deflator from Statistics Norway

PAKISTAN

Agricultural Fixed Capital Formation

1965-1992: CLBM

1993-2006: UN Statistics Division and State Bank of Pakistan

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1960-1990: CLBM

1991-2006: Agriculture value added deflator from UN Statistics Division

PAPUA NEW GUINEA***Agricultural Fixed Capital Formation***

1970-1972: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Deflators

1970-2006: Total investment deflator from UN Statistics Division

PERU***Agricultural Fixed Capital Formation***

1970-1991: CLBM

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1960-1990: CLBM

1991-2006: Total investment deflator from UN Statistics Division

PHILIPPINES***Agricultural Fixed Capital Formation***

1967-1992: CLBM

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1960-1990: CLBM

1991-2006: Total investment deflator from UN Statistics Division

POLAND***Agricultural Fixed Capital Formation***

1956-1990: CLBM

1991-2004: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2006: FAOSTAT

Deflators

1956-1990: CLBM

1991-2006: Agriculture value added deflator from UN Statistics Division

PORTUGAL***Agricultural Fixed Capital Formation***

1952-1992: CLBM

1993-2005: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1950-1990: CLBM

1991-2006: Agriculture value added deflator from UN Statistics Division

QATAR***Agricultural Fixed Capital Formation***

2001-2005: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1989-2005: FAOSTAT

Deflators

1970-2007: Agriculture value added deflator from UN Statistics Division

REPUBLIC OF KOREA***Agricultural Fixed Capital Formation***

1953-1992: CLBM

1993-2006: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1953-1992: CLBM

1993-2006: Agricultural investment deflator from EUKLEMS database

SENEGAL***Agricultural Fixed Capital Formation***

1996-2006: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Deflators

1970-2006: Agriculture value added deflator from UN Statistics Division

SLOVAKIA***Agricultural Fixed Capital Formation***

1992-2007: National Institute of Statistics

Livestock Capital

1993-2006: FAOSTAT

Orchard Capital

1993-2005: FAOSTAT

Deflators

1990-2006: Agriculture value added deflator from UN Statistics Division

SLOVENIA***Agricultural Fixed Capital Formation***

1996-2005: National Institute of Statistics

Livestock Capital

1992-2006: FAOSTAT

Orchard Capital

1992-2005: FAOSTAT

Deflators

1990-2006: Agriculture value added deflator from UN Statistics Division

SOUTH AFRICA***Agricultural Fixed Capital Formation***

1950-2007: Department of Trade and Industry, Republic of South Africa
(<http://www.dti.gov.za/econdb/resbank/rb6080JJ.html>)

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1950-2007: Department of Trade and Industry, Republic of South Africa
(<http://www.dti.gov.za/econdb/resbank/rb6080JJ.html>)

SPAIN***Agricultural Fixed Capital Formation***

1995-2006: INE

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1970-2006: Total investment deflator from UN Statistics Division

SRI LANKA***Agricultural Fixed Capital Formation***

1959-1992: CLBM

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1960-1990: CLBM

1991-2006: Total investment deflator from UN Statistics Division

SWEDEN***Agricultural Fixed Capital Formation***

1950-1990: CLBM

1991-2006: Statistics Sweden

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1985-2005: FAOSTAT

Deflators

1950-1989: CLBM

1990-2007: Agricultural investment deflator from Statistics Sweden

SYRIAN ARAB REPUBLIC

Agricultural Fixed Capital Formation

1966-1990: CLBM

1991-2006: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1960-1992: CLBM

1998-2007: Agriculture value added deflator from UN Statistics Division

TAIWAN PROVINCE OF CHINA

Agricultural Fixed Capital Formation

1951-1990: CLBM

1991-2005: National Statistics, Republic of China

Deflators

1951-1990: CLBM

1991-2005: Agriculture investment deflator from UN Statistics Division

TOGO

Agricultural Fixed Capital Formation

1970-1972: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1960-1990: CLBM

1991-2006: Total investment deflator from UN Statistics Division

TONGA

Agricultural Fixed Capital Formation

1975-1982: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Deflators

1970-2006: Agriculture value added deflator from UN Statistics Division

TRINIDAD AND TOBAGO

Agricultural Fixed Capital Formation

1966-1990: CLBM

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1960-1990: CLBM

1991-2006: Total investment deflator from UN Statistics Division

TUNISIA

Agricultural Fixed Capital Formation

1960-1992: CLBM

1996-2006: Institut National de la Statistique (2006) Annuaire Statistique de la Tunisie n. 49.

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1960-1992: CLBM

1998-2007: Total investment deflator from UN Statistics Division

TURKEY

Agricultural Fixed Capital Formation

1963-1992: CLBM

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1963-1990: CLBM

1991-2006: Agriculture value added deflator from UN Statistics Division

UKRAINE

Agricultural Fixed Capital Formation

1989-2006: UN Statistics Division

Livestock Capital

1992-2006: FAOSTAT

Orchard Capital

1992-2005: FAOSTAT

Deflators

1990-2007: Agriculture value added deflator from UN Statistics Division

UNITED ARAB EMIRATES

Agricultural Fixed Capital Formation

2001-2007: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Deflators

1970-2007: Agriculture value added deflator from UN Statistics Division

UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND

Agricultural Fixed Capital Formation

1950-1990: CLBM

1991-2005: Euklems database

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1950-1990: CLBM

1991-2005: Agricultural investment deflator from EUKLEMS database

UNITED REPUBLIC OF TANZANIA

Agricultural Fixed Capital Formation

1966-1992: CLBM

Livestock Capital

1961-2006: FAOSTAT

Deflators

1960-1990: CLBM

1991-2006: Total investment deflator from UN Statistics Division

UNITED STATES OF AMERICA

Agricultural Fixed Capital Formation

1950-1990: CLBM

1991-2005: Euklems database

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1950-1990: CLBM

1990-2005: Agricultural investment deflator from EUKLEMS database

URUGUAY

Agricultural Fixed Capital Formation

1955-1990: CLBM

1994-2005: Banco Central de Uruguay

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1950-1990: CLBM

1991-2006: Agriculture investment deflator from Banco Central de Uruguay

VENEZUELA

Agricultural Fixed Capital Formation

1960-1985: CLBM

1997-2006: Banco Central de Venezuela

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1950-1990: CLBM

1991-2007: Total investment deflator from UN Statistics Division

ZAMBIA

Agricultural Fixed Capital Formation

1970-1973: UN Statistics Division

Livestock Capital

1961-2006: FAOSTAT

Deflators

1970-2006: Total investment deflator from UN Statistics Division

ZIMBAWE

Agricultural Fixed Capital Formation

1954-1989: CLBM

Livestock Capital

1961-2006: FAOSTAT

Orchard Capital

1966-2005: FAOSTAT

Deflators

1954-1990: CLBM

1991-2006: Total investment deflator from UN Statistics Division

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