

## Gregory Chow's and Chow/Li's Capital Series for China

This appendix examines Gregory Chow's (1994) capital series and the later capital series by Gregory Chow and Kui-Wai Li (2002) which uses Gregory Chow's (1994) initial-year value.

### 1. Gregory Chow (1994)

Gregory Chow (1994, Ch. 16) provides sectoral constant price capital series for China. These series are based primarily on accumulation data he obtained from the National Bureau of Statistics (NBS) and on published asset data on state-owned units (SOUs).

#### *Definitions*

In the *Statistical Yearbook 1992* (p. 73), "accumulation" is defined within the socialist economies' Material Product System (MPS) as

$$\begin{aligned} \text{accumulation} &= \text{fixed asset accumulation (productive and non-productive)} \\ &+ \text{circulatory asset accumulation (productive and non-productive)} \end{aligned}$$

where accumulation is obtained as residual of national income and consumption.<sup>1</sup> Productive accumulation comprises newly increased productive fixed assets (net of wear and tear) but also raw materials, energy, semi-finished products, and inventories of "production materials" (*shengchan ziliao*). Non-productive accumulation comprises newly increased non-productive fixed assets (net of wear and tear) and changes in the stock of consumer goods.<sup>2</sup> Circulatory assets comprise such items as cash, deposits, short-term investments, accounts receivable and prepayments made, and inventories.<sup>3</sup>

Accumulation contrasts with gross capital formation, a term defined in the System of National Accounts (SNA) as one of the three components of GDP (besides private and government consumption, and net exports):

$$\begin{aligned} \text{gross capital formation} &= \text{gross fixed capital formation} \\ &+ \text{changes in inventories.} \end{aligned}$$

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<sup>1</sup> In contrast to value-added (or GDP), national income in the production approach covers only the five material production sectors (agriculture, industry, construction, commerce, and communication) and does not include depreciation but includes service payments to non-productive units (for example, interest payments). For details see Carsten Holz and Yi-min Lin, 2001. On the expenditure side, accumulation is not limited to the five material production sectors (*Statistical Yearbook 1992*, p. 72).

<sup>2</sup> In the official definition in the *Statistical Yearbook*, both productive and non-productive newly increased fixed assets come with the qualification "less wear and tear." If this is "wear and tear" during the production of newly increased fixed assets, it appears appropriate. It logically should not be the decommissioning of existing fixed assets and technically cannot be because accumulation and consumption would then no longer add up to national income produced in the current period.

<sup>3</sup> *Statistics Dictionary* (1996), p. 412.

Since Gregory Chow (1994) wrote his article (book chapter), the NBS has switched to the SNA and now publishes the gross capital formation series (with the two subcategories) only.

### *Gregory Chow's accumulation data*

Gregory Chow's accumulation data consist of total accumulation data for each of the four ownership categories SOUs, urban collectives, rural collectives, and individuals, as well as of *fixed* asset accumulation data for each of the first three of these four ownership categories. Circulatory asset accumulation for the first three ownership categories can then be obtained as residuals for the first three ownership categories.

Gregory Chow's objective is to distribute the fixed and circulatory accumulation data from the first three ownership forms—he states that he drops the category of accumulation by individuals (p. 200)—to the five material production sectors. The result, when accumulation is accumulated over time, is a “total” capital stock series (from total, i.e., fixed and circulatory asset accumulation) for each of the five material production sectors, and a “fixed” capital stock series (from fixed asset accumulation) for each of the five material production sectors.

A double-check of Gregory Chow's accumulation data with the official accumulation data published in, for example, the *Statistical Yearbook 1992*, p. 45, shows that the sum of Gregory Chow's accumulation data across the four ownership forms is identical to the aggregate accumulation data in the *Statistical Yearbook*. The sum of Gregory Chow's fixed asset accumulation data across the first three ownership forms plus all accumulation by individuals (where a separate figure for fixed asset accumulation is not available) is identical to the aggregate fixed asset accumulation data in the *Statistical Yearbook* in 1952 through 1983, and almost the same in 1984 and 1985 (Gregory Chow's sum is slightly larger than the fixed asset accumulation data in the *Statistical Yearbook*).<sup>4</sup> Consequently, the sum of Gregory Chow's circulatory asset accumulation in the first three ownership categories is identical to the aggregate circulatory asset accumulation data in the *Statistical Yearbook* in 1952-83 and slightly smaller in 1984 and 1985.

The values of the MPS variable circulatory asset accumulation in 1952-83 (when obtained from Gregory Chow as sum across the first three ownership categories) or in 1952-85 (when obtained from the *Statistical Yearbook 1992*) are identical to those of the SNA variable changes in inventories. In other words, circulatory asset accumulation in the three ownership groups is identical to changes in inventories across the whole economy; this suggests that accumulation covers more than just the five material production sectors (in accordance with the official definition of accumulation),<sup>5</sup> and that there is no inventory accumulation in the individual-owned economy. However, the SNA variable gross *fixed* capital formation exceeds the MPS variable fixed asset accumulation in all years, even if all accumulation by individuals is included in fixed asset accumulation (see Figure 1). If accumulation were not limited to the five material production sectors (which, according to the official definition, it is

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<sup>4</sup> Gregory Chow's 1984 and 1985 accumulation values are deflated in the process of capital creation, but the reported original accumulation values should still all be in nominal values. Also, if the fixed asset accumulation values of 1984 and 1985 in Gregory Chow's accumulation table are deflated, so should the total data in the same table be, which, as a countercheck with the *Statistical Yearbook* reveals, aren't. Possibly Gregory Chow obtained first published fixed asset values for 1984 and 1985 which were later revised by the NBS.

<sup>5</sup> See note 1. Otherwise it would imply the total absence of inventory changes in the tertiary sector.

not), this implies that the scope of fixed asset accumulation and gross fixed capital formation differ.

The definition of productive and non-productive accumulation, with its qualifier “net of wear and tear,” could mean that accumulation only comprises *newly increased* fixed assets, i.e., “effective” investment, or that accumulation comprises investment of that year less some wear and tear but is not necessarily equal to the value of newly created fixed assets (may still be different due to inefficiencies or time lags in the production of fixed assets). As a double-check one may want to compare the value of effective investment to the value of fixed asset accumulation. Figure 1 not only shows gross fixed capital formation to be larger than fixed asset accumulation, but also reveals that if gross fixed capital formation were multiplied by an approximate transfer rate of 80%, it would still exceed fixed asset accumulation. This implies that gross fixed capital formation is a more broadly defined variable than accumulation (either in its scope or in its coverage of enterprises/ units).

Highly reliable investment and effective investment data for the years prior to 1981 are available for SOUs. A double-check against these available data indicates that Gregory Chow’s SOE fixed asset accumulation data do not match any of the later published SOE data (SOE investment in fixed assets, SOE effective investment in fixed assets). Comparing Gregory Chow’s state-owned fixed asset accumulation to SOU *investment* shows that the latter is always larger; this would result if Gregory Chow’s data cover effective investment only, but also if the SOU investment data came with a different scope or different coverage of enterprises/ units. More conclusive is a comparison of Gregory Chow’s state-owned fixed asset accumulation data with economy-wide SOU *effective* investment; the annual values of the second series vary from 0.61 to 1.12 times the values of the first series. In other words, in some (in fact, most) years Gregory Chow’s state-owned fixed asset accumulation data are significantly larger than effective SOU investment. This suggests that Gregory Chow’s accumulation data are investment rather than effective investment data and that their coverage is limited in some unknown respect.<sup>6</sup>

### *Gregory Chow’s derivation of sectoral capital series*

Gregory Chow is interested in the sectoral capital stock of the material production sectors agriculture, industry, construction, transportation, and commerce. He translates asset accumulation (total, fixed) according to ownership group into capital stock according to sector.

In the case of *fixed* asset accumulation, he uses the sectoral proportions of capital construction to translate SOU fixed asset accumulation into sectoral SOU fixed capital stock, and for urban and rural collectives he uses constant proportions derived from reform period data. In the case of *circulatory* asset accumulation, he uses the fixed-quota working capital distribution across sectors of budgetary SOEs (available for some years only) to translate SOU circulatory asset accumulation into sectoral SOU circulatory capital stock, and for urban and rural collectives he uses budgetary SOU sectoral proportions of circulatory to fixed assets.

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<sup>6</sup> Alternatively, the official effective investment data of SOUs could underestimate actual effective investment, but why should they if more complete investment and/or effective investment data were indeed available and incorporated in the accumulation series?

The initial capital stock values of SOUs in each sector are the budgetary SOU original value of fixed asset data and fixed-quota working capital data (what he labels “circulatory” funds) available according to sector; those of urban and rural collectives are derived via a comparison of SOU vs. urban and rural collective accumulation in 1953-57, combined with the SOU initial values.

### *Shortcomings of Gregory Chow’s aggregate capital series*

An obvious shortcoming if an economy-wide series is desired is that Gregory Chow’s initial-year capital stock data are limited to the five material production sectors and that he excludes accumulation by individuals throughout.<sup>7</sup>

Second, the SOU initial *fixed* capital stock is limited in its coverage. The SOU initial fixed capital stock, which also forms the basis for the estimation of the initial fixed capital stock of urban and rural collectives, consists of the original value of fixed assets of *budgetary* SOUs only, i.e., is an underestimate.

Third, even if a capital stock which includes inventories were meaningful (I am not sure it is), the construction of the first-year *circulatory* capital stock is problematic. The SOU initial *circulatory* capital stock, which also forms the basis for the estimation of the initial circulatory capital stock of urban and rural collectives, is taken to equal fixed-quota working capital (fixed quota circulatory assets). Working capital, i.e., current assets, covers everything from bank deposits to accounts receivable and the stock of inventories. *Fixed-quota* working capital, furthermore, is an accounting concept of the planned economy in that enterprises are supposed to receive an appropriate, government-determined amount of funding (fixed-quota working capital) to maintain production; any shortfall of funding is covered through short-term bank loans. Fixed-quota working capital, thus, is likely to be smaller than total working capital. If Gregory Chow wants to include inventories in his initial year capital stock, as he does in the accumulation data, fixed quota working capital is a rather complicated (and removed) approximation thereof. If he wants to include all working capital, fixed-quota working capital falls short.<sup>8</sup>

Fourth, since the annual increments to the capital stock are based on accumulation data, and since these only cover inventories, Gregory Chow’s capital stock series throughout includes the *initial year* bank deposits and accounts receivable etc., unchanged throughout all years, plus the current-year additions to the stock of inventories.

Fifth, Gregory Chow appears to ignore the fact that some fixed assets are decommissioned every year. He makes no mentioning of any use of a scrap rate (or “depreciation” rate). Summing accumulation data across ownership groups to obtain a

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<sup>7</sup> Other sectors, such as public utilities or the material supply system, for which SOU fixed asset and fixed-quota circulatory asset data are available, are apparently ignored in the calculation of the initial-year value and probably also in the calculation of the capital increments in later years.

<sup>8</sup> If Gregory Chow wants to include fixed-quota working capital in his capital stock series throughout all years, his accumulation need to be augmented to include (some) changes in bank deposits and in accounts receivable, etc.

Gregory Chow also uses sectoral fixed-quota working capital data to break down inventory accumulation data into sectoral inventory accumulation; if one assumes that the *annual change* in inventories in a particular sector is proportional to the ‘*total stock* of inventories *plus* bank deposits *plus* accounts receivable *plus* a number of other accounting items,’ all somehow in fixed-quota terms, then his procedure is appropriate.

nationwide aggregate total, and summing capital stock data across his five sectors to obtain an economy-wide (material production sector) total capital stock, the annual change in capital stock should equal annual accumulation. This should hold for Gregory Chow's fixed asset accumulation and fixed capital stock series; it need not hold for his total accumulation and capital stock series because his circulatory capital stock data are not solely based on accumulation data. But it does not hold for his fixed asset accumulation and fixed capital stock data, whether accumulation includes accumulation by individuals or not. Accumulation is always larger than the change in capital stock.

Accumulation should be larger than the change in capital stock if some capital stock is scrapped each year. But the implicit scrap rate in Gregory Chow's data is highly irregular across years, with a mean implicit scrap rate of 2.69% (3.43% if accumulation by individuals is included) and a coefficient of variation in this scrap rate of 0.75 (0.65).<sup>9</sup> Presumably Gregory Chow did not use scrap rates (since he makes no mentioning of them and otherwise meticulously documents his procedure). A more likely explanation for the excess of accumulation over the change in capital stock is that Gregory Chow did not distribute all fixed asset accumulation to the five material production sectors but also to some of the non-material production sectors, for which he does not offer capital stock data. This is also suggested by his use of sectoral proportions to turn accumulation into capital data, where the sectoral proportions (of capital construction, and of budgetary SOE fixed quota circulatory assets) are from tables which contain more than just the five material production sectors. But if Gregory Chow used a scrap rate of zero, this may not be realistic.

Sixth, Gregory Chow does not deflate his accumulation data prior to 1984; he feels that the variation in price levels prior to 1984 are small enough to regard the nominal series as a real series (p. 199). While the long-run trend in the pre-reform period is indeed rather stable—Table 3 in the paper shows that the cumulative deflator for gross fixed capital formation is indeed only about 12% higher in 1983 than in 1952—in the short run the deflator varied considerably. See, for example, the 1950s and 60s. This may matter if accumulation data are added up; Gregory Chow's capital series does not capture these fluctuations. (The deflator is reported for all years in the paper and examined further in the appendix on the investment in fixed asset deflator.)

Seventh, Gregory Chow's table with capital data has an initial capital stock in agriculture of zero because his source for initial values (the original value of fixed assets of budgetary SOUs) has a value of zero; the source reports values only for a few years prior to 1975 (1952, 1957, 1962, 1965, 1970), and in each of these years the value for agriculture is zero. Consequently, before running regressions, Gregory Chow assumes an initial capital stock in agriculture in 1952 of 450 (times 100 million yuan RMB), which compares to 582.6 total capital across the other four sectors or to 315.6 fixed capital across the other four sectors.<sup>10</sup> In comparison, by the end of the period he examines, in 1985, when the initial capital stock should not matter much any more, total capital in agriculture of 1578.6 (3 times its 1952

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<sup>9</sup> Four different scenarios explored here are total accumulation (with, or without that by individuals) compared to total capital stock, and fixed asset accumulation (with, or without total accumulation by individuals) compared to fixed capital stock. Scrap values of the current year were related to the previous-year capital stock (and also, in separate calculations, to the current-year capital stock). Accumulation is always larger than the change in capital stock, i.e., the scrap rate is positive, except in 1967, when aggregate total accumulation (with or without that by individuals) falls short of the change in the total capital stock across the (sum of the) five material production sectors.

<sup>10</sup> Presumably, this initial value is then added to the derived capital stock data for agriculture in all other years (since the derived values in the other years reflect accumulation only).

value) compares to total capital in the other four sectors of 16380.1 (30 times the 1952 value); i.e., agricultural capital in 1985 accounts for 9.64% of the total compared to 43.58% in 1952. One may wonder if the initial agricultural capital stock is not overestimated.

Eighth, Gregory Chow further adds an assumed initial land value of 720. He makes no additional adjustments for land values in the following years, and assumes a constant price of land through 1983, as he does for all other capital; industrial, commercial, and residential land, thus, come with the same value as agricultural land. Gregory Chow then obtains a grand total of total capital (including assumed initial capital in agriculture) plus land of approximately 1750 for 1952; i.e., the derived capital data account for only one-third of the final value he uses, with the other two-thirds being assumed (the derived *fixed* capital value accounts for less than one-fifth of the final value he uses). He also considers an alternative total capital stock series based on an initial capital stock of 2213 (whose justification is unclear to me (p. 207)). In other words, in the final scenario Gregory Chow's initial-year capital stock thanks to the inclusion of inventories, an assumed, constant land value, a large (assumed) initial agricultural capital stock, and the inclusion of bank deposits and accounts receivable, etc., exceeds the relatively reliably derived fixed capital stock *seven* times.

Ninth, if the later published gross fixed capital formation were the more comprehensive (and correct) measure of investment, the use of accumulation data implies that values are used which are too small. Gregory Chow's capital stock series then is likely to increase too little in absolute values. Variation in growth rates of Gregory Chow's capital stock series over time are also likely to be of questionable quality because the ratio of official gross fixed capital formation to Gregory Chow's accumulation values is exhibiting a far from stable trend over time. Alternatively, the later published gross fixed capital formation series could be problematic. (See Figure 1.)

Tenth, Gregory Chow does not use effective investment values but a measure that appears closer to total investment. Contrary to the previous point, this implies the *overestimation* of the annual increment to the capital stock.

With so many different influences, I do not know how to conclude on the overall impact of the shortcomings on the quality of the resulting capital series.

How does Gregory Chow's initial-year capital stock compare to the fixed asset series derived in the paper? Gregory Chow's 1952 (lower) capital value of 175b yuan RMB consists of his derived 31.56b yuan RMB and 26.70b yuan RMB values for the fixed and the circulatory capital stock, an assumed 45b yuan RMB initial capital stock in agriculture, and an assumed land value of 72b yuan RMB. In the paper here, the 1953 fixed asset values, in 1953 prices, for the three final series in the cumulative approach are 45.301, 62.219, and 46.858b yuan RMB (1% scrap rate, depreciation-based scrap rates and pre-1986 non-SOU investment obtained as residual, investment-based scrap rates and pre-1986 non-SOU effective investment obtained via non-SOU gross output value real growth rates). These values are between 50 and 100% higher than Gregory Chow's somewhat reliably derived fixed capital stock in 1952. The percentage difference has to cover the one-year difference in time and the limitation of Gregory Chow's estimate to four material production sectors (excluding agriculture and some tertiary subsectors) and to, in the case of the state-owned economy, budgetary SOEs. Given these limitations, the 1953 fixed asset values derived in the paper and Gregory Chow's estimate are remarkably close. Gregory Chow's assumption of the initial capital stock in agriculture, the inclusion of an assumed initial land value, and the

inclusion of circulatory assets then create the big gap between the series derived in the paper and Gregory Chow's final capital stock value.

## 2. Gregory Chow and Kui-Wai Li (2002)

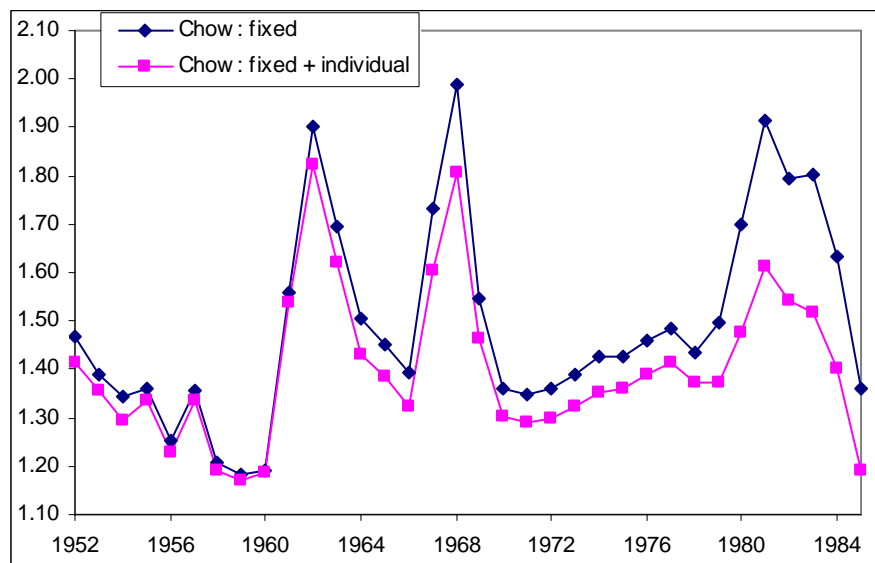
This new study, which is interested in economy-wide capital values, uses Gregory Chow's larger initial total capital stock value of 221.3b yuan RMB (in 1952 prices) and derives capital stock data through 1978 by adding total accumulation every year. This means that the capital values for 1952-78 incorporate (i) an assumed 45b yuan RMB initial capital stock in agriculture, (ii) an assumed, constant land value throughout of 72b yuan RMB, (iii) a scrap rate (or depreciation rate) of 0%, (iv) the assumption of no price changes, (v) an (to me unclear) augmentation factor for the initial year of 1.26457 (over and above the total which already includes the assumed agricultural and land values), (vi) inventories, and (vii) bank deposits and accounts receivable, etc., in the initial-year value. Furthermore, (viii), the coverage in the initial year is limited to the five material production sectors. In contrast to Gregory Chow (1994), a double-check on their data also reveals that their accumulation value is the original total, i.e., does not exclude accumulation by individuals, as Gregory Chow (1994) reports his capital stock data to do.

For the years since 1978, the authors derive the capital stock as the sum of previous year's capital stock, net of depreciation, plus (deflated) gross capital formation.<sup>11</sup> I.e., the authors mistakenly subtract depreciation rather than scrap values (unless they view their capital stock series as *net* fixed assets, a variable, as argued in the paper, not appropriate for production function estimations). The authors continue to include inventories in their capital stock by using gross capital formation, which comprises changes to inventories plus gross fixed capital formation. Since gross fixed capital formation is likely to in fact exceed actual investment, and since investment exceeds effective investment, the absolute values of the annual additions to capital stock are with certainty overestimated. Similarly, the inventory component may well contain a fair amount of inventories which can never be sold; how inventories contribute to the production process is unclear to me to begin with.<sup>12</sup> Finally, while the 1953 fixed asset value includes Gregory Chow's (1994) estimate of land, none of the increments added to obtain fixed asset values in later years include increments to the value of land (the same is true for bank deposits and accounts receivable, etc.).

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<sup>11</sup> Since the authors assume constant prices from 1952 through 1978, their resulting capital stock series is a real series with 1978 (or 1952, or any year in between) constant prices.

<sup>12</sup> In that the depreciation rate is applied to gross capital formation (i.e., inventories plus gross fixed capital formation), inventories are also depreciated each year, which could make up for inventories which can never be sold (or for inventories which can only be sold at a reduced price).



The chart shows the ratio of official gross fixed capital formation to Gregory Chow's fixed asset accumulation values. Gregory Chow's data offer two values for fixed asset accumulation. One is the sum of fixed asset accumulation across state-owned units, urban collectives, and rural collectives. A second value further includes the *total* accumulation by individuals (where he has no fixed asset accumulation data).

In order to match the assumptions underlying Gregory Chow's data, official gross fixed capital formation values of 1952-83 are in current prices, while 1984 and 1985 values are based on real growth rates applied to the 1983 data.

Sources: gross fixed capital formation: *GDP 1952-95*, pp. 50f.; Gregory Chow (1994), p. 201.

**Figure 1. Gross Fixed Capital Formation vs. Gregory Chow's Fixed Asset Accumulation**

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