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ECONOMIC RENT AND ESTIMATION OF SOVIET GNP GROWTH

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The extraction of fuels and metals and production of agricultural goods in the USSR involve increasing marginal cost, which generates economic rent. In computing Soviet GNP accounts, though, the CIA excludes economic rent in measuring value added. The effect is to value output at average, as opposed to marginal, cost. The exclusion of rent understates the shares of fuels, metals, and agriculture in Soviet GNP, which adversely affects the CIA's calculations of Soviet growth. In this paper, the author estimates the economic rent generated by Soviet extraction of fuels and metals and agricultural production. He then uses the estimates to recompute the shares of these sectors in Soviet GNP, and GNP growth. The results suggest that inclusion of economic rent in value added (or alternatively, marginal cost valuation of output) more than doubles the share in GNP of mining (fuels and metals extraction), and increases agriculture's share during the 1980s from 20 percent to about 25 percent. The reestimates of Soviet GNP growth also differ from those of the CIA by 10-30 percent.

I. INTRODUCTION

The Central Intelligence Agency (CIA) produces the most closely watched estimates of Soviet GNP in the West. The CIA's main estimation approach is based on value added by sector of origin. The procedure requires two types of data: growth in the volume of output over the period measured, and sectoral weights based on value added within sectors. For agricultural and mined products, the value added weights conceptually should include economic rent. Rent results because greater fertility/accessibility results in certain land and deposits being superior to others, and measures the contribution of these superior resources to the value of output. An indication that rent exists is increasing marginal cost of output, as production moves to less arable land or less easily extracted deposits.

In its estimation of Soviet GNP growth, though, the CIA does not include economic rent in measuring value added for the agriculture and fuels and metals extraction sectors.[1] The effect is to understate these sectors' shares in total value added (GNP), which adversely affects the estimates of GNP growth. This paper reestimates the shares of these sectors in Soviet GNP and the growth of Soviet GNP during 1970-87 with rent included in the measure of value added. As explained later, the main empirical challenge in the reestimation of value added with rent included is calculating the marginal cost (MC) of output within the affected sectors.

The results indicate that inclusion of economic rent in value added raises the shares of the designated sectors in Soviet GNP by a nontrivial amount. CIA

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[1]Such estimates are found in the CIA's annual *Handbook of Economic Statistics* and in its major 1982 study on Soviet economic growth (CIA, 1982).

figures indicate that during the 1980s extraction of fuels and metals (mining) contributed about 4 percent of GNP by value added, and agriculture 20 percent. We calculate values of 9 percent and 26 percent, respectively. Also, the CIA's and our estimates of annual GNP growth differ by about 10–30 percent.

Due to the difficulty of estimation, our MC calculations on which the final results rest are undoubtedly inaccurate to some degree. Also, estimating Soviet GNP growth is the most important task in empirical work on the Soviet economy. Thus, suggestions for altering the CIA's well established system of estimation should be regarded cautiously. Yet, the CIA agrees that estimation of Soviet GNP growth inclusive of economic rent for mining and agriculture is becoming increasingly important, and is currently examining whether suitable estimation techniques can be developed (Kurtzweg, 1987, p. 160, and Kurtzweg, forthcoming). Our objective in this paper is to contribute to this study by using admittedly simple methods to estimate sectoral shares for value added that include economic rent, and then computing a range of feasible estimates for Soviet GNP growth based on these revalued sectoral weights.[2]

In the second section we discuss the concept of economic rent and its relationship to the issue of marginal versus average cost valuation of output. The third section explains the procedures for estimating the MC of relevant output, and the fourth reestimates the shares of the designated sectors in Soviet GNP, as well as GNP growth. The final section presents some conclusions.

II. Economic Rent and Marginal vs. Average Cost Valuation of Output

The specific valuation scheme the CIA uses for Soviet output in its GNP accounts is Bergson's adjusted-factor-cost (AFC) standard (Bergson, 1961, p. 105), with one important qualification. The AFC standard is suitable for computing value added within sectors of production as well as the value of total output within sectors. This valuation system has been the dominant one used in empirical work on Soviet GNP estimation.[3] Bergson developed the AFC standard because Soviet prices are too flawed a measure of economically meaningful value. Demand plays virtually no role in determining prices for producer goods, while consumer goods' prices are often deliberately set below market-clearing levels. Even when prices are based on cost, certain costs, such as interest charges on capital, are ignored.[4]

Bergson defines the AFC of goods as consisting of (1) direct labor costs; (2) direct costs of capital (depreciation and an interest charge); (3) charges on land and natural resources directly used in production, given on average by the

[2]Boretsky (1987) and Prell (1989) also question the CIA's procedures and accuracy in estimating Soviet economic growth. Boretsky argues that the CIA's sector of origin methodology uses commodity samples poorly representative of industries. Also, the CIA relies heavily on data in physical rather than value terms, which Boretsky argues will understate real growth that results from qualitative improvements. Prell finds that the CIA ignores quality improvements in services, particularly with respect to labor and housing. Both argue that these deficiencies result in understating Soviet growth. These issues differ from those we raise, and thus our paper does not address them.

[3]In addition to the CIA, Becker (1969) also uses the AFC standard in his work on Soviet GNP.

[4]For an introduction to Soviet prices, see Gregory and Stuart (1986, pp. 193–202). For a deeper discussion of Soviet prices and their flaws, see Bornstein (1987).

differential return to superior land and resources; and (4) costs of intermediate inputs, which measure the value added by primary inputs used indirectly in production. Value added by primary inputs directly used in production, pertinent for computing sector shares in GNP based on value added, equals the sum of (1) through (3).

The differential return to superior land and resources, or economic rent, results from variation in the fertility of land and accessibility of resources, which leads to an upward sloping MC of production curve. Economic rent equals the difference between valuation of output based on MC and valuation based on average cost (discussed further below). By including economic rent in output valuation, the AFC standard conceptually has the merit of MC valuation of output for agricultural and extracted products. Economically efficient valuation of output for allocative purposes requires that a good's exchange value equal the value of resources used to produce the highest cost unit of output (MC). Thus, a foundation of price theory is that efficient prices equal MC.

Figure 1 can be used to demonstrate that economic rent equals the difference between MC and average cost (AC) valuation of output. The figure presents an upward sloping supply curve for a good. In order for the curve to have meaning,

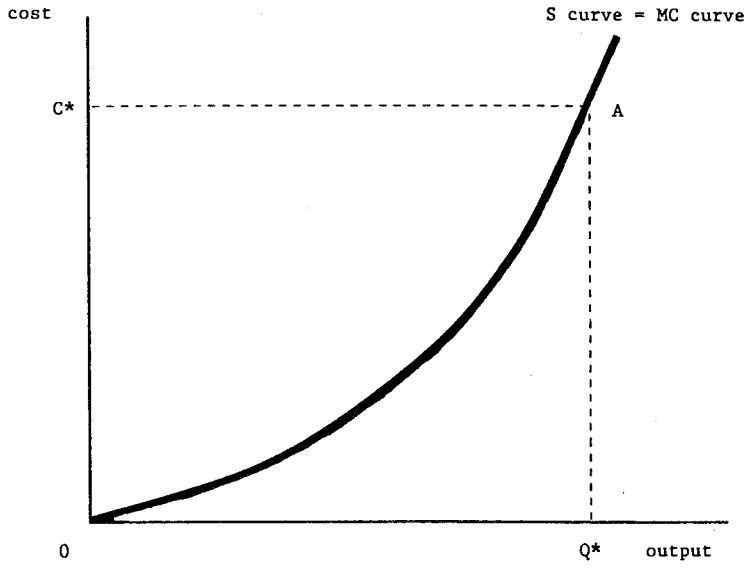

Figure 1. Economic Rent and MC vs. AC Valuation of Output

it must be equivalent to the MC of production curve. Assume that Q^* of output is produced, at a MC value equal to C^*. If the unit value, or price, of the good equals MC (C^*), the total value of output equals MC times the quantity of output ($C^* \cdot Q^*$). Economic rent equals $C^* \cdot Q^*$ minus the area under the MC curve over the range of output. Thus, economic rent equals $C^* \cdot Q^* - OAQ^* = OAC^*$. The area under the MC curve, though, equals the total cost of production, which can be expressed as $AC \cdot Q^*$. Economic rent then equals $MC \cdot Q^*$ minus $AC \cdot Q^*$—the difference between valuation of output based on MC and valuation

based on AC. This analysis does not mean economic rent is really a cost, though it measures the contribution of land and resources to the value of output. Rent exists, though, *because of* rising MC.

The qualification to the CIA's use of the AFC standard is that the CIA excludes economic rent in the valuation of Soviet agricultural products and extracted resources. The CIA's reluctance to include rent is explained by the difficulty of its estimation, coupled with the belief (at least held until recently) that economic rent in sectors would be too small to change the sectoral weights used in computing GNP growth.[5] In other major works on Soviet GNP, Bergson (1961) and Becker (1969) both exclude rent in extractive industries in their empirical work. Only Bergson computes agricultural rent, though he bases his estimate on calculations of the ratio of agricultural land rent to farm labor income in the United States. This paper shows, though, that because of rising MC, Soviet agricultural production and extraction of fuel and metals since 1970 has generated nontrivial rents, with consequences for estimation of Soviet GNP growth.

One possible reason for altering the CIA's handling of Soviet GNP accounts is to improve their economic content in an absolute sense. An even more important reason, though, is to make the accounts more similar to GNP accounting systems used for other countries (primarily the industrialized market economies, or IME's). Greater similarity in accounting procedures makes comparisons of GNP estimates more valid. The main system used for the IME's is the System of National Accounts (SNA) employed by the United Nations (UN, 1989).

In both its cost and value added accounts for GNP, the SNA has a component that conceptually contains economic rent. In the SNA, total value added generated by production within sectors is broken down into employee compensation, capital consumption, net operating surplus, and indirect taxes (with subsidies subtracted from the total). Operating surplus is a residual. It can include such things as the interest return to capital and economic rent generated by superior land and resource deposits, as well as other elements (such as the return to labor of the self-employed). In the UN's SNA for the United States in 1986, operating surplus comprises 68 percent of total value added in agriculture. The corresponding figure for manufacturing is 13 percent (UN, 1989, pp. 1606-07). Economic rent within agriculture probably explains much of the difference between the two percentage figures, which suggests that rent generated by U.S. agriculture is not insubstantial. Since economic rent is included in operating surplus, rather than appearing

[5]In computing the growth of Soviet factor productivity (estimates of which appear in the annual *Handbook*), the CIA recognizes land as one of the three primary inputs, along with labor and capital, that add value to output. As mentioned before, economic rent measures the contribution of land to output value. The CIA uses a value of 3 percent for the share of agricultural rent in total value-added (which equals GNP). This value comes primarily from a study by Diamond (1966), in which agricultural rent is estimated essentially as the difference between the value of agricultural output and payment to all inputs other than land.

The CIA, though, handles agricultural rent inconsistently in estimating productivity growth. Two steps in calculating the growth of productivity are estimating GNP growth, and the share of primary inputs in contributing to the total value-added of output (GNP). In determining the value weight for agriculture used in computing GNP growth, the CIA excludes rent. Yet, in determining the distribution of total value-added by primary inputs, the CIA recognizes land as a contributor to value, and computes and uses economic rent as a measure of that value.

separately, the SNA lacks a one-to-one equivalent with the component of economic rent in total value added in Bergson's AFC system. Both systems, though, conceptually capture economic rent generated by mining and agriculture in total value added.

In addition to measuring the contribution of primary inputs to value added in production, Bergson's AFC can also be used to measure the distribution of income generated from production among inputs. If one wishes to compare the AFC standard with the SNA with respect to earned income, the income and outlay accounts of the SNA are more appropriate than the value added accounts.

In its GNP accounts, the CIA adopts the assumption of the AFC standard that industrial production is characterized by constant average, and thus also marginal, cost. Consequently, production in these industries is treated as not generating economic rent. This assumption is common in empirical work on the Soviet economy (such as that involving input-output analysis), and we accept it in our reestimation of GNP accounts. In the short run, some industrial production might involve increasing MC, because of certain inputs being fixed (such as capital). All industrial, extractive, and agricultural production, though, can experience rising MC for this reason. Assume the values of MC/AC that result from this cause are equal across all sectors (including services). Calculations of the shares of sectors in GNP, and GNP growth, based on MC valuation of output, would then not differ from those based on AC. All relevant values would simply be multiplied by a scalar, which would cancel out in computing shares.

The AFC standard accepts economic rent for agriculture and mining because production in these sectors has a special cause of rising MC not shared by manufacturing: superior land and deposits. Increasing MC occurs because the land or extractable resources are inherently of nonhomogeneous "quality." As production moves to lower quality land or deposits, increasing amounts of other inputs are needed for output.

Also, the Soviet cost and price data that allow estimation of MC for agriculture and natural resource extraction are not available for manufacturing. A major reason the Soviets are more concerned about cost data for the former, and thus make more available, is because they realize that regional disparities in the quality of farmland and accessibility of extractable resources result in important cost differences.

III. Estimation of Marginal Costs of Production

The next section explains in greater detail the methods used to reestimate sectoral shares in GNP and GNP growth. As explained in that section, reestimation of both requires values for the ratio of MC to AC of production within sectors. The MC/AC ratios identify the disparity between valuation based on MC and AC, or alternatively, between valuation inclusive and exclusive of economic rent. The ratios are used to adjust the CIA's figures for sector shares in GNP. Estimation of MC is the main challenge in computing the ratios. The aggregate MC/AC ratios computed for sectors are weighted averages of MC/AC for specific products within the sectors.

(i) *Fuel*

The three fuels for which MC/AC of extraction is estimated are oil, natural gas, and coal. In a previous paper (Liefert, 1988), we compute MC/AC in the USSR of extracting oil and gas. The estimation method used is also employed in the present paper to calculate MC/AC for coal. The AC values are from Tretyakova and Heinemeier (*Oil Industry*, pp. 8 and 51; *Gas Industry*, pp. 72–73; and *Coal Industry*, p. 100), and cover labor, capital (interest and depreciation), and intermediate input costs. The source for output quantities is the Soviet statistical yearbook (*Narkhoz*).

Our procedure for estimating MC is based on its definition—the change in total cost from the production of additional output. Thus, the following method is used, with interpolation:

1. total cost is calculated for a given year by multiplying AC times the year's quantity of output;
2. the changes in total cost and quantity of output over a given production period are computed;
3. MC over this period equals the change in total cost divided by the change in output.

To avoid extreme changes in cost or output over a single year's time which might distort the MC calculations, we use 5-year production periods.

Full MC values of Soviet oil and gas extraction should include not only rent, but also depletion cost. This results from the exhaustibility of the resources, and measures the opportunity cost of using up some of these scarce resources rather than preserving them for future use. Depletion costs can also be interpreted as the special value added by use of scarce and thus increasingly valuable resources. In our paper previously cited, we compute the depletion cost from extraction of these fuels. In the present paper, however, we do not include depletion cost in MC, thereby excluding it from value added. Doing so would complicate comparison of growth rates of the U.S.S.R. with that of other countries for which the SNA is used.

The SNA excludes depletion in valuing output and value added, not only because of the difficulty of estimating depletion cost, but also for conceptual reasons. Depletion represents a decrease in the stock of available resources, which should then be balanced by additions to stock (discoveries). Major changes in annual stocks can occur, though, because of both large discoveries, and the need to scale back reported reserves because of overestimation in previous years. The result can be major imbalances in given years in net changes in stocks (reserves). The imbalances, particularly if they involve large negative entries, can distort GNP growth calculations.[6]

(ii) *Metals*

MC/AC for aggregate metals is estimated by computing a weighted average of the estimates of MC/AC for seven different ores and metals—iron ore,

[6]See Jaszi (1958, pp. 93–94). For criticism of the exclusion of depletion in national accounting systems, see Landefeld and Hines (1985) and Harrison (1989).

chromium ore, copper, lead, zinc, aluminum, and nickel. Soviet enterprise wholesale prices for these resources in 1967 and 1982 (both years of major industrial price changes) are used to compute the "prime cost" of production (sebestoimost'), which covers labor, depreciation, and intermediate input expenses. This value serves as an estimate of AC.[7] Average annual growth rates of AC are computed, based on the 1967 and 1982 values, to determine AC for other years. The method employed to estimate MC for fuel production is then used to compute MC for metals.

(iii) *Agriculture*

Due to fluctuations in agricultural output due to weather, the procedure used to estimate the MC of Soviet agricultural production differs from that employed to compute the marginal extraction cost of fuels and metals. The Soviet statistical yearbook (*Narkhoz*) presents the AC (sebestoimost') of producing 12 agricultural goods on collective (kolkhoz) and state (sovkhoz) farms in each of the 15 Soviet republics, as well as nationwide figures. Estimated national AC is a value-weighted average of the national AC figures given separately for collective and state farms. The assumption is made that national MC of production in a given year equals AC in the highest AC republic (on either collective or state farms), with the following adjustments. First, the Soviets might produce a small amount of a good in a republic at high cost for reasons other than short run economic efficiency. Thus, a republic must produce at least 1 percent of national output of a good in a given year in order for its AC to qualify as national MC.

Second, an adjustment for transportation costs is necessary. Low cost regions are most likely net exporters of output, and high cost regions net importers. This means that AC in the highest AC republic will overstate national MC. To correct for this problem we (1) determine the rail distance between the capital cities of the lowest and highest AC republics (Arkhangel'skii *et al.*, 1969); (2) determine the cost of transporting a unit of output (typically a ton) between the two cities (rail freight rates from Shafirkina, 1978); and (3) subtract the transport cost from AC in the high cost republic, thus obtaining a transportation adjusted estimate of national MC.

This estimation approach assumes that the Soviets are generally efficient in the geographic distribution of agricultural production, in that they produce in all regions to levels such that MC values across regions are equal (with adjustment for transport costs). Efficient geographic distribution of production is of course not the sole objective of Soviet agricultural planning. Production might occur in recognizably high cost areas for social and political, as well as, economic reasons. Limited production might also occur on less favorable land for experimental purposes. Even if economic efficiency is the dominant objective in regional planning, problems and errors in implementation (due to transport difficulties, etc.) might compromise efficiency.

[7]Sources for Soviet prices are Belousov (1969, p. 35), Kuznetsov (1977, pp. 74–75 and 83), Bunich (1982, p. 129), and *Proizvodstvo tsvetnykh metallov* (1984, p. 90). The source for quantities of output is U.S. Dept. of Interior, *Minerals Yearbook*.

The procedural rule previously mentioned that a republic must produce at least 1 percent of national output of a good in a given year in order for its AC to qualify as national MC is intended to correct for much of the departure from efficient regional distribution of output. If MC is accepted as rising, an estimation procedure in which AC in high cost areas determines national MC seems reasonable.

Our method of estimating MC is similar to that used by Vanous (1984) to calculate the MC of Soviet grain production. The major differences are that Vanous does not set a minimum output qualifying rule for republics and does not adjust for transport costs. Since *Narkhoz* does not present cost data for grain for 1981–84, the MC/AC ratios for grain during these years are assumed to equal the unweighted average of the values during 1975–80.

Although the method used to estimate MC in Soviet agriculture is simple, our results are supported fairly well by other evidence. Since economic rent equals the difference between valuation of output based on MC and AC, our MC estimates can be used to compute the share of rent in the adjusted-factor-cost value of Soviet agricultural output. The Soviet economist Karnaukhova (1977) estimates that the share of rent in the total value of output of crops during 1969–71 is 30 percent, while our estimate for crops during these years is 35 percent.

Two studies have been done that estimate aggregate Cobb–Douglas production functions for Soviet agriculture. Since the coefficients in the functions can serve as estimates of the share of inputs in the total value of output, the estimated coefficient for land can be interpreted as the share of economic rent in the value of output. Brooks' (Johnson and Brooks, 1983) estimate of the coefficient for land results in a share for rent in agricultural output of 69 percent (for 1960–79), which seems unrealistically high. Brooks' coefficients for machinery and animals are in fact negative, which further reduces the acceptability of her estimates as measures of the shares of inputs in output value. Clayton's (1984) estimated production function (for 1965–75) is more credible, since all coefficients are positive. Her coefficient for land corresponds to a share for rent in total value of 29 percent. Our estimate of rent's share in the value of all agricultural output over 1970–75 is 32 percent.

The AC values for fuels on which the MC estimates are based include interest charges on capital, whereas the AC values for metals and agricultural goods do not. Yet, as previously mentioned, what is required to redo the CIA's estimates of GNP growth and the share of sectors in GNP are not calculations of the absolute value of MC, but rather ratios of marginal to average cost (MC/AC). Thus, the procedure for estimating MC/AC for metals and agriculture (though not for fuels) assumes that the ratio of marginal to average cost for capital equals the aggregate ratio of MC/AC computed with respect to all noncapital costs. The procedure, though, does not require the assumption that MC/AC is uniform for each other element of cost.

(iv) *Results*

In estimating Soviet GNP growth since 1970, the CIA has used both 1970 value weights (for calculation through 1984) and 1982 value weights. Thus, to be consistent with the CIA's use of fixed value weights, we must compute and

use aggregate MC/AC ratios for the relevant sectors specifically for 1970 and 1982. We, however, wish to avoid using single-year estimates of MC/AC that are atypical because of peculiar events in either year. Consequently, the MC/AC values used are unweighted averages of annual estimates during the five-year periods around 1970 and 1982.

In Table 1 we present estimates of MC/AC for extracted fuels and metals and agriculture. The ratio for crude oil quadruples from 1970 to 1982, which contributes to the more than doubling of the ratio for all fuels. Estimated MC/AC for metals rises by 39 percent. MC/AC for agriculture remains fairly steady between 1970 and 1982 at about 1.55.

TABLE 1

ESTIMATES OF MC/AC FOR FUELS, METALS, AND AGRICULTURE IN U.S.S.R.: 1970 AND 1982

Year	Crude Oil	Natural Gas	Coal	All Fuels[1]	Metals[1]	Agriculture
1970	1.40	1.72	1.39	1.41	1.52	1.58
1982	5.76	1.33	2.44	3.16	2.11	1.55

Source: Own estimates.

[1]Values cover only the extraction of fuels and metals. Processing costs are not included.

The large rise in MC/AC for fuels and metals does not necessarily mean that factor proportions change significantly over time. Rather, the extraction of increasingly less accessible deposits involves rising amounts of all inputs.

The ratio for crude oil rises so highly because the MC of extraction increases enormously, at a rate we estimate to produce an eightfold rise between 1970 and 1982 (Liefert, 1988, p. 5). If MC rises substantially, AC will also rise, though by a lesser percentage. Thus, MC/AC will increase. The MC of oil extraction rose for primarily two interrelated reasons. First, during the 1970s extraction in older fields in the European part of the country became increasingly difficult and costly, requiring expensive techniques, such as use of submersible pumps. Second, the drying up of economically operable fields in Europe led to the development of the vast West Siberian oil fields. Extremely inclement conditions in such a remote area, though, resulted in high costs for labor, capital, and transport of inputs (Tretyakova and Heinemeier, *Oil Industry*, pp. 2-5).

Although the explosion in oil production costs in the U.S.S.R. coincided with the multifold increase in world prices for oil engineered by OPEC, the two developments were indirectly, rather than directly, related. The rise in world prices motivated the Soviets to expand production for increased export. Additional output in both European and Asian fields, though, could only occur at sharply rising cost.

IV. REESTIMATION OF SOVIET GNP ACCOUNTS

(i) *Reestimation of Shares of Sectors in GNP*

Before reestimating Soviet GNP growth, we must recompute the shares in GNP for the sectors fuel, metals, and agriculture. Reestimation for these sectors

then changes shares in GNP for all other sectors. The level of sector disaggregation used is that presented in CIA (1982). Output is divided into nine main sectors, with the large industry sector further subdivided into eleven subsectors.

If only primary inputs, and thus no intermediate inputs, were used directly in production, reestimation of the shares in GNP for fuel, metals, and agriculture would be very straightforward. It would first involve multiplying the CIA's GNP share for each sector times our estimate of each sector's aggregate MC/AC. Next, one must adjust the shares for all sectors to account for the rise in total estimated GNP as a result of the switch from AC to MC valuation for these special sectors.

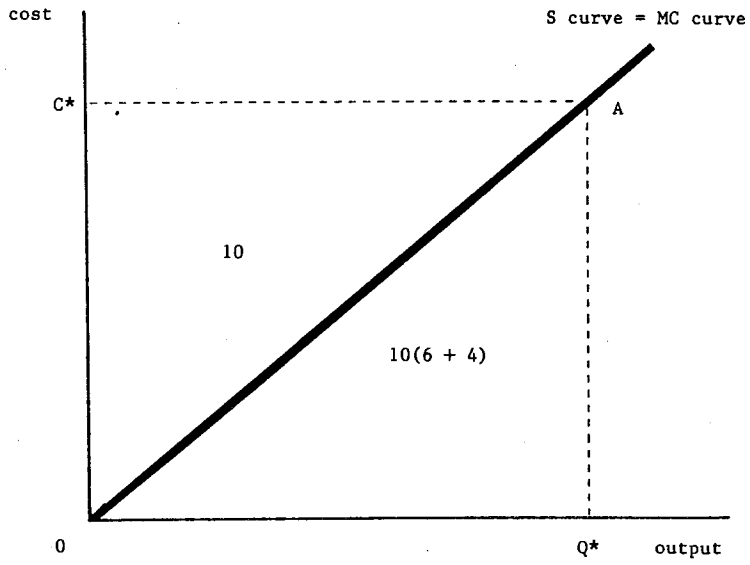

Figure 2. The Breakdown of a Good's MC-based Value of Output

Figure 2, a reproduction of Figure 1, is used to illustrate the procedure. Figure 2 again gives the supply, or MC, curve for a good, though now with the simplifying assumption that the curve is linear. The area under the MC curve over the range of output, OAQ^*, gives the total cost of production. By assumption, the value OAQ^* consists wholly of value added within the sector. In the figure assume this value equals 10. (The number could alternatively be a percent share in GNP before adjustment.) The total value of output based on MC is $2 \cdot 10 = 20$ (with a linear MC curve that begins at the origin, MC/AC equals 2). 10 of this value, corresponding to area OAC^*, equals economic rent. Thus, total value added equals 20. This example demonstrates that if no intermediate inputs are used in production, the inclusion of rent in value added does not change the result that the total value of gross output within a sector consists wholly of value added within that sector.

The procedure and analysis change, though, if intermediate inputs are used in production. Of the total cost of production of 10, assume now that direct primary inputs account for 6 and intermediate inputs 4. Since intermediate inputs

must be subtracted out to obtain value added by direct inputs, value added within the sector now is $20-4=16$. An important point, though, is that economic rent still equals 10—the sum of *both* direct primary and intermediate inputs. Thus, although intermediate inputs must be excluded as direct contributors to net value added within the sector, by augmenting cost these inputs contribute to the generation of economic rent. Thus, they contribute indirectly to the creation of value added.

This point has relevance for estimating sectoral shares in GNP and GNP growth. Continue to assume intermediate inputs are used in production. If one wishes to include economic rent in value added within a sector, the numerator of the adjustment formula for determining the new sectoral value added shares (S^n) should be

$$S^n = \mathrm{MC/AC} \cdot (S^p + S^i) - S^i \tag{1}$$

where S^p is the sector's share in total value added before adjustment, which represents primary inputs directly used in production; S^i is the value of intermediate inputs used in production within the sector, expressed as a percentage of total value added before any adjustments. The denominator of the adjustment formula represents the new value of total value added, or GNP. Total value added changes as a result of the inclusion of economic rent in value added for the mining and agricultural sectors.

With respect to Figure 2, $S^n = 2(6+4)-4=16$. Suppose one were simply to multiply 2 by 6 to obtain 12. One would then understate the contribution of economic rent to value added by 4, by ignoring the role intermediate inputs play in generating rent. If, however, production involved no intermediate inputs, S^i drops out of the calculation, leaving the simple calculation described at the start of this section.

A conclusion from this analysis is that MC/AC in equation (1) for agriculture and mining should be based on total costs of production, inclusive of intermediate inputs. All the estimates of MC/AC for Soviet products in the paper fulfill this condition. Since the MC/AC ratios are being used to adjust sectoral shares in GNP by value added, at first glance one might ague that MC/AC should be based exclusively on costs of direct primary inputs. MC/AC would thereby exclude the costs of intermediate inputs. Yet, the previous analysis shows that if production is characterized by rising MC, intermediate inputs constitute part of the increasing cost. Consequently, as just argued, intermediate inputs play a role in determining the total value of output based on MC, and thereby the total value of economic rent generated by production. Thus, they contribute to the generation of total value added to national production within the sector.

To establish its GNP accounts, the CIA has had to create Soviet input-output tables for 1970 and 1982 in adjusted-factor-cost (AFC).[8] These tables provide the breakdown for the total AFC value of output within sectors between primary and intermediate inputs used in production. Thus, the tables contain the information necessary to use equation (1) to estimate sectoral shares in total value added

[8]The 1970 and 1982 tables in AFC are estimated from a reconstructed 1972 Soviet input-output table in producers' prices (Gallik *et al.*, 1983).

inclusive of economic rent. Publications presenting the CIA's work on Soviet GNP accounts, though, present data only for value added by direct inputs; the interindustry quadrant of the tables in AFC are not included. Consequently, if one attempted to use CIA data along with equation (1) to recompute sectoral shares in GNP, values for S^i would be lacking.

Thus, for lack of necessary information, the equation we use to recompute sectoral shares in GNP is

$$S^n = \mathrm{MC/AC} \cdot S^P \tag{2}$$

where S^P is the unadjusted CIA share value. Consequently, our recalculations exclude the contribution that intermediate inputs indirectly make to the generation of economic rent. Using weights in equation (2) based on only primary inputs (S^P) biases the estimate of S^n, but we at least know the direction of bias (downward). MC/AC is still calculated, though, inclusive of intermediate inputs. Computing MC/AC using only primary inputs would conceptually distort the estimation of S^n, and in a way that would make determining the direction of error difficult.

The paper's main purpose is to argue the conceptual basis and need for including economic rent in value added in handling GNP accounts for the USSR. The CIA has all the information necessary to use the recommended approach [equation (1) rather than (2)] in recalculating the sectoral weights. In this paper, the reestimates of sectoral shares in GNP and GNP growth are intended to provide a "first order" estimate as to how the accounts could then change; by default, we cannot compute the most precise reestimates possible. The use of equation (2) rather than (1) in our recalculations understates the sectoral shares for mining and agriculture. Therefore, it also understates the extent to which GNP growth rates would change if economic rent were included in value added. The effect is to strengthen the paper's empirical argument as to the effect on the GNP accounts of including economic rent in value added.

If one nevertheless wished to use equation (1) rather than (2) in reestimation using available published data, the best approach would be to base recalculation on the 1972 reconstructed Soviet input-output table in producers' prices (Gallik *et al.*, 1983). One could assume that the ratio of (a) the total value of intermediate inputs within each sector in producers' prices to (b) the value added by direct primary inputs within the sector, equaled the same ratio when intermediate inputs were valued at AFC. However, we use this approach in the paper to only a limited degree; specifically, to reestimate sector shares for agriculture in the 1980s using both 1970 and 1982 weights. These calculations are mentioned only in the text, and provide an idea as to how the larger body of reestimates might be understated. All the results given in the paper's remaining tables (Table 2-4) are based on calculations from equation (2) rather than (1).

Agriculture has a large share in Soviet GNP, and among major sectors output in agriculture is the most volatile. Consequently, our reestimates of agriculture's share in GNP and the growth of GNP are sensitive to the values used for MC/AC for agriculture. Thus, sensitivity tests are made. The figures in Table 1 provide intermediate estimates of MC/AC for agriculture. Lower and upper values used equal 1.25 and 1.75 (for both 1970 and 1982 weights). These figures are chosen

TABLE 2

ESTIMATED SHARES OF MINING AND AGRICULTURE IN GNP FOR U.S.S.R. AND U.S.A.: 1970

	1970 Value Weights-U.S.S.R.				1982 Value Weights-U.S.S.R.						1982 Value Weights-U.S.A.	
	Mining[1]		Agriculture		Mining[1]			Agriculture				
Year	Own	CIA[2]	Own	CIA	Own	CIA[2]	Own (low)[3]	Own (middle)	Own (high)	CIA	Mining[1]	Agriculture
1970-75[4]	4.7	3.5	26.3	18.8	8.8	3.7	28.3	32.9	35.6	25.7	5.1	2.7
1976-80	4.8	3.5	22.5	15.8	9.3	3.8	24.5	28.7	31.2	22.1	4.2	2.4
1981-87	4.6	3.4	20.3	14.3	9.4	3.8	22.0	26.0	28.4	19.9	3.7	2.5

Sources: CIA estimates for U.S.S.R. with 1970 weights: 1970-80, *U.S.S.R.: Measures of Economic Growth*, p. 61, 1981-84 for agriculture, CIA *Handbook 1985*, p. 65, 1981-84 for mining, obtained directly from CIA; CIA estimates for U.S.S.R. with 1982 weights obtained directly from CIA; own estimates; estimates for U.S.A.: *Economic Report of the President*, 1989 (Washington, DC: U.S. GPO, 1989), p. 321.

[1]Mining covers the extraction of fuels and metals.

[2]CIA data used include processing, as well as extraction, costs for some products. Processing costs are estimated and subtracted out.

[3]Low, middle, and high estimates for U.S.S.R. agriculture with 1982 weights are based on values of MC/AC for aggregate agriculture of 1.25, 1.55, and 1.75, respectively.

[4]Figures for 1970-75, 1976-80, and 1981-87 are average annual values. Figures for U.S.S.R. mining and agriculture for 1981-87 with 1970 weights cover only 1981-84.

as plausible lower and upper values intended to provide a credible range of estimates of GNP shares and GNP growth.

In Table 2 we present the CIA's and our estimates of the share of mining and agriculture in Soviet GNP.[9] For comparison, shares of mining and agriculture in GNP are also given for the United States (using 1982 value weights). Our calculations of mining's share in Soviet GNP with 1970 weights do not substantially exceed the CIA's. Our estimates with 1982 weights, though, are about $2\frac{1}{2}$ times those of the CIA, and are also more than double mining's share in GNP for the United States.

The switch from 1970 to 1982 weights raises the CIA's calculations of agriculture's share in GNP about 6 percentage points. Also, our estimates of agriculture's share in GNP are about 6 percentage points higher than the CIA's figures, using 1970 weights. The same difference holds for our middle estimates vis-a-vis the CIA's with 1982 weights. Recall that our estimates are all downwardly biased for the reason previously given involving intermediate inputs. As mentioned before, one could employ the 1972 reconstructed Soviet input-output table in producers' prices to recompute (somewhat crudely) sectoral shares that include the contribution of intermediate inputs to the generation of economic rent. Such recalculations raise the estimated share of agriculture from 20 percent to 23 percent for the period 1981–84 using 1970 weights, and the middle estimate for agriculture from 26 percent to 28 percent for 1981–87 using 1982 weights.

Our findings suggest that during the 1980s agriculture has comprised about a quarter of Soviet GNP. All the calculations of agriculture's share in Soviet GNP using both sets of weights dwarf the corresponding figures for the United States. Our middle (and still understated) estimates using 1982 weights give a share for the U.S.S.R. ten times that for the U.S.A.

(ii) *Reestimation of Soviet GNP Growth*

We then recompute annual GNP growth rates, by multiplying the CIA's output growth rates (based on constant prices) for sectors times our recomputed sector shares in GNP (in the previous year). One then sums the results to get aggregate growth.

In Table 3 we present the CIA's and our estimates of Soviet GNP growth, using both 1970 and 1982 value weights. Due to the volatility of agricultural output, and because MC exceeds AC, the new estimates fluctuate more than the CIA's. The largest disparities between the CIA's and our calculations are in years in which decreases in the quantity of agricultural output result in low, or negative, GNP growth. With 1982 weights, the CIA's and our middle estimates of GNP

[9]Mining comprises the extraction of fuels and metals. In the CIA's breakdown of Soviet GNP by sector of origin, the sectors ferrous metals, nonferrous metals, and fuel include processing as well as extraction. We use input-output data (primarily from Gallik *et al.*, 1983) to divide the sectors into extraction and processing. Equation (2) is used to estimate the share in GNP of output in these sectors. The MC/AC values estimated for extraction of fuels and metals are applied only to extraction; values equal to one are used for MC/AC for processing within the sectors. The figures in Table 2 for the CIA's estimated share of mining in GNP are thus not values computed specifically by the CIA. Rather, they give the CIA's published figures for the share in GNP of the sectors ferrous and nonferrous metals and fuels, which include processing costs, but adjusted by us to eliminate processing.

TABLE 3

ESTIMATES OF GROWTH RATES OF SOVIET GNP: 1970-87

(in percents)

	1970 Value Weights				1982 Value Weights			
Year	CIA	Own low estimate[1]	Own middle estimate	Own high estimate	CIA	Own low estimate[1]	Own middle estimate	Own high estimate
1970	7.7	8.0	8.4	8.5	8.3	8.4	8.8	9.0
1971	3.9	3.6	3.3	3.2	2.9	2.7	2.3	2.1
1972	1.9	1.4	0.9	0.6	0.4	0.1	−0.5	−0.8
1973	7.3	7.6	8.1	8.3	8.6	9.0	9.6	9.9
1974	3.9	3.6	3.3	3.2	3.1	2.8	2.3	2.1
1975	1.7	1.1	0.3	−0.1	0.5	0.1	−0.7	−1.2
1976	4.8	5.0	5.3	5.4	5.3	5.5	5.9	6.1
1977	3.2	3.2	3.3	3.3	2.7	2.8	2.7	2.7
1978	3.4	3.4	3.4	3.4	2.9	2.9	3.0	3.0
1979	0.8	0.5	0.0	−0.2	−0.4	−0.6	−1.1	−1.3
1980	1.4	1.1	0.7	0.5	0.6	0.3	−0.1	−0.3
1981	1.9	2.0	1.9	1.8	1.0	0.9	0.7	0.6
1982	2.6	2.6	2.7	2.8	2.7	2.8	3.1	3.3
1983	3.7	3.7	3.8	3.8	3.3	3.3	3.4	3.5
1984	2.5	2.0	1.9	1.8	1.4	1.2	1.1	1.0
1985					0.7	0.5	0.2	0.1
1986					3.9	4.1	4.4	4.6
1987					0.5	0.4	0.1	−0.1

Sources: CIA estimates with 1970 weights: 1970-80, *U.S.S.R.: Measures of Economic Growth*, p. 58, 1981-84, CIA *Handbook 1985*, p. 64; CIA estimates with 1982 weights obtained directly from CIA; own estimates.

[1]The low, middle, and high estimates with 1970 weights are based on MC/AC values for aggregate agriculture of 1.25, 1.58, and 1.75; with 1982 weights on MC/AC values for aggregate agriculture of 1.25, 1.55, and 1.75. Thus, the words "low," "middle," and "high" refer to the relative size of the share of agriculture in Soviet GNP used in estimating the GNP growth rates, not the relative size of the GNP growth estimates themselves.

TABLE 4

DIVERGENCE BETWEEN CIA AND OWN ESTIMATES OF SOVIET GNP GROWTH: 1970-87

	Low[1]	Middle	High
1970 value weights[2]	12	25	40
1982 value weights[3]	6	16	24

Source: Table 3.

[1]Figures give average annual percentage difference between CIA and own estimates of Soviet GNP growth. Annual percentage difference determined by dividing CIA growth estimate by our growth estimate.

[2]Figures with 1970 value weights cover only 1970-84. Figure with 1970 weights in Low column excludes 1979; in Middle and High columns 1975 and 1979.

[3]Figures with 1982 weights exclude 1972, 1975, 1979, 1980, 1985, and 1987.

growth in 1972 equal 0.4 percent and −0.5 percent, respectively; in 1975 0.5 percent and −0.7 percent; and in 1979 −0.4 percent and −1.1 percent.

Although some aggregate measure of the divergence between the CIA's and our estimates of Soviet GNP growth over 1970-87 is desirable, no simple and yet nonmisleading calculation is possible. However, in Table 4 we present our best attempt at such a measure. In the table we give the average annual percentage difference between the CIA's and our estimates of Soviet GNP growth.

In computing an *average annual* value of the percentage difference, though, we upwardly bias the disparity between the CIA's and our estimates. In those years in which either the CIA's or our growth calculations are low in absolute terms, a distortingly large percentage difference will exist between the two estimates. To correct for this problem, we exclude in calculating the figures in Table 4 the years in which either the CIA's or our growth estimate falls between 0.5 percent and −0.5 percent. We also exclude the years in which the CIA's and our growth estimates differ in the direction of growth (one positive and one negative). When this happens, the method for computing the divergence between the two estimates breaks down.

In computing the divergence figures with 1970 value weights, these two rules result in dropping the years 1975 and 1979 (though only 1979 for the figure in the Low column). With 1982 weights, the excluded years are 1972, 1975, 1979, 1980, 1985, and 1987. In Table 3 we show that the largest differences between the CIA's and our growth estimates, not only in percentage but also absolute terms, occur in the excluded years. Thus, the exclusion of these years downwardly biases the divergence calculations, particularly those using 1982 weights.

It is important to note that the results in Table 4 indicate that less divergence exists between the CIA's and our estimates using 1982 weights than 1970 weights. This is initially surprising, since 1982 weights give a greater disparity between the CIA's and our estimated shares in GNP for agriculture and mining than 1970 weights. One would expect a larger difference between the CIA's and our growth estimates. We believe the divergence calculations with 1970 weights exceed those with 1982 weights because the former overstate the divergence and the latter understate it. The calculations with 1970 weights exclude only two years (1975 and 1979). The upward bias that results from larger percentage differences in lower growth years probably dominates the downward bias from omitting only two years in which the divergence is greatest. The calculations with 1982 weights exclude six years, in which the absolute as well as relative differences between the estimates are greatest. Consequently, the downward bias most likely exceeds the upward. The calculations using the two sets of weights might then provide rough upper and lower bound estimates of divergence. Thus, the results suggest that MC valuation of output might improve estimation of Soviet GNP growth on the order of 10-30 percent. Recall again, though, that underestimation of the shares of mining and agriculture in value added acts to understate the potential disparity between the CIA's and our recalculations of GNP growth.

V. Conclusion

In computing the shares of sectors in GNP and GNP growth for the U.S.S.R., the CIA does not include economic rent in value added for the mining and agricultural sectors. The effect is to value output in these sectors at AC rather than MC; to include economic rent in valuation would result in jumping to MC valuation. Using simple methods, this study estimates the MC of Soviet extraction of fuels and metals and of agricultural production. Although the results should be regarded as rough rather than precise estimates, they indicate that MC for this output exceeds AC by a nontrivial amount, particularly during the 1980s.

Our reestimation of the share of mining in GNP over 1970–87 inclusive of economic rent (at MC valuation) gives a fairly steady figure of almost 10 percent, about $2\frac{1}{2}$ times that of the CIA. Our middle value reestimation of the share of agriculture in GNP during 1981–87 raises the CIA's figure of about 20 percent to 26 percent. Our estimates of Soviet GNP growth also differ from the CIA's by 10–30 percent. The lack of full data in reestimating all these values results in fact in a downward bias. The CIA itself is presently experimenting with including economic rent in the valuation of certain output in computing Soviet GNP accounts. This paper provides an initial look as to how the accounts could change.

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