STUDENT ESSAY

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WHAT HAS THEIR BOMB COST THE CHINESE?

By

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USAWC RESEARCH ELEMENT
Essay

WHAT HAS THEIR BOMB COST THE CHINESE?

by

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Carlisle Barracks, Pennsylvania
18 February 1966

SUMMARY

An estimate of the cost, in US dollars, of development and production of China's first nuclear device is presented. The estimate is based upon capital and operating costs of the facilities known to be required in a nuclear weapons program.

The US dollar value of the effort expended is related to the Chinese economy in terms of the cost of complete industrial plants which China could purchase on the world market.

The impact of the nuclear development program on the Chinese economy is illustrated by examples of increased capacity which could have been obtained in the agriculture, steel, electrical generation, petroleum, and other industries with investments comparable to that made in the nuclear program.

The magnitude of the economic sacrifice provides an understanding of the importance attached to membership in the nuclear club by Chinese Communist leaders.

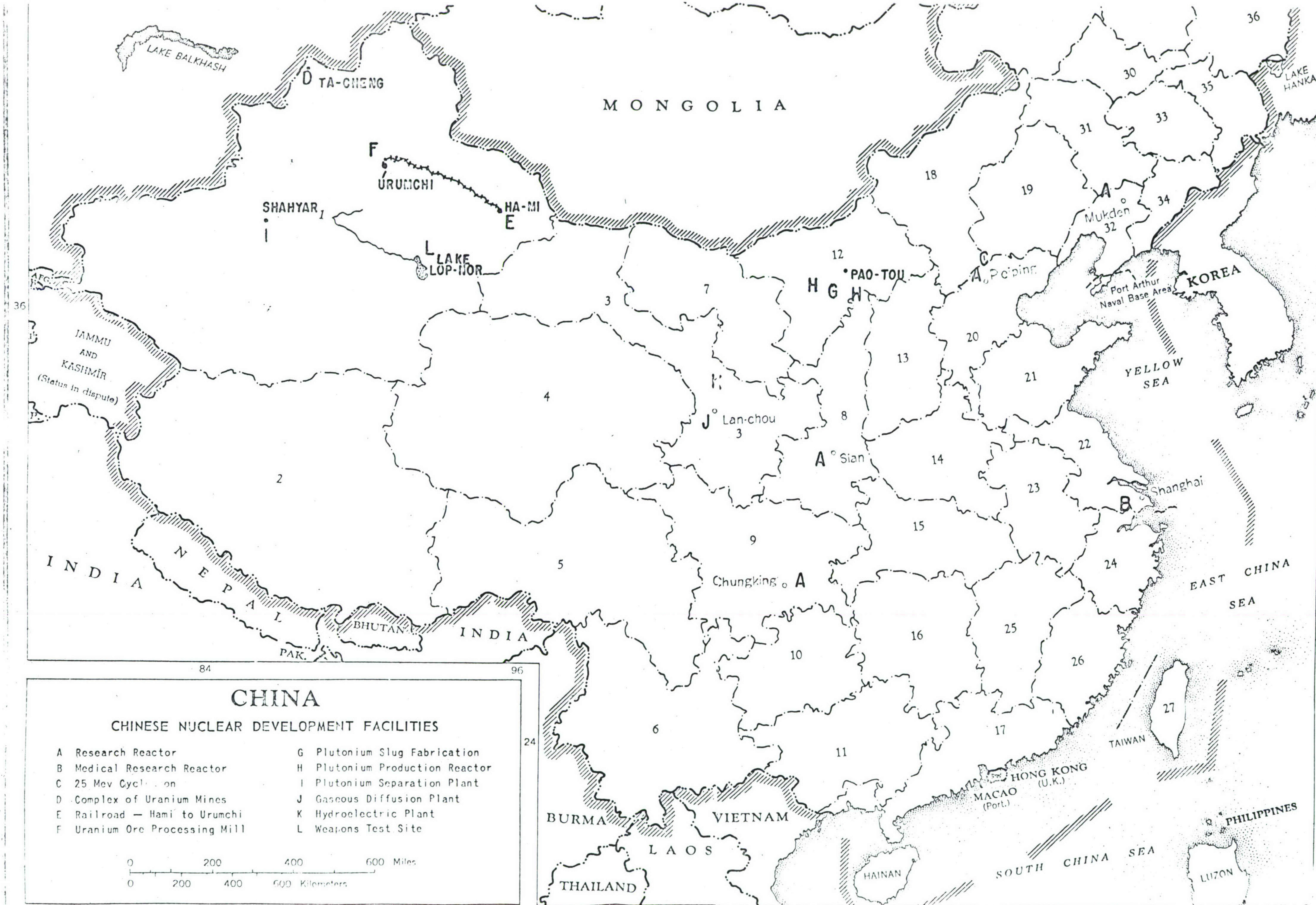
ILLUSTRATIONS

WHAT HAS THEIR BOMB COST THE CHINESE?

The explosion of Communist China's first nuclear device in October 1964 has been interpreted as signifying a number of things; e.g., an automatic membership in the nuclear club, a radical change in foreign relations between China and her neighbors, a demonstration of the Chinese Communists' ability to "make it on their own" without Soviet assistance, the revival of science and technology in China, an example of the ability of a highly disciplined Communist state to focus national energies on a difficult undertaking, and others. There seems to be no end to the conclusions that might be drawn from the single event, and, in fact, the many meanings of China's first nuclear explosion may never be completely disclosed.

However, there is a strong possibility that the event signified for Mao Tse-tung, and other high party officials, an accomplishment equivalent to burning the mortgage by the average home buyer. Certainly, there must have been a tremendous sense of relief when the successful test explosion provided a dramatic, if not pecuniary, return on the several years of considerable investment by the bomb buyers (who could ill afford to be buying into such an exclusive neighborhood).

When the decision was made to embark on a nuclear weapons development program, one can only conjecture as to whether the decision-makers had any real estimate of the magnitude of the undertaking. Furthermore, when the October 1964 explosion signified fruition (of sorts), it is doubtful that they had any accurate understanding of


CHINA
CHINESE NUCLEAR DEVELOPMENT FACILITIES
A Research Reactor
B Medical Research Reactor
C 25 Mev Cycl . on
D Complex of Uranium Mines
E Railroad — Hami to Urumchi
F Uranium Ore Processing Mill
G Plutonium Slug Fabrication
H Plutonium Production Reactor
I Plutonium Separation Plant
J Gaseous Diffusion Plant
K Hydroelectric Plant
L Weapons Test Site
0 200 400 600 Miles
0 200 400 600 Kilometers
MONGOLIA
LAKE BALKHASH
TA-CHENG
URUMCHI
SHAHYAR
HA-MI
LAKE LOP-NOR
JAMMU AND KASHMIR (Status in dispute)
INDIA
NEPAL
BHUTAN
PAK.
BURMA
LAOS
VIETNAM
THAILAND
PAO-TOU
Lan-chou
Sian
Chungking
Peiping
Mukden
Port Arthur Naval Base Area
KOREA
YELLOW SEA
Shanghai
EAST CHINA SEA
TAIWAN
HONG KONG (U.K.)
MACAO (Port.)
HAINAN
SOUTH CHINA SEA
PHILIPPINES
LUZON
LAKE HANKA
36
24
84
96
108

what their true costs had been. This is not to say that they were unable to inventory the new facilities that had been created (see map, Figure 1), to recount their annual operating expenses, to identify the bills that had been presented by the Soviets for goods and services furnished prior to their ideological clash, or to recapitulate other out-of-pocket expenses. It is doubtful, however, if there has been any calculated understanding on the part of the Chinese Communist leadership of what they have denied their country by electing to divert a significant fraction of their strained economy toward an undertaking which can contribute little to the economic well-being of their nation.

Except for satisfying a normal curiosity, there is little value in knowing the monetary amount of the Chinese investment in nuclear development. What is valuable is to understand the degree of importance placed upon that program by the Chinese Communist leaders and to obtain a feeling for how much they were willing to sacrifice to obtain the weapon that they have dubbed a "paper tiger."

The method employed in preparing this analysis involved itemizing the requirements for conducting a nuclear development program, estimating their value in terms of US dollars, and then converting the US dollar value into a measure of Chinese value. In this approach, only the conversion of dollar value presents any real difficulty.

To use the official exchange rate for dollars and yuan is patently incorrect. To use a black market exchange rate at Macao or Hong Kong would not be much better. Instead, the value of complete industrial plants which could be purchased by the People's Republic of China on the international market was selected for use as a conversion factor. This selection has three important advantages. First, their purchase on the international market requires the completion of a hard money transaction which is not only identifiable but translatable in terms of US dollars. Second, these purchases would represent a true outlay on the part of the People's Republic of China--a diversion of money or goods from their internal consumption--which they pay with religious exactitude. Their credit standing in international finance is impeccable. Third, by converting their estimated outlays for nuclear development in terms of productive capacity, one gets a better understanding of what they have denied themselves in terms of future production of consumer and producer goods by electing to expend their resources for an economically nonproductive program.

The question might be raised as to whether China could purchase from abroad the industrial plants needed to increase its productive capacity. The facts are that she has done so on a limited scale,[1] and that her economic relations with over 100 nations of the world include all of the great industrial powers except the United States. Barring any widespread reversal of international economic attitudes, it is not likely that China would be denied the purchase of any capital goods for which she is able to pay.

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[1]Dick Wilson, "Peking's Trading Plans," <u>Far East Economic Review</u>, Vol. XLVIII, No. 8, 20 May 1965, p. 353.

REQUIREMENTS FOR PRODUCING A NUCLEAR DEVICE

To itemize the requirements for producing a nuclear explosive device, it is only necessary to have a general idea of the recipe for assembling such a device. There have been a number of public descriptions of the principles of nuclear weapons from which a suitable recipe can be drawn.[2,3,4,5]

There must be a fissionable material of adequate mass to sustain a chain reaction. There must be a means for rapidly assembling the material into its critical geometry, and there must be a mechanism which triggers the entire process.

These requirements imply the need for materials, personnel and facilities to work the materials, and a technology that provides the proper scientific and engineering disciplines necessary to create the desired end products.

COST ESTIMATE IN US DOLLARS

Table I has been prepared by identifying the major operations which must be performed to create a nuclear device, allocating resources of facilities and personnel to each operation, estimating the time necessary to conduct the operations prior to a first test firing, and by calculating the cost of operations in terms of capital investment and operating expenses of corresponding US operations.

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[2] Henry DeWolf Smyth, Atomic Energy for Military Purposes, Chap. 6.

[3] Ralph E. Lapp, Atoms and People, Chap. 3 and 4.

[4] Arthur H. Compton, Atomic Quest, Chap. 3.

[5] David Dietz, Atomic Science, Bombs and Power, Chap. 12.

COST ESTIMATE
CHINESE COMMUNIST NUCLEAR DEVELOPMENT TO OCTOBER 1964
TABLE I

Description	Location	Capital Cost US$ millions	Date Completed	Operating Manpower: Scient Engrs	Operating Manpower: Techn	Annual Operating Cost US$ millions	Operating Cost to Oct '64 US$ millions	Information Sources
RESEARCH FACILITIES:								
Research reactor, 10Mw MTR-type	Peking	18	Jun '58	20	50	15	90	1,3,19
Research reactor, " " "	Mukden(or Harbin)	18	Jun '59	10	25	10	50	3,24,19
Research reactor, " " "	Chunking	18	Dec '59	10	25	10	45	3,19
Research reactor, " " "	Sian	18	Jun '60	10	25	10	40	3,19,24
Research reactor, Walter Reed type	Shanghai	10	Jun '61	10	25	10	30	7
25 Mev cyclotron	Peking	10	'61	20	25	12	36	7
2.5 Mev electrostatic accelerator	Unknown	3	'60	10	15	8	32	7
PRODUCTION FACILITIES:								
Complex of uranium mines	Tacheng	10	'57	40	200	15	105	22,53
Railroad (300 miles)	Hami to Urumchi	8	'61	10	150	10	30	22
Ore processing mill, 1000 tons/day	Urumchi	11	'59	20	200	10	50	51
Uranium refining plant	Unknown	25	'57	20	500	15	105	20
Slug fabrication for Plutonium	Paotou	70	'60	40	300	15	60	53
Plutonium production reactor 200Mw	Paotou	50	Oct '64	50	200	50	--	1,3,15,23,26 47,49
Plutonium production reactor 200Mw	Paotou	50	'61	50	200	50	150	3,7,15,26,49
Plutonium separation plant	Tarim River in Sinkiang Province	70	'62	50	200	50	100	1,3,53
Gaseous diffusion plant	Lanchou	500	'62	100	500	80	160	3,7,22,45 47,53
Hydroelectric plant, 750 Mw	Liu-Chia Gorge on Yellow River	225	'60	20	60	10	40	22,47
Uranium conversion plant, UF_6 to metal	Unknown	25	'62	20	100	45	90	----
Weapon assembly plant	Unknown	27	'63	100	300	25	25	53
TEST FACILITIES:								
Weapons test site	North shore of Lop Nor	40	'63	80	400	20	20	7
		$1203				$470	$1258	

INFORMATION SOURCES FOR TABLE I
(see last column)

[1]"Red China Gets Ready to Fire Its A-Bomb," Business Week, No. 1822, 1 Aug. 1964, p. 32.

[3]"The Explosion of October 16," Bulletin of the Atomic Scientists, Vol. 21, Feb. 1965, p. 19.

[7]Chu-yuan Cheng, "Progress of Nuclear Weapons in Communist China," Military Review, Vol. 45, May 1965, pp. 9-14.

[15]Ralph L. Powell, "Communist China as a Military Power," Current History, Vol. 49, No. 289, Sep. 1965, p. 139.

[19]Gordon Evans, "Communist China's A-Bomb Program," New Leader, Vol. 44, 18 Sep. 1961, p. 15.

[20]"Red China--Soon to Have the A-Bomb," US News and World Report, 11 Jan. 1960, p. 47.

[22]Emerson Chapin, "Peking Foresees a Delay of Years on Atomic Bomb," New York Times, 29 Oct. 1963, p. 1.

[23]John W. Finney, "Fusion Test Seen for China's Bomb," New York Times, 6 Oct. 1964, p. 5.

[24]Chalmers Johnson, "China's Manhattan Project," New York Times Magazine, 25 Oct. 1964, p. 23.

[26]John W. Finney, "Hints of 2 Chinese Reactors Lead US to Upgrade Estimates," New York Times, 20 Oct. 1964, p. 2.

[45]Leonard Beaton, "The Chinese Bomb," Survival, Vol. 7, No. 1, Jan.-Feb. 1965, p. 3.

[47]Morton H. Halperin, China and the Bomb, p. 75.

[49]Morton H. Halperin, "China and the Bomb--Chinese Nuclear Strategy," The China Quarterly, No. 21, Jan.-Mar. 1965, p. 74.

[51]US Congress, Senate and House, Joint Committee on Atomic Energy, AEC Uranium Procurement Program, Hearings, 87th Congress, 18-19 Jun. 1962, p. 310.

[53]American Society of Mechanical Engineers, Uranium, Plutonium, and Industry, pp. 9, 11, 44-45.

No claim is made that the individual values shown in Table I are rigorously accurate. There are too many gaps in available information concerning the Chinese weapons program to be able to be more definitive. Similarly, there are apparent omissions from Table I. For example, there is a cost associated with the development of electronic components for a nuclear device and a cost incurred in the conduct of research necessary to develop an operating technology for chemical and metallurgical operations used in the preparation of special nuclear materials. The magnitude of this type of work in supporting technologies is indicated by the fact that the United States spent $26 million to develop the process for extraction of uranium metal from the concentrate of uranium ore.[6] To compensate for the omission of such costs as identifiable line items, the estimates of operating costs for research and production facilities have been made high.

There is one factor that could not be quantitatively considered in the preparation of this cost estimate; i.e., the difference in intrinsic value between a unit of effort which China can generate from her internal resources and a unit of effort which China must import. The latter, because it requires the expenditure of scarce credits in foreign exchange, carries a special penalty. It is important to recognize this difference but no way was found to quantify it.

[6] US Congress, Senate and House, Joint Committee on Atomic Energy, AEC Uranium Procurement Program, Hearings, 87th Congress, 1st Session, p. 280.

It should be mentioned that the inclusion of facilities for electromagnetic separation of Uranium-235 from natural uranium is based upon the author's assumption that this technique was used to supplement gaseous diffusion in producing highly enriched uranium for the first nuclear device. It does not appear to have been possible to obtain sufficient quantities of highly enriched uranium from the diffusion plant at Lanchou during the time that was available from its completion to assembly of the first device. However, using a partially completed gaseous diffusion plant to produce relatively large quantities of slightly enriched uranium for use as feed material to electromagnetic separation devices (mass spectrographs) is an efficient compromise solution. It has the advantages of permitting an early use of the initial stages of a partially completed gaseous diffusion plant while increasing the yield from electromagnetic separation. Although no large facilities for electromagnetic separation have been reported, it is quite possible to use a number of mass spectrographs and to have them widely scattered in universities and industrial laboratories.

This theory is further supported by the reported delay in completion of the hydroelectric plant at Liu-chia Gorge near Lanchou. It is known that the Russians delayed delivery of the turbine-generators for that plant following the ideological split in 1960. Best estimates are that incremental delivery was made beginning in 1961. It is likely, therefore, that there was insufficient power to operate all stages of a gaseous diffusion plant even if they had been available. On the other hand, power for a number of scattered mass spectrographs could have been supplied by small, existing power stations.[7]

From Table I, the estimated total cost of the Chinese nuclear program from 1957 through their first explosion in 1964 is US $2.5 billion. The current annual cost is US $470 million, not including any costs associated with the development of delivery means for nuclear warheads.

Several other cost estimates have been made public, and they cover a wide range of values. It is interesting to consider the source of these estimates and to compare their values with the estimate from Table I.

Dr. Glenn T. Seaborg, now Chairman of the U. S. Atomic Energy Commission, told US News and World Report that $100 million would pay for a first nuclear weapon for any one of twelve nations who have an adequate technological base.[8]

The editorial staff of Newsweek estimates that France spent $200 million over six years to achieve a nuclear detonation with no

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[7]Leonard Beaton, "The Chinese Bomb," Survival, Vol. 7, No. 1, Jan.-Feb. 1965, p. 3; the use of gas centrifuges in lieu of gaseous diffusion is discussed as follows: "Gas centrifuges are receiving much attention at present, though the evidence is that a substantial development would still be required to make them effective in separating U_{235} from U_{238} in quantities adequate for a weapons programme. In any case, the first cost would probably be about as great as for gaseous diffusion. . . ."

[8]Glenn T. Seaborg, Interview by US News and World Report, Vol. 59, 19 Jul. 1965, pp. 60-65.

appreciable outside help.[9]

Daniel Wolfstone offers a different figure in a quotation from the Far East Economic Review:

> The commonest estimate of the cost of China's atomic bomb is around US $250 million. This is not much, perhaps, for a government which is presumably spending a total of around $18,000 million annually. It represents, shall we say, just over 1% of China's annual spending--or five days spending. . . .[10]

Dr. Morton Halperin suggests a different amount measured in terms of the GNP:

> The Chinese Gross National Product was estimated to be $35-$45 billion in 1957. Their nuclear weapons program has probably cost them the equivalent of approximately 2% of their GNP and could be drawn from a defense budget of more than $2.3 billion.[11]

Dr. Halperin's estimate amounts to $700-$900 million if he intended the total program cost to be 2% of one year's GNP. If, on the other hand, he means that 2% of each year's GNP is spent on nuclear development, the total cost from 1957-64 would be approximately US $6.8 billion, and current annual costs would approach US $860 million.[12]

Chi-fang Wu writing for the Institute of Political Research on Taiwan evaluates the effort as follows:

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[9] "The Bomb" From Hiroshima to ---," Newsweek, Vol. 59, 9 Aug. 1965, p. 54.

[10] Daniel Wolfstone, "The Costly Bomb," Far East Economic Review, Vol. XLVIII, No. 8, 20 May 1965, p. 351.

[11] Morton H. Halperin, China and the Bomb, p. 47.

[12] Stanford Research Institute, The Economic Potential of Communist China, Vol. 3, p. 165: Using a relationship of one yuan = US$0.40, the sum of the GNP for 1957-64 is approximately US$340 billion, and 2% of that amount is US$6.8 billion. Similarly, the GNP in 1964 is estimated at approximately US$43 billion. Two percent of US$43 billion is US $860 million.

> It was estimated that by the time their first nuclear test was conducted, the Chinese Reds had already spent at least US $1,500 million and mobilized 1800 scientists and engineers for the project. It will cost at least US $200 million a year if they continue their program of nuclear research and test.[13]

In 1963, this estimate appeared in US News and World Report: "Red China is said to be spending about as much as France on atomic development--some 400 million dollars a year."[14] Assuming that such a level represents maximum sustained effort, and that the early years cost less, the total cost from 1957 through 1964 would be something less than $2.8 billion.

The editorial staff of Nation's Business recently offered their estimate:

> The bill for nuclear weapons to date can only be guessed at on the basis of similar programs carried out by other powers--a total expenditure of perhaps $2.5 billion between 1959 and 1964 and current annual outlays of some $500 million; . . . .[15]

The wide range of reported estimates should be an adequate caution to use them more for their qualitative rather than their quantitative value. In any event, the point is not that a determinable amount of money was spent for the first Chinese bomb but that the decision to spend for this purpose had a significantly detrimental

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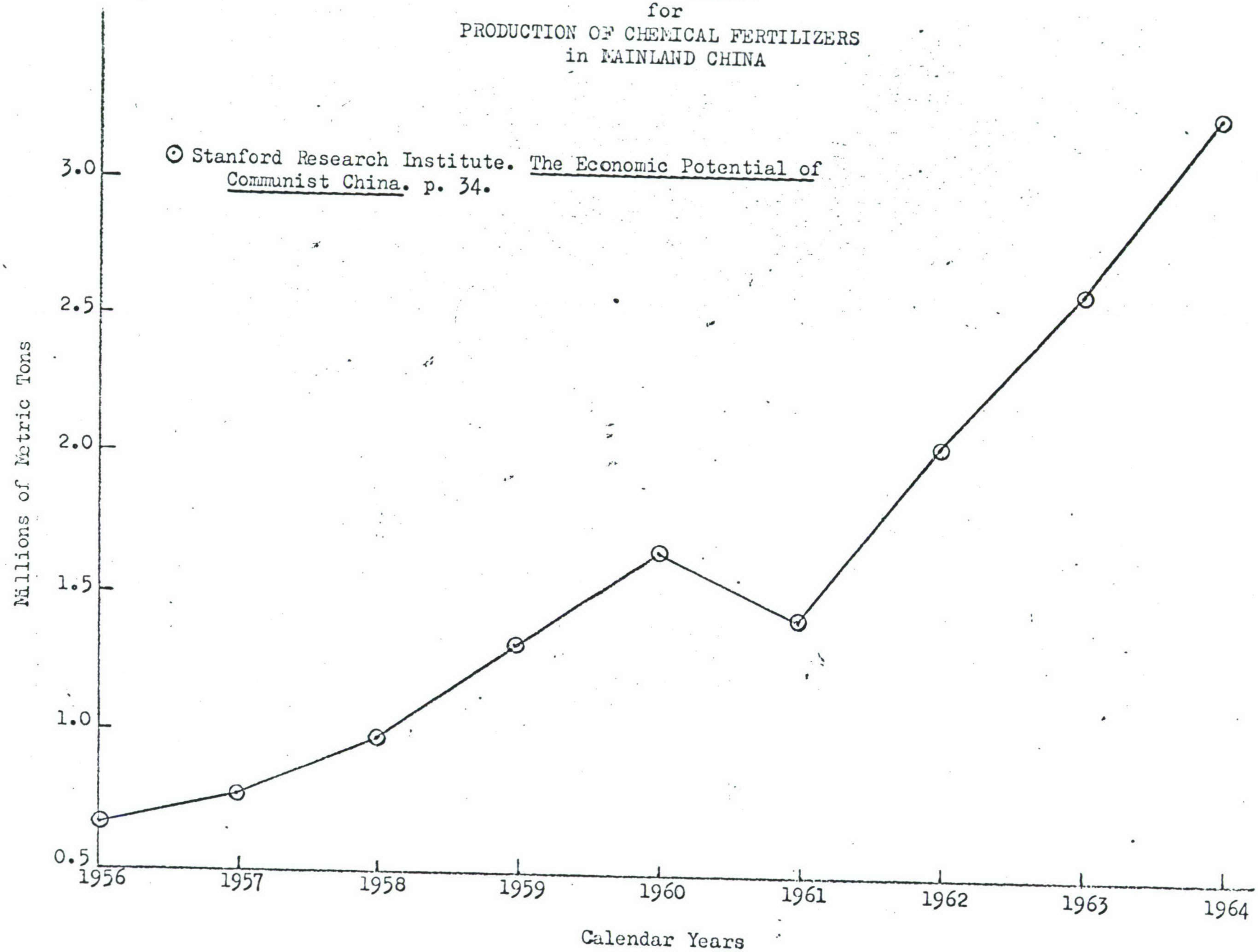
[13]Chi-fang Wu, "Peiping's Nuclear Test and its Military Industry," Chinese Communist Affairs, Vol. 2, No. 1, Feb. 1965, p. 13.

[14]"Now Red China Makes the Bomb," US News and World Report, Vol. 57, 15 Jul. 1963, p. 39.

[15]"What to Expect Next from Red China," Nation's Business, Vol. 53, No. 10, Oct. 1965, p. 44.

REPORTED VALUES
for
PRODUCTION OF CHEMICAL FERTILIZERS
in MAINLAND CHINA



(Figure 2)

effect on an already strained economy. For the purpose of illustrating that effect, the value of the effort expended as estimated in Table I will be used.

INVESTMENT IN CHEMICAL FERTILIZER

As a first comparison, consider the benefit to agriculture from a major capital investment in the capacity to produce chemical fertilizers. Nothing is closer to the Chinese people than agriculture, and more of the Chinese people are directly affected by agriculture than any other sector of the economy. One recent periodical emphasized the situation with the statement, "When one tries to bring China into focus, the most important thing to remember is that it is a land of 600,000,000 peasants--out of a total population of over 700,000,000."[16]

Agriculture accounts for roughly 1/2 of the GNP.[17]

A new fertilizer plant bought by India on the world market cost US $65 million and produces 375,000 tons of chemical fertilizer yearly.[18] The total Chinese production in 1964 was estimated to be only 3,250,000 tons,[19] (see Figure 2). Estimates for the actual need

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[16] "China's Long Haul Towards a Modern Society," Realities, No. 174, May 1965, p. 36.

[17] US Dept of Agriculture, Economic Research Service, The Far East, Communist China, Oceania Agricultural Situation, p. 37.

[18] Dick Wilson, "The Tortoise and the Hare," Far East Economic Review, Vol. XLVIII, No. 2, 8 Apr. 1965, p. 80.

[19] Stanford Research Institute, The Economic Potential of Communist China, Vol. 3, p. 35.

for chemical fertilizer vary from 14,000,000 tons[20] to 40,000,000 tons.[21] In the most extreme case, one hundred new fertilizer plants costing US $6.5 billion would be required to meet the demand for 40 million tons. In the most conservative estimate, thirty-eight new plants, costing US $2.4 billion, would provide all of the fertilizer needed. Unquestionably, there are other factors which must be added to convert available fertilizer into harvested grain; e.g., proper application, favorable weather, even the transportation necessary to distribute additional tonnage--but the availability of adequate supplies of fertilizer to a basically agricultural society would have a tremendous effect on the bulk of the people.

China has relatively little undeveloped land suitable for agriculture. On the intensely cultivated land being farmed in 1964, the Economic Committee for Asia and the Far East of the United Nations estimates a yield of more than 190 million tons of food grains.[22] Other estimates are around 160 million tons.[23] Both of these estimates correspond to the range of estimates for production during 1957-58 (Figure 3). Faced with a population that is exploding at 2½% a year,[24]

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[20]Dick Wilson, "The Tortoise and the Hare," <u>Far East Economic Review</u>, p. 79: Mr. Wilson states that "Farmers . . . get only a quarter of the chemical fertilizer they really need." 3,250,000 tons divided by ¼ = 14,000,000 tons.

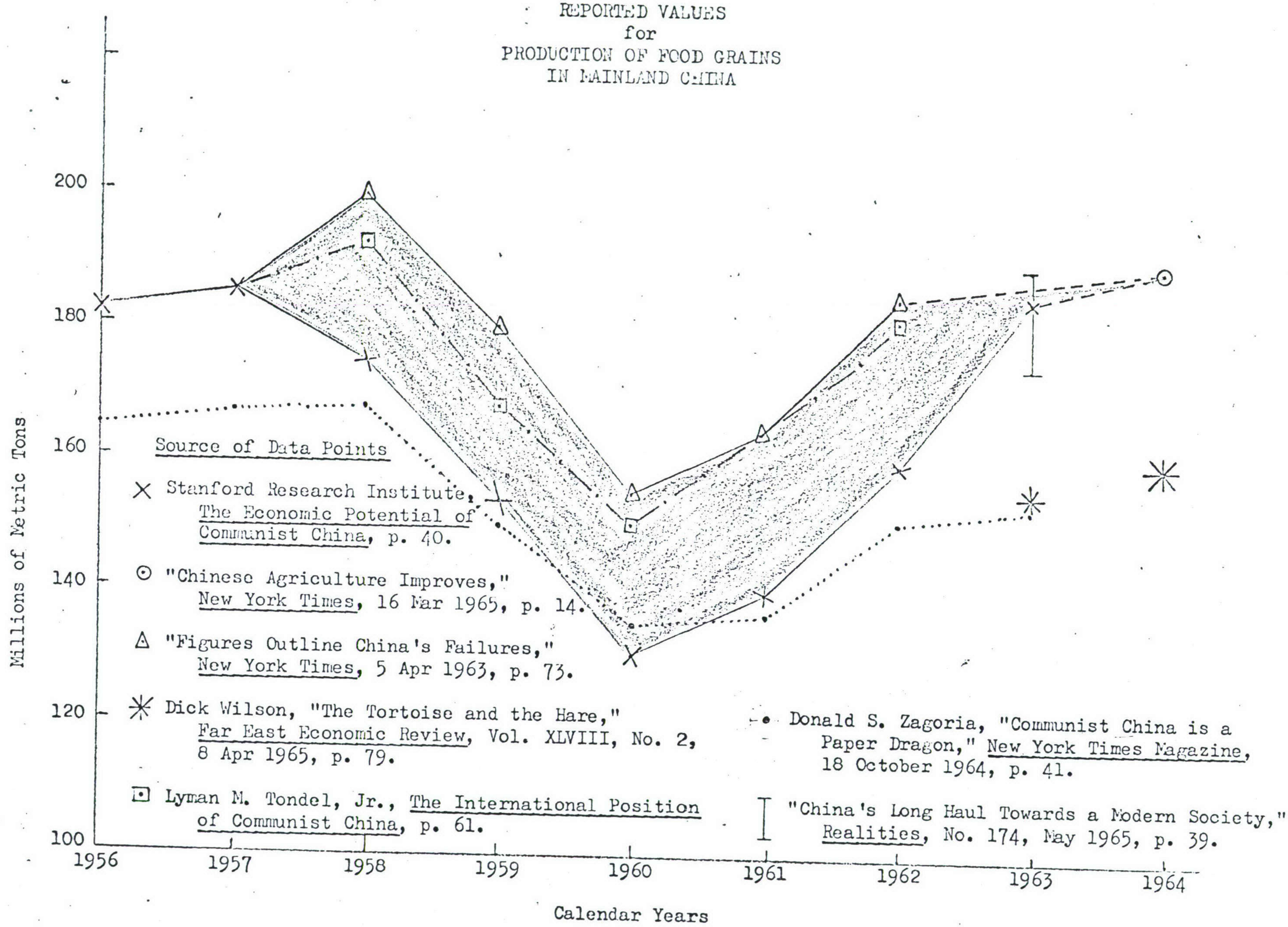
[21]Ching-wen Cho, <u>Chinese Communist Regime Trapped in Spiral Crisis</u>, p. 12.

[22]"Chinese Agriculture Improves," <u>New York Times</u>, 16 Mar. 1965, p. 14.

[23]Dick Wilson, "The Tortoise and the Hare," <u>Far East Economic Review</u>, p. 79.

[24]<u>Ibid</u>.

REPORTED VALUES
for
PRODUCTION OF FOOD GRAINS
IN MAINLAND CHINA



(Figure 3)

such stagnation in agricultural production can lead to calamity. Confronted with an absolute necessity for expanded production and a practical limit to the amount of arable land, the only choice is to increase the yield per unit area farmed. The application of liberal amounts of chemical fertilizer has been proven to result in substantially increased yields.[25] It appears to be China's best hope for ever being able to feed herself, and, until she can feed herself, only a small fraction of her foreign exchange can be directed towards the purchase of capital goods so desperately needed for industrial growth.[26]

In spite of the necessity for expansion of the fertilizer industry, China has taken only modest steps to do so. There is a new chemical fertilizer plant in Shanghai which cost US $25 million and makes 100,000 tons per year. It is completely Chinese in design, construction, and operation.[27] In addition, China has recently purchased two complete plants from an Italian manufacturer for US $14 million.[28] The capacity

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[25]Stanford Research Institute, The Economic Potential of Communist China, p. 37: For rice crops in China, the application of one ton of two parts ammonium sulfate to one part superphosphate is estimated to yield an increase of 2.5 tons of unprocessed grain. The rate of application per unit area varies according to specific soil conditions. This is an average figure which assumes a proper rate of application.

[26]Dick Wilson, "Peking's Trading Plans," Far East Economic Review, Vol. XLVIII, No. 8, 20 May 1965, pp. 354-355: "It must be remembered that 2/3 of the money China spends in the non-Communist world go on food and raw materials ($400 million on grain last year, $90 million on raw cotton, $65 million on fertilizer, and $65 million on crude rubber--these four items alone added up to $260 million last year, leaving only $360 million for other imports: it is estimated that machinery and plant accounted for $140 million of this). . . . Peking's intense need of capital goods, especially of complete plant, is undoubted, but her capacity to allocate more funds towards them cannot match her enthusiasm."

[27]Dick Wilson, "The Tortoise and the Hare," Far East Economic Review, p. 80.

[28]Dick Wilson, "Peking's Trading Plans," Far East Economic Review, p. 353.

of these two was not reported but they are estimated to be about 50,000 tons per year combined.

With a society crying for increased food production; with the prospect of an exploding population that is equivalent to feeding a new Canada each year;[29] with an economy in which shortfalls in farm production have an almost immediate impact on industrial production as well;[30,31] with improved yield from each acre as the only means to increase the national production, the decision to invest $2.5 billion in a nuclear device instead of in fertilizer plants seems to have overlooked proper consideration of the interests of the Chinese people.

INVESTMENT IN STEEL

Consider next the Chinese steel industry and what an investment of $2.5 billion in new plant would mean in terms of current output.

In 1963, the United States government investigated the inclusion of a large steel mill as a part of its economic aid to India. Estimates prepared by the U. S. Steel Corporation priced the proposed mill

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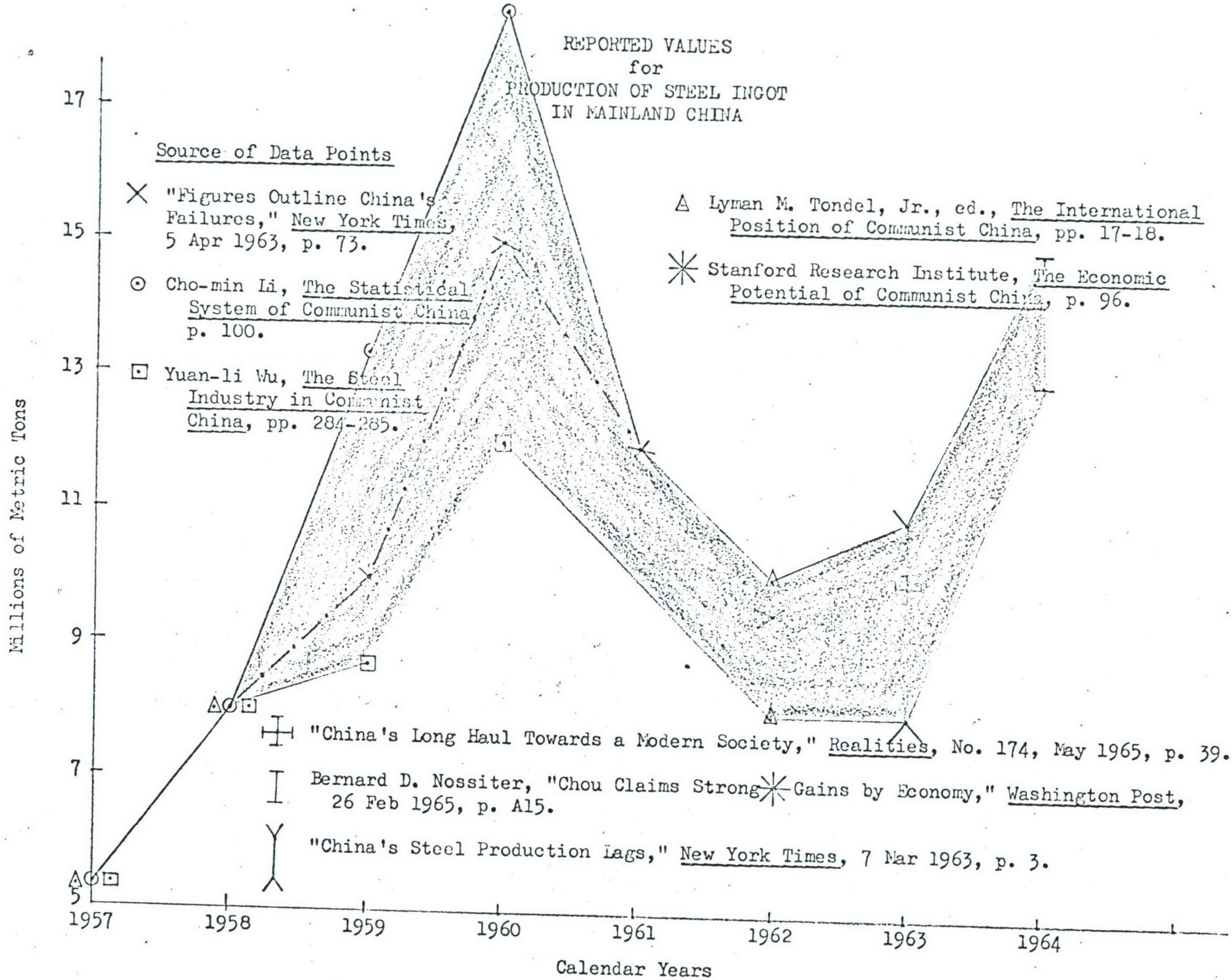
[29] Dick Wilson, "The Tortoise and the Hare," Far East Economic Review, p. 79.

[30] Alexander Eckstein, "On the Economic Crisis in Communist China," Foreign Affairs, Vol. 42, No. 4, Jul. 1964, p. 656: Mr. Eckstein states, "Under Chinese conditions, agricultural stagnation and poor harvests have an almost immediate impact on industrial production as well. . . shortfalls in farm production thereby reduced the country's capacity to import capital goods for industrialization."

[31] Lyman M. Tondel, ed., The International Position of Communist China, p. 18: "This sagging in the industrial effort . . . derives from two graver factors, namely; (1) the failure of agriculture to produce the necessary industrial raw materials and export goods, and (2) the breach between China and its Soviet ally that has been growing since 1958."


REPORTED VALUES
for
PRODUCTION OF STEEL INGOT
IN MAINLAND CHINA
Source of Data Points
"Figures Outline China's Failures," New York Times, 5 Apr 1963, p. 73.
Cho-min Li, The Statistical System of Communist China, p. 100.
Yuan-li Wu, The Steel Industry in Communist China, pp. 284-285.
Lyman M. Tondel, Jr., ed., The International Position of Communist China, pp. 17-18.
Stanford Research Institute, The Economic Potential of Communist China, p. 96.
"China's Long Haul Towards a Modern Society," Realities, No. 174, May 1965, p. 39.
Bernard D. Nossiter, "Chou Claims Strong Gains by Economy," Washington Post, 26 Feb 1965, p. A15.
"China's Steel Production Lags," New York Times, 7 Mar 1963, p. 3.
Millions of Metric Tons
17
15
13
11
9
7
5
1957
1958
1959
1960
1961
1962
1963
1964
Calendar Years

(Figure 4)

at US $1.8 billion for an annual capacity of 2,500,000 ingot tons (or $408 per ingot ton).[32]

Had the Chinese Communists elected to invest $2.5 billion in new steel capacity, they would have added 3.5 million tons to their annual production.* An incremental addition of that magnitude is equal to half of what they had been able to achieve during their first Five Year Plan.[33] It would be equivalent to a 25% increase in their present national capacity (Figure 4). What effect this would have had on other industry can only be inferred, but the successful expansion of such a basic industry as steel cannot fail to stimulate growth in construction and manufacturing. Unfortunately, this opportunity, too, was ignored in favor of developing a home-grown nuclear device.

INVESTMENT IN NICKEL

Closely allied to basic steel are some of the nonferrous metals which play an ever-increasing part in the materials demanded by new technology. Aluminum, magnesium, titanium, berylium, nickel, and others are essential to many of the high performance machines of war, and of peace. How important these are is indicated by the fact that

*2,500,000 ingot tons x $\frac{(\$2.5)}{(\$1.8)}$ = 3,470,000 ingot tons.

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[32]US Congress, House, Committee on Appropriations, Foreign Assistance and Related Agencies Appropriations for 1964, Hearings, 88th Congress, 1st Session, p. 1633.

[33]Yuan-li Wu, The Steel Industry in Communist China, pp. 284-285: Beginning of the first Five Year Plan, 1953--1.774 million metric tons of ingot steel; 1958--8.0 million metric tons.

> both Soviet Russia and Communist China have had a general policy of withholding all physical output figures of nonferrous metals, presumably because of the close relationship between the nonferrous metals production and the production of military goods.[34]

Therefore, even though we do not have current production data available for comparison, it is meaningful to see what capacity they could have added in this important industry.[35]

The International Nickel Company recently announced a planned investment of US $100 million to increase their productive capacity in 1965 by 12½%, or 60 million pounds.[36] A straight line extrapolation of $2.5 billion would equate to an increase in capacity of 1.5 billion pounds of nickel, or 25 times the one year increase planned by the International Nickel Company. It is not likely that China could profitably consume such a large amount of nickel in its own industry, and a more prudent investment would probably be some fraction of the $2.5 billion in nickel plant with the remainder going to other applications. However, it is clear that an investment considerably smaller than that made in their nuclear program would alleviate any

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[34]Kang Chao, "Indices of Industrial Output in Communist China," The Review of Economics and Statistics, Vol. XLV, No. 3, p. 287.

[35]Alice Langley Hsieh, Communist China's Strategy in the Nuclear Era, p. 154: In assessing the Chinese capability to develop nuclear weapons, the author quotes Dr. John Berberet as follows: ". . . there appear to be no problems which the Chinese are not capable of solving. They have the manpower, but it is very inexperienced. They have materials shortages, the main one being stainless steels. These aspects will delay their progress, but will not stop it." Nickel is a principal alloying element in high quality stainless steels.

[36]"INCO Expansion Plans Announced," Wall Street Journal, 22 Apr. 1965, p. 5.

shortage which they might have and provide a valuable surplus for foreign exchange.

INVESTMENT IN ELECTRICITY

Energy resources are a useful index of the modernity of a nation's society because the replacement of human and animal effort by machines is characteristic of all of the truly advanced nations of the world. China is habitually regarded as a land where ant-like hordes of coolies toil at tasks that would be more efficiently performed by powered machinery, and that picture must continue until the kilowatt-hour and the B.T.U. replace the arms, legs, and backs that deliver the bulk of China's energy today.[37] As Figures 5, 6, and 7 show, production figures for electricity, petroleum, and coal are pitifully low for a nation of 700 million people. As an example of what might have been done, consider the investment of US $2.5 billion in electric generating capacity.

In round numbers, an installed kilowatt of thermal-electric generating capacity costs US $250. Hydroelectric plants cost slightly more in capital investment but operate for less. $2.5 billion invested in new electric generating stations would add 10 million kilowatts to the nation's total. Assuming an average plant factor of 80%, this new generating capacity would add 70 billion kilowatt-hours to

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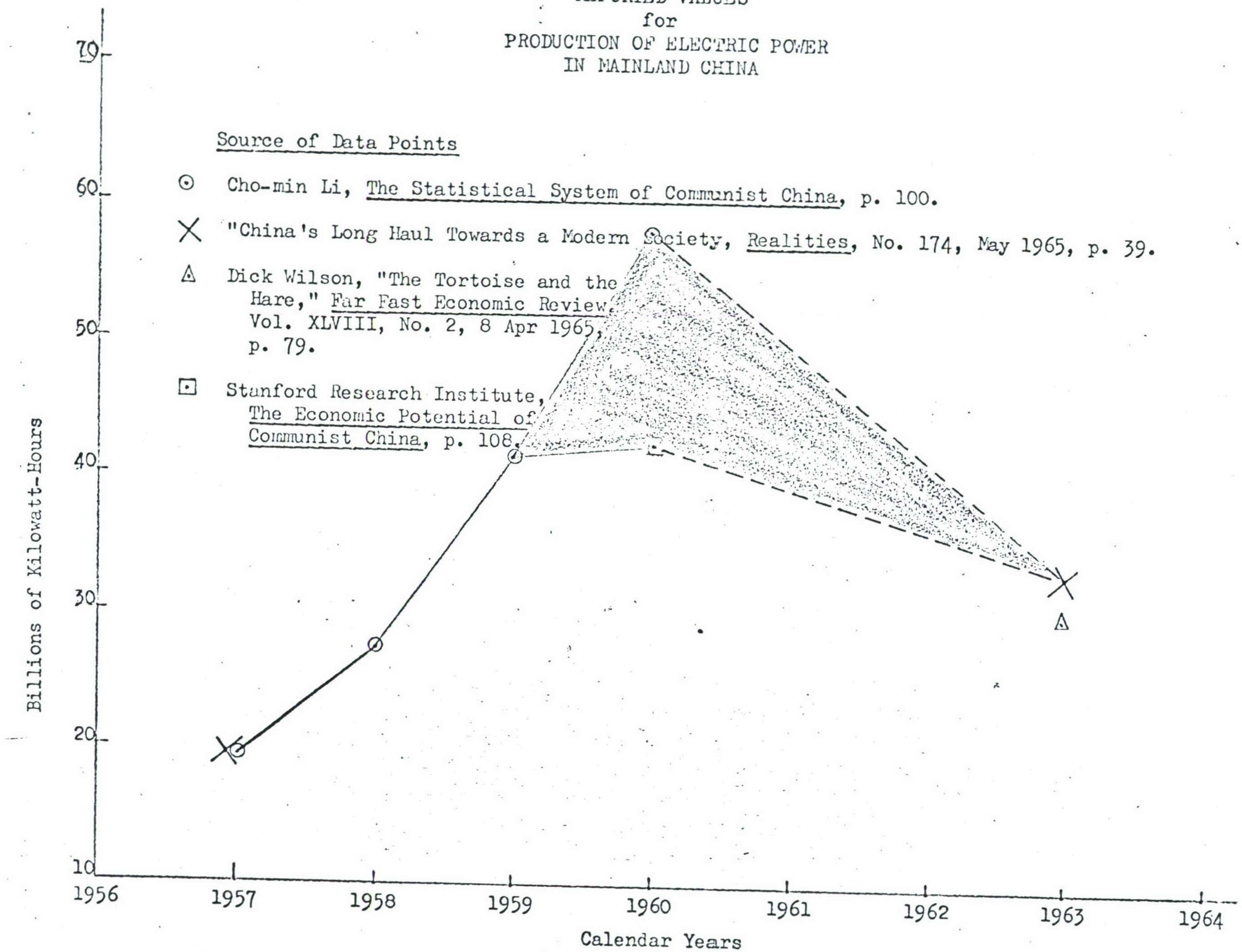
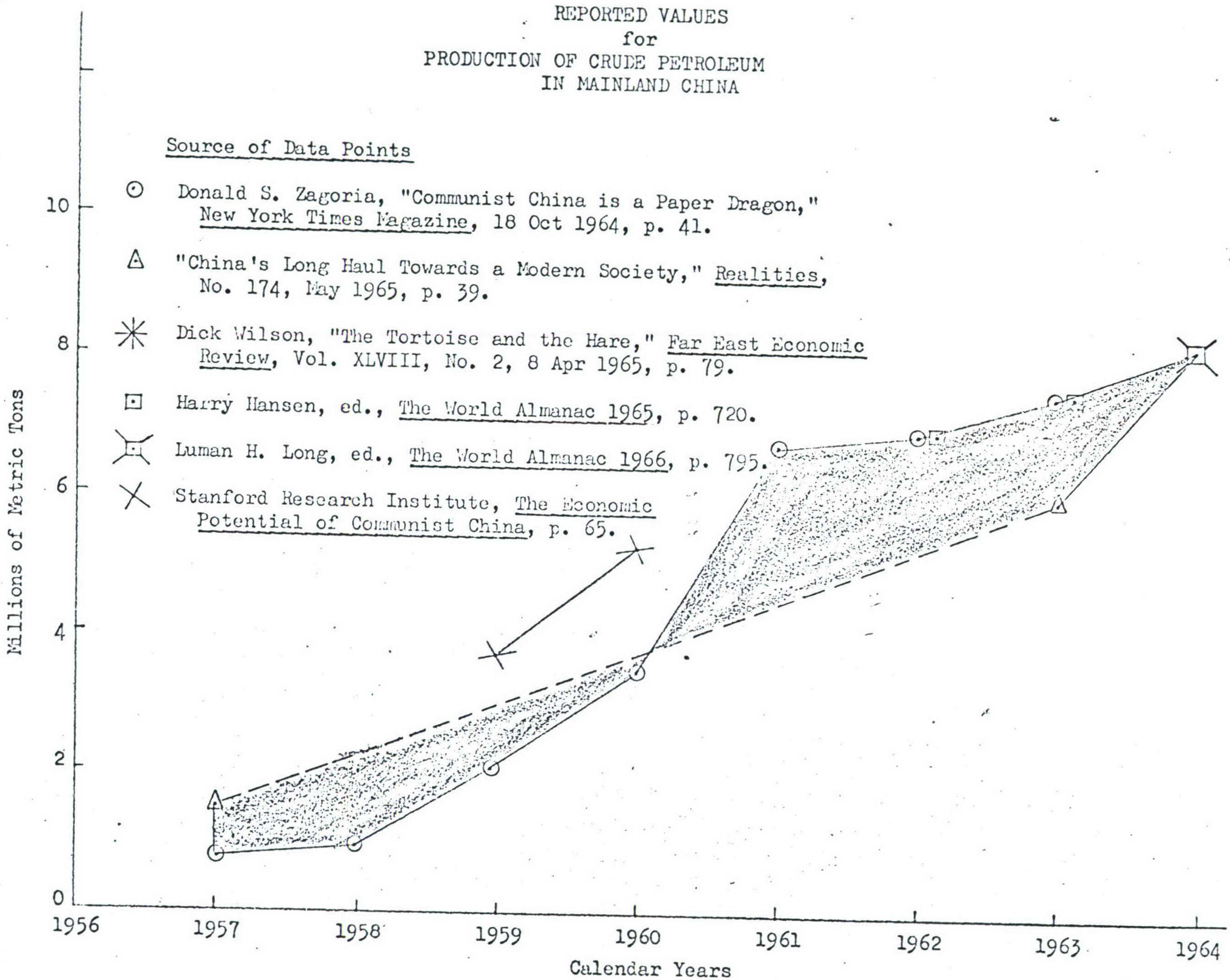
[37]Beaton, op. cit., p. 3: Mr. Beaton states: "The common experience of visitors to China today is that the country is desperately short of electric power."

REPORTED VALUES
for
PRODUCTION OF ELECTRIC POWER
IN MAINLAND CHINA



(Figure 5)


REPORTED VALUES
for
PRODUCTION OF CRUDE PETROLEUM
IN MAINLAND CHINA
Source of Data Points
Donald S. Zagoria, "Communist China is a Paper Dragon," New York Times Magazine, 18 Oct 1964, p. 41.
"China's Long Haul Towards a Modern Society," Realities, No. 174, May 1965, p. 39.
Dick Wilson, "The Tortoise and the Hare," Far East Economic Review, Vol. XLVIII, No. 2, 8 Apr 1965, p. 79.
Harry Hansen, ed., The World Almanac 1965, p. 720.
Luman H. Long, ed., The World Almanac 1966, p. 795.
Stanford Research Institute, The Economic Potential of Communist China, p. 65.
Millions of Metric Tons
0
2
4
6
8
10
1956
1957
1958
1959
1960
1961
1962
1963
1964
Calendar Years

(Figure 6)

the annual production of electric power. Referring to Figure 5, this increase is greater than twice the total production in 1963! This relatively abundant power could be put to many industrial purposes as well as to the sorely needed expansion of irrigation in support of agriculture.[38]

INVESTMENT IN PETROLEUM

With respect to the capacity to produce petroleum products,

> one group of experts points out that in different parts of the world, investment in fixed assets (plants, property, and equipment) per barrel of daily oil throughput may vary from a low of about $2,000 to a high of perhaps $10,000.[39]

For a conservative analysis, assume a figure of $8,000 as applicable to China. $2.5 billion invested in the Chinese petroleum industry would potentially have added 114.1 million barrels per year (≈16.8 million tons/year)* to their petroleum production. This increase amounts to more than twice their total production in 1963 (see Figure 6). It is equal to the production of crude from Kuwait during that same year.[40]

It is true that China may not possess the reserves of crude

*Assumes an average crude weighing 7 pounds per gallon.

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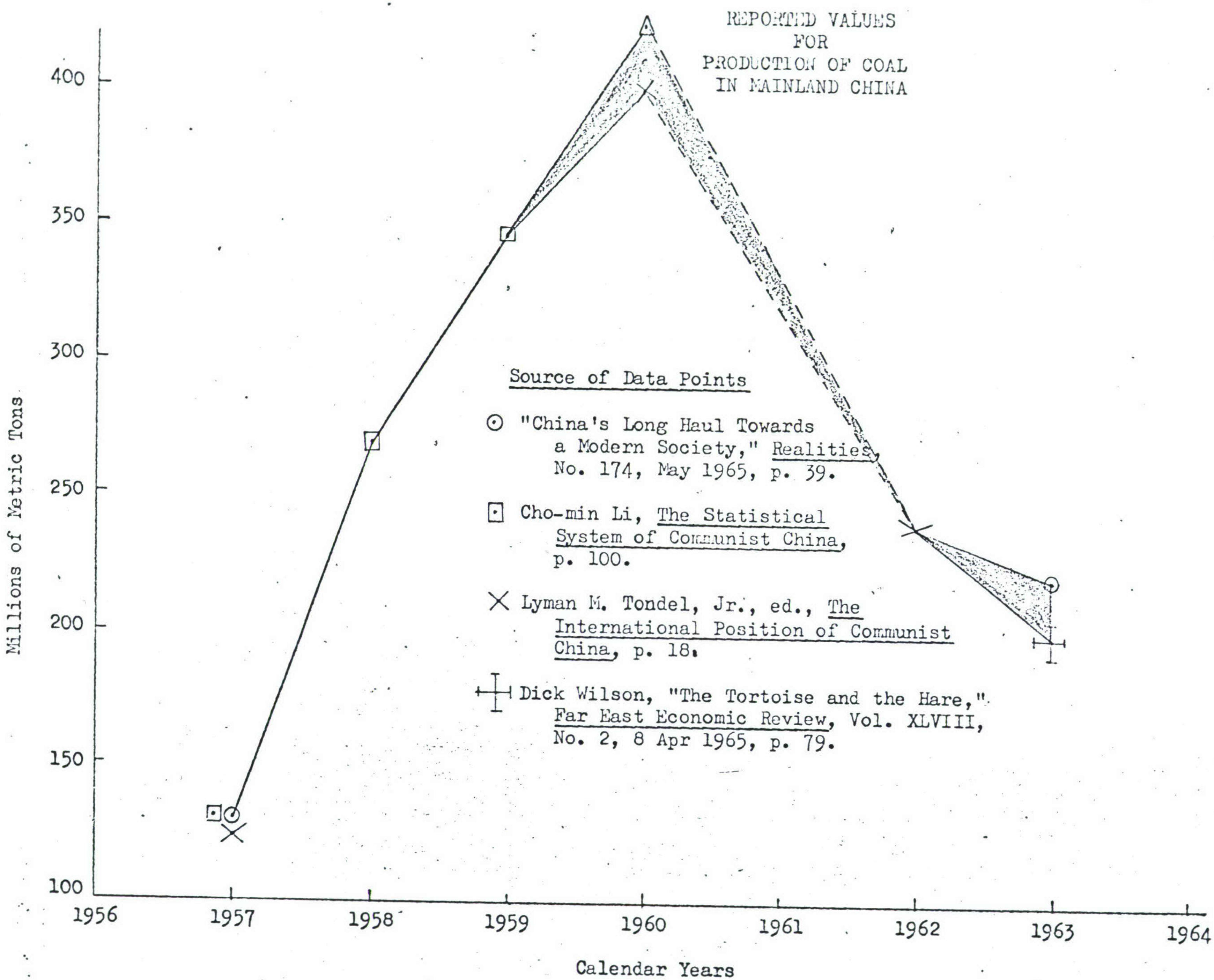
[38] P. Lin, "Trends in Communist China's Economic Policy," Free China and Asia, Vol. XII, No. 4, Apr. 1965, p. 4: "Only 30% of the tillable land is irrigated."

[39] Raymond F. Mikesell, US Private and Government Investment Abroad, p. 413.

[40] Harry Hansen, ed., The World Almanac 1965, p. 720.



REPORTED VALUES
FOR
PRODUCTION OF COAL
IN MAINLAND CHINA
Millions of Metric Tons
400
350
300
250
200
150
100
1956
1957
1958
1959
1960
1961
1962
1963
1964
Calendar Years
Source of Data Points
"China's Long Haul Towards a Modern Society," Realities, No. 174, May 1965, p. 39.
Cho-min Li, The Statistical System of Communist China, p. 100.
Lyman M. Tondel, Jr., ed., The International Position of Communist China, p. 18.
Dick Wilson, "The Tortoise and the Hare," Far East Economic Review, Vol. XLVIII, No. 2, 8 Apr 1965, p. 79.

(Figure 7)

petroleum necessary to develop a 24 million ton per year petroleum industry. However, it is equally true that what crude petroleum there is in the ground in China is of little value to the economy without the means to extract, refine, and distribute it to where its contained energy can be released as useful work or to where it can be sold for other goods and services.

If China does have substantial untapped reserves in petroleum, a substantial investment in its development would result in the growth of an industry of great value both for internal consumption and for use in the world market. It is of particular importance if they aspire to reach an advanced state of industrialization. They must buy the means to produce manufactured products until their own industry develops to the extent that it can build its new plants, and there is no doubt as to the value of petroleum in foreign exchange. It is one of the products for which the world demand is rapidly expanding, and the best customers for petroleum products are, also, the best sources of industrial equipment.

Furthermore, exportable petroleum products are a powerful tool in international politics. Undoubtedly, the Chinese Communists consider a nuclear weapon a powerful tool as well, but they have failed to recognize that investment in the development of their petroleum industry might have given them a potent political lever while contributing substantially to their economic well-being--a side benefit which does not accrue from a nuclear development program!

INVESTMENT IN PAPER

Still another possibility is the development of a paper industry. A new 1,000 ton per day paperboard mill was recently reported to cost US \$60 million.[41] \$2.5 billion invested in paper mills could have provided a productive capacity of some 41,500 tons of paperboard per day. At current prices, that is an export potential of US \$2.5 billion per year.[42] Compared to China's recent history of foreign trade, i.e., US \$4.295 billion in 1962, US \$2.715 billion in 1963, and US \$3.005 billion in 1964,[43] the addition of US \$2.5 billion in paperboard exports would be of major significance. With the demand for paper in Asia and the Far East estimated at 25 million tons per year in 1975,[44] China would do well to consider carefully the encouragement of a paper industry as a complement to its highly agrarian economy.

There are the two distinct advantages of being able to turn marginal land to the raising of pulpwood trees and of employing large numbers of the rural population in their planting, care, and harvesting. Pulpwood is one of the few money crops which not only grows on marginal

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[41] "International Paper Announces New Mill," Wall Street Journal, 13 May 1965, p. 6.

[42] United Nations, Food and Agriculture Organization, Proceedings of the Conference on Pulp and Paper Development in Asia and the Far East, p. 177: The range of average Swedish export values for paperboard is given as US \$162.70 - US \$171.30 per ton. A value of US \$165.00 is used here.

[43] Dick Wilson, "Peking's Trading Plans," Far East Economic Review, p. 352.

[44] United Nations, Food and Agriculture Organization, Proceedings of the Conference on Pulp and Paper Development in Asia and the Far East, p. 6.

land but serves as a conservation measure as well, and there would be relatively little retraining necessary for the people involved in raising and harvesting the trees. It is one way that China could extend its total arable land, and probably turn to a more profitable pursuit some marginal land that is presently yielding small returns of other crops.

INVESTMENT IN TRANSPORTATION

Finally, consider what improvements in transportation could mean to a country the size of China.

US $2.5 billion could buy a representative mix of transportation facilities as follows:

40	airfields @ $5 million
400	short range jetliners @ $2.75 million[45]
100,000	2½ ton trucks @ $4,000
4,000	miles of two-lane, all-weather road @ $200,000

This is probably a poor mix for China today. She needs more railroads and rolling stock, more roads and automotive equipment, and relatively few jet passenger aircraft. Nevertheless, it is indicative of what a tremendous increase in the ability to move people and things could be obtained with an investment equivalent to that made in nuclear weapon development.

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[45]"TWA Buys British Jets," Wall Street Journal, 29 Apr. 1965, p. 10: Fourteen short range British Aircraft Company Model 111 jetliners were sold for US $40 million.

CONCLUSION

These separate examples of productive facilities and equipment which could have been obtained for approximately the same investment as was made in the first Chinese nuclear device are not intended to be singular solutions to China's economic dilemma. On the contrary, the adoption of any one of the examples as the sole area to receive the benefit of substantial investment capital would be as fallacious as has been the decision to ignore them all. The separate examples were developed to dramatize the impact of diverting large amounts of scarce resources to a nonproductive undertaking.

In terms of real value, it might be said that their first nuclear explosion cost the Chinese 14.4 million tons of chemical fertilizer per year, and that the lack of 14.4 million tons of fertilizer cost them 36 million tons of food grains per year.

Alternatively, the cost might be viewed as a lost opportunity to triple their national production of electric power or petroleum or to increase their annual production of steel by 25%.

Stated another way, the cost could be considered as US $2.5 billion per year of lost paper exports that might have been realized under other circumstances.

Any one of these; any combination of portions of these; or any other examples of productive capacity that could have been created with the resources which were expended in nuclear weapon development only demonstrate what a prodigious price was paid by the Chinese people for a military luxury. However, it appears that the priorities established by Chinese Communist leadership place political gain ahead of economic development, and that possession of nuclear weapons is regarded as a substantial political asset by Peking. Halperin and Perkins state a similar conclusion this way:

> Economics in Peking's eyes is more a means to various ends than it is an end in itself. If a choice comes down to a selection between attainment of international political goals or domestic economic development, it is by no means clear that China will always opt for the latter. . . . China would be willing to sacrifice a certain amount of economic development in order to attain international political goals, how much development depending on the size and importance of the political gain.[46]

Although the decision is explainable by this rationale, it is difficult to foresee circumstances in which China's possession of nuclear weapons will be worth the costs incurred in their development.

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[46] Morton H. Halperin and Dwight H. Perkins, Communist China and Arms Control, p. 47.

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