THE EFFECTS OF CHANGES IN THE ECONOMIC STRUCTURE ON ENERGY DEMAND IN THE USSR AND THE US*

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ABSTRACT

Researchers in both the US and the USSR expect further reduction in their economy's energy use per output. An important factor underlying this trend is the shift in the structure of economic production away from energy-intensive sectors. This paper focuses on studies conducted in both countries to measure the relative importance of shifts within the economy on energy demand. These studies use the same methodology--a Divisia index decomposition--to separate this shift trend from other energy use trends, thus eliminating one source of discrepancy between studies. Both historical and projected trends for the two countries are examined.

INTRODUCTION

It is widely recognized that an economy can reduce its energy intensity through many channels. Improvements in the energy efficiencies of certain processes in individual industries are important but capture only a part of the response. Shifts in the structure of an economy's production for energy-intensive sectors have been and will continue to be an important factor in lowering the energy use per output in many economies (Marlay 1984). Analysts in both the USSR and the US expect that the changing economic structure will continue to reduce the aggregate energy intensity in each country. There exists, however, considerable uncertainty about the rate of decline in the energy intensity due to such shifts.

This paper focuses on studies conducted in both countries to measure the relative importance of shifts within the economy on energy demand using the same methodology--the Divisia index--for decomposing energy intensity trends. Since conventions for measuring energy consumption and economic output are different in the two countries, a comprehensive comparison of international experiences was beyond the scope of our collaboration. A rigorous comparison of past trends in the two countries, if it can even be done reliably, would require extensive revisions and adjustments to the existing data. Instead, our objective was more modest: to use the most recent data available internally within each country to help identify and understand the important energy intensity trends in the two countries. Thus, this paper summarizes two separate but concurrent studies on aggregate energy intensities.

The decomposition of energy intensity trends into those due to changing economic structure and those due to other factors, e.g., new processes within an industry, is an important first step in understanding energy use patterns. For a market economy, energy intensity trends within an industry are governed largely by the prices of energy and other inputs as well as industry-specific technological progress. These same factors, however, may not be as critical for economy-wide or aggregate energy intensity trends, which will be strongly influenced by shifts in the relative importance of different economic sectors. For example, aggregate energy intensity is significantly influenced by the widespread substitution of newer, more versatile materials for the traditional, energy-intensive raw materials, e.g., various plastics for primary metals. Moreover, the indirect effects of energy price changes--the redistribution of income and the shifting share of investment--are often at least as important as the direct effect. Analyses that ignore these differences are likely to misrepresent the factors determining aggregate energy use trends in economies that either now or will in the future depend upon markets.

Policymakers in the US and USSR are increasingly interested in strategies for reducing the aggregate energy intensity within each country. In the Soviet Union, energy production is often extremely capital intensive. In the absence of market prices, many analysts perceive an overinvestment in energy supplies in that country that retards economic growth by misallocating capital. Thus, declining energy intensity in the economy would release capital to other sectors where it could be employed more productively. As the USSR moves toward a market economy, energy efficiency gains achieved through shifts among sectors of the economy are likely to respond to different factors than those gains realized from new processes and technology implemented within a sector.

In the United States and other developed market economies, some analysts argue that market prices undervalue the social cost of using additional energy. Incomplete information, public utility regulation favoring supply options, and other market imperfections could bias aggregate economic consumption towards too much energy use. Moreover, increased energy consumption means increased production from and dependence upon the Persian Gulf, the source of marginal supplies in world energy markets. Growing dependence upon insecure energy supplies increases the vulnerability of the world market economies to oil market disruptions and price shocks.

In recent years, policy concerns in both countries have been broadened to include environmental problems such as pollution and possible climate change through increasing concentrations of carbon dioxide and other greenhouse gases. Much recent attention has been focused on the forces influencing energy use and the relationship between energy use and environmental degradation. Estimates of the effect of different carbon-reduction strategies, for example, depend critically upon how rapidly energy will grow in the absence of such limits as well as upon the degree of substitution away from energy as energy use is restricted.

The two country studies reported in this paper were done to provide an initial perspective on past USSR energy intensity trends and possible future developments, within the context of the US experience. A clear understanding of the different channels for reducing energy in the major economies is a prerequisite for an informed analysis and discussion of the relative benefits and costs of various strategies for reducing energy use.

The concurrent studies of the two countries were conducted just as new 1985 data were becoming available on the use of energy in both economies. The research also commenced at a time when the Soviet Union was just beginning to contemplate major changes in its economy and energy sector. Since that time, the challenge of this transition has grown substantially, creating considerable uncertainty about future developments in both the USSR economy and its energy sector. Given these developments, one must view any attempt to project future economic and energy trends as extremely risky with large error bands in either direction (a problem in any economy relying upon market forces). Nonetheless, we view these projections and their decomposition into sectoral shift and efficiency effects as a useful comparison of how these forces could unfold in the two countries.

Our analysis reveals three key conclusions. (1) The use of a Divisia index for separating the shift effect from other factors is a useful method when there are large or sudden changes either in energy intensity within a sector or in the relative economic importance of a sector. (2) Shifts in the composition of economic output have an important effect on the trend in aggregate energy intensity of the economy. However, shifts within the industrial sector away from energy-intensive industries have a more pronounced effect than do shifts among major macrosectors (e.g., industry, transportation, agriculture). (3) Within industry, there has been a dramatic decline in aggregate fuel intensity in both countries over the last 20 years. During the post-embargo period (after 1973), however, this trend accelerated in the US but slowed in the USSR, due largely to little improvement in energy intensity within industries. After a brief discussion of the methodology, we discuss the Soviet and US results in separate sections.

METHODOLOGY

Variations in aggregate energy intensity were decomposed into changes in energy intensity at the industry level (measured by real energy intensity) and changes in the composition of output (i.e., sectoral shift). These components were formally defined for the analysis as follows:

- Real energy intensity: the (weighted) average of the energy intensity of separate sectors, equivalent to the "real" change in energy intensity that remains when output mix effects are removed from the aggregate measure. Given the level of aggregation in our studies, the measured change in real energy intensity will be incorporating some shifts in the mix of output or industry on a disaggregated basis.
- Sectoral shift: the total contribution of changes in output mix to changes in aggregate energy intensity.

We decompose the aggregate energy intensity with the Divisia index, which is constructed from growth rates using variable weights based upon total energy use. This approach has been used to study energy trends in the US and other market economies (e.g., see Boyd et al (1987a)); its advantages and limitations for energy use studies are considered in Boyd et al (1988). The change in aggregate energy intensity is calculated by the following formula:

$$\Delta \ln e = \sum w_i \, \Delta \ln e_i + \sum w_i \, \Delta \ln d_i$$

where e_i is the energy-output ratio in a particular sector, d_i is the share of output in that sector, w_i is the sector's share of total energy consumption[1] and the subscript $_i$ refers to a sector.

The principal distinctions of this method are:

1) The effect of sectoral shift is estimated dynamically, year by year rather than by comparing the beginning and ending year in the period. This procedure uses a logarithmic index representation that ensures additivity of the results.

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[1]Btu rather than price weights have been used because prices have historically been a poor indicator of relative value in the USSR. Btu weights overstate the decline in energy intensity for the US because measured intensity includes substitution towards higher-quality energy, e.g., electricity, as well as the shift away from energy. See Huntington and Myers (1987).

2) Sectoral shifts are weighted by the structure of energy demand changing over time (in contrast to fixed-weight methods, which weighs the components by energy use in the base year).

THE USSR EXPERIENCE

Since the USSR energy trends are not widely known, we initially discuss some key aspects. We then analyze the contribution of sectoral shift to these trends. The discussion and results are based upon historical Soviet data for the 1960-1985 period from Pavlenko and Nekrasov (1972), Aksutin and Veretennikov (1981), Melentiev and Makarov (1983), and Narodnoye (1985), and upon Siberian Energy Institute projections presented by Anoshko et al (1986). Some shares and trends obtained from these data are described in the next section.

Key Trends

The pattern of the energy-output ratio differs substantially depending on the particular energy carrier (electricity, heat, fuels) and time period. Figure 1 presents the calculated indexes of electricity-, heat-, fuel- and energy intensities of economic output for 1985.[2] Total energy use is the sum of fuel, electricity, and heat use. The latter is thermal power produced and used in the form of steam, hot water, and space heat, primarily for district heating systems.

In 1960-1985, the indexes of electricity and heat intensity were very similar; annual increases in these intensities averaged 1%. The change of electricity and heat intensity was caused mainly by the increasing contribution of industry to aggregate output and its high energy intensity.

[2]Throughout this section, output refers to the net output, or value added, in a sector. For the aggregate economy, net material product (NMP) rather than gross national product (GNP) is used. NMP excludes output in the service industries.

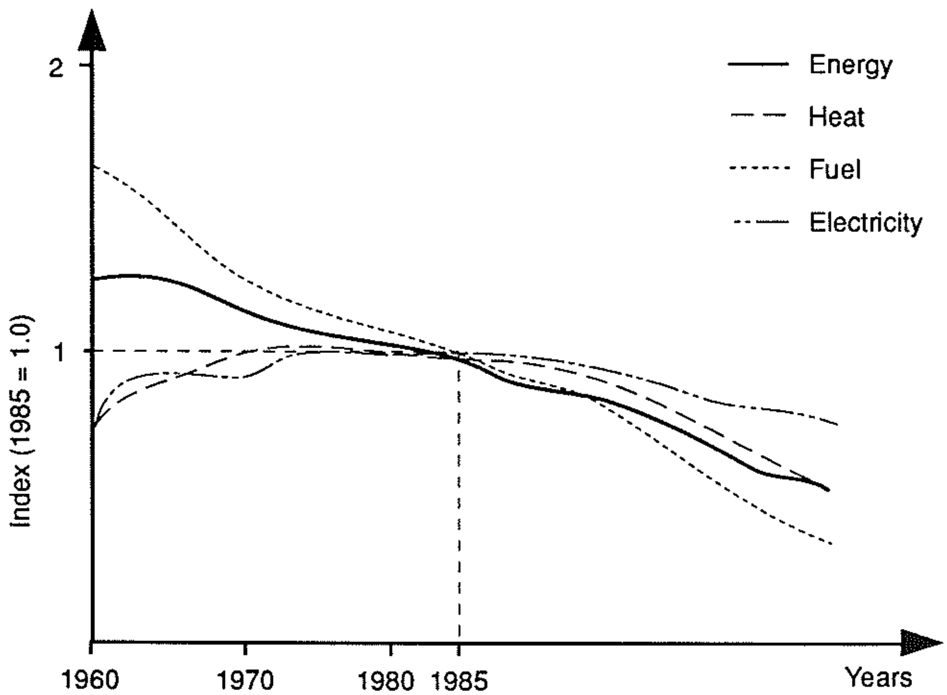

Figure 1: Index for Energy-Output Ratio in the Soviet Economy

Industry's energy intensity was more than two times higher than for the country as a whole in 1960 and 1.3 times higher in 1985 (Melentiev and Makarov, 1983). Strong growth in the electricity intensity of agricultural output (a tenfold increase for the period reported by Melentiev and Makarov (1983)) also contributed to this trend. However, in the future the electricity- and heat-output ratios may be expected to decrease by 1 and 2 percent per year, respectively. This projected trend is caused by the further decline of the electricity- and heat-intensity of industrial output; the growth of industry's relative importance to the economy does not offset this effect.

The rates of decline in the aggregate fuel-output ratio are much higher. They average up to 2 percent per year in the historical period and the projection. This trend is explained mainly by the low fuel-intensity of industrial output, whose value was 1.1 times lower than the fuel-output ratio for the economy in 1960 and will be 1.7 times lower in the future (Melentiev and Makarov, 1983). In addition, the industry share of aggregate output grows continuously.

Changes in energy intensities equal changes in the combined intensities for electricity, heat, and fuels. The decline in the resulting aggregate energy-output ratio was 1 percent per year in the historical period and are projected to be not less than 2 percent in the future.

These trends show that the energy intensity of industrial output has a decisive impact on the change in the aggregate energy-output ratio in the 1960-85 period as well as in the future because industry's relative importance in the economy grows continuously. Figure 2 compares the changes in the energy-industrial output and the aggregate energy-output ratios. It also shows the changes in energy intensity of agricultural output and transportation. The indexes for the energy intensity of industrial output and of the economy are similar.

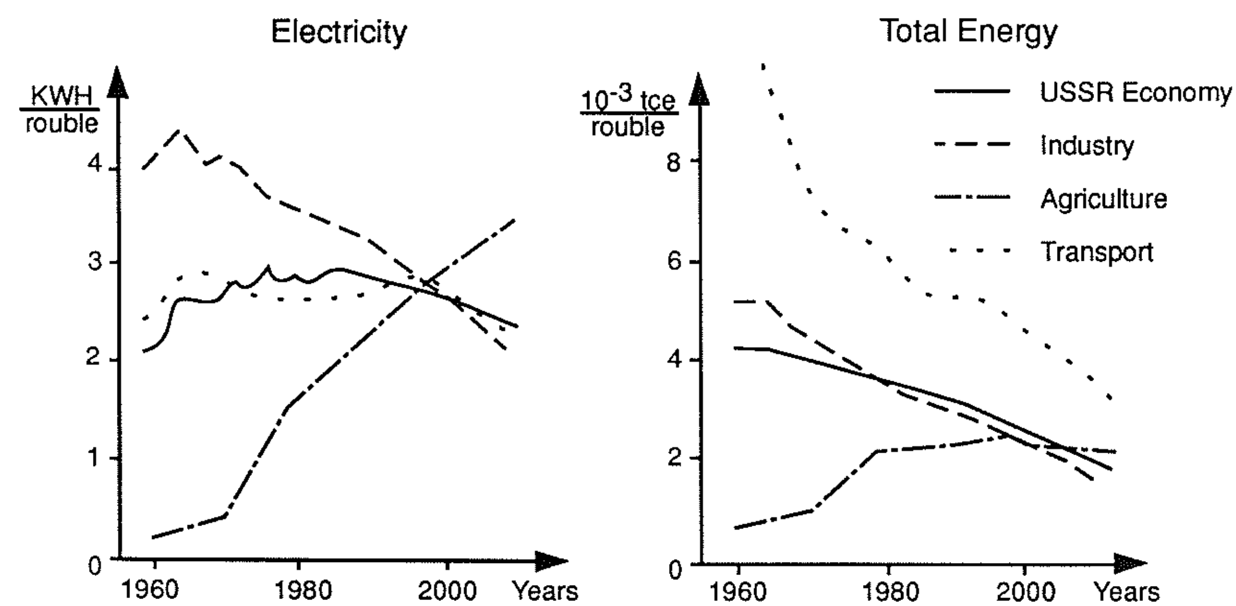

Figure 2: Trends in Sectoral Energy Intensity

Within the industrial sector, changes in the energy intensity will be governed by trends in two sectors:

- sector 1 (materials industries: ferrous and non-ferrous metallurgy, chemistry and petroleum chemistry, construction materials, forest and pulp-paper, fuel/energy complex), and
- sector 2 (manufacturing industries).

The historical period is characterized by the high and increasing share of sector 2 in industrial output. This trend reduces the aggregate energy intensity within industry because the energy-output ratio for manufacturing industries is much lower than for sector 1 (the materials-producing industries). The electricity intensity of the output in sector 2, for example, is 4-10 times lower than it is in sector 1 (the first figure corresponds to 1960, the second one to the end of the time period), and the fuel intensity is lower by a factor of 16-120 (calculated from the data of Pavlenko and Nekrasov (1972), Aksutin and Veretennikov (1981), Melentiev and Makarov (1983)). Such a large difference in the energy intensity indexes for the two sectors causes changes in the relative shares of industrial output in the two sectors to have a substantial effect on the changes in the aggregate energy intensity of industrial output.

The contribution of the industries in sector 1 to energy demand within industry is clearly seen from Figure 3, showing the trends in the sectoral demand for electricity, heat, fuel, and aggregate energy (calculated from the same data). The share of sector 1 in electricity demand by industry for the 1960-85 period decreases from 67 to 60 percent, in heat demand from 61 to 54 percent, and in aggregate energy from 77 to 68 percent. This sector's share in fuel demand increases from 89 to 94 percent.

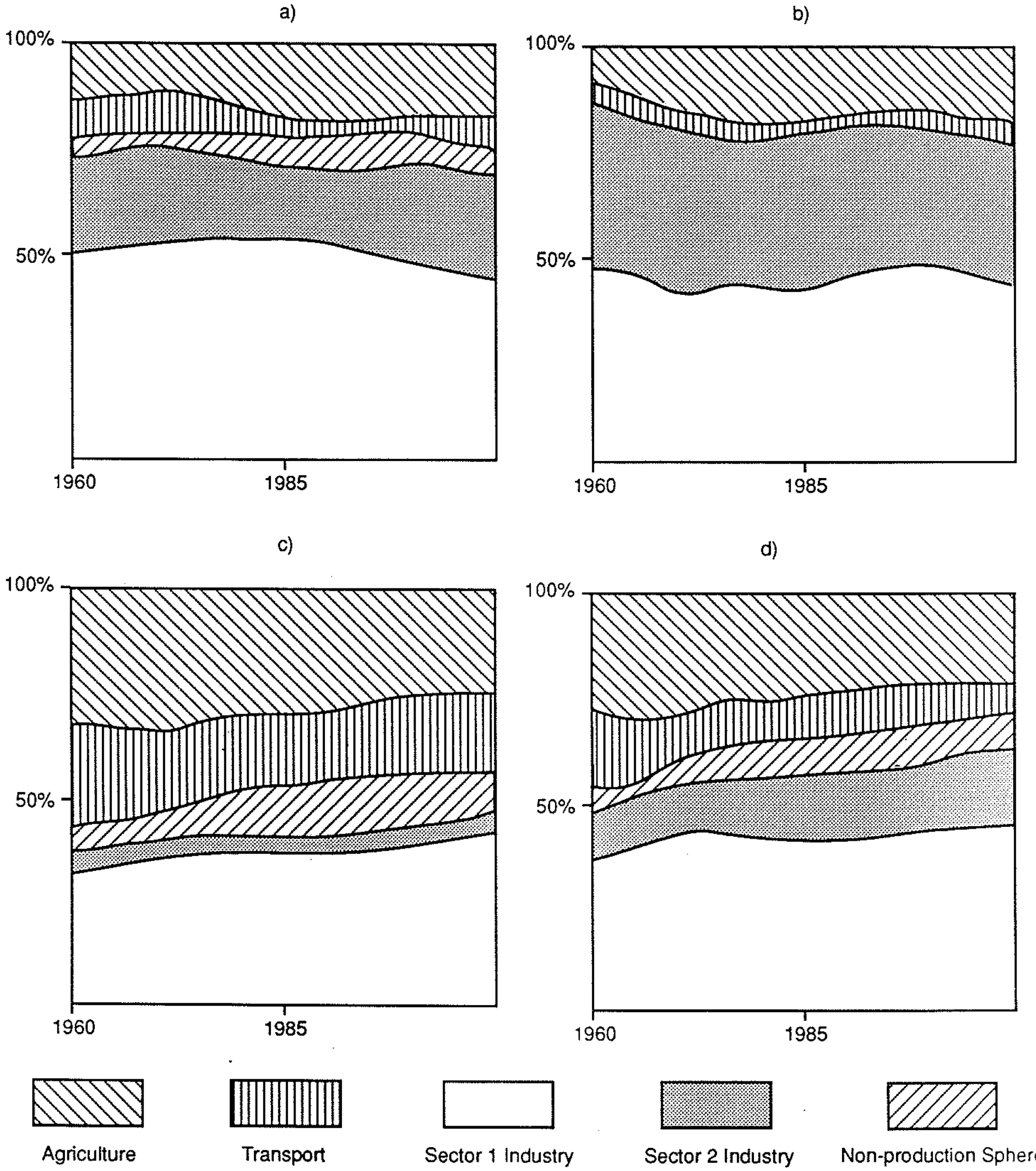

Figure 3: Change in the Structure of Electricity (a), heat (b), fuel (c), and energy (d), demand in the economy

Energy use by households and service industries (the so-called non-production sphere in Soviet statistics) increases in relative importance over the 1960-85 period. This sector's share of electricity demand for the whole period increases from 11 to 16 percent, and its share of heat energy rises from 10 to 18 percent, reaching its maximum of 21 percent in 1980. Its share of fuel demand decreases somewhat. Agriculture's relative importance increases in total electricity use but decreases in fuel and total energy use. Transportation's share falls for all energy carriers during this period.

Contribution of Sectoral Shift to the Change in Energy Intensity

The indexes calculated by the Divisia index approach for electricity and fuel intensity of NMP[3] and industrial output are given in Figure 4 and 5. Figure 4 shows the shifting trends in the electricity-NMP ratio during the 1960-1985 period. In the period between 1960 and 1965 the index was growing at a rate of 4 percent per year, during the following 7 years its growth rate was low (0.7 percent per year), and later--from 1972 to 1985 and in the near future--the electricity intensity is practically stabilized.

The effect of sectoral shift is particularly pronounced in the early 1960s when its share is more than 90 percent. In the period 1965-1985, its contribution to the change of electricity-NMP ratio is in the range from 40 to 85 percent. In the future, the electricity-NMP ratio is expected to fall. The role of sectoral shift will also decrease, to 32 percent by the end of the period. The fuel-NMP ratio (see Figure 4b) decreases by 2.8 percent per year in 1960-1985 and is estimated to decline by 2.5 percent per year in the projections. Its pattern is almost completely determined

[3]Households and services are excluded from the decomposition of the energy-NMP trends.

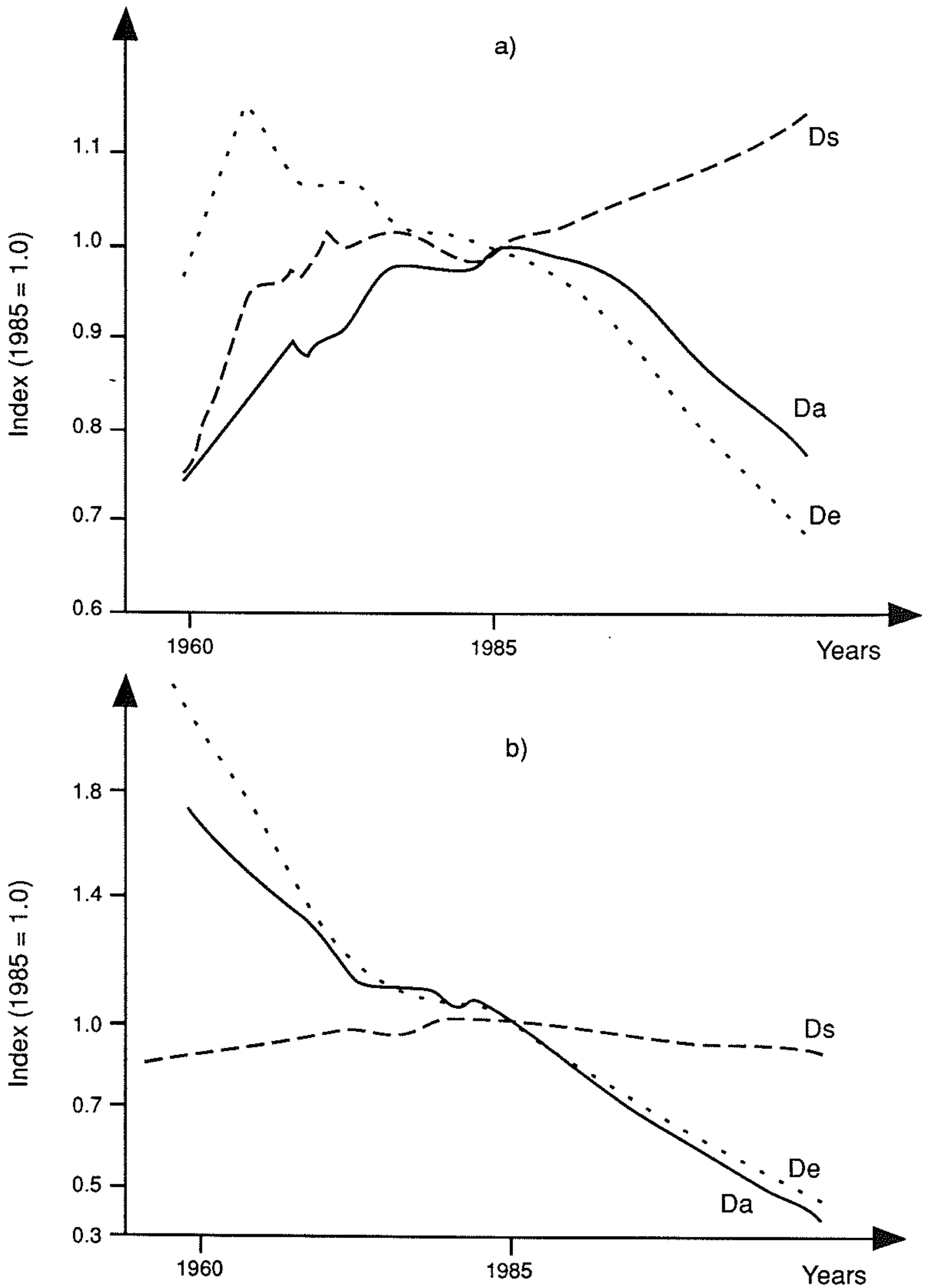

Figure 4: Changes in Electricity (a) and fuel (b) intensities of NMP (Da) in production sphere.
Ds - sectoral shifts;
De - changes in real electricity and fuel intensities

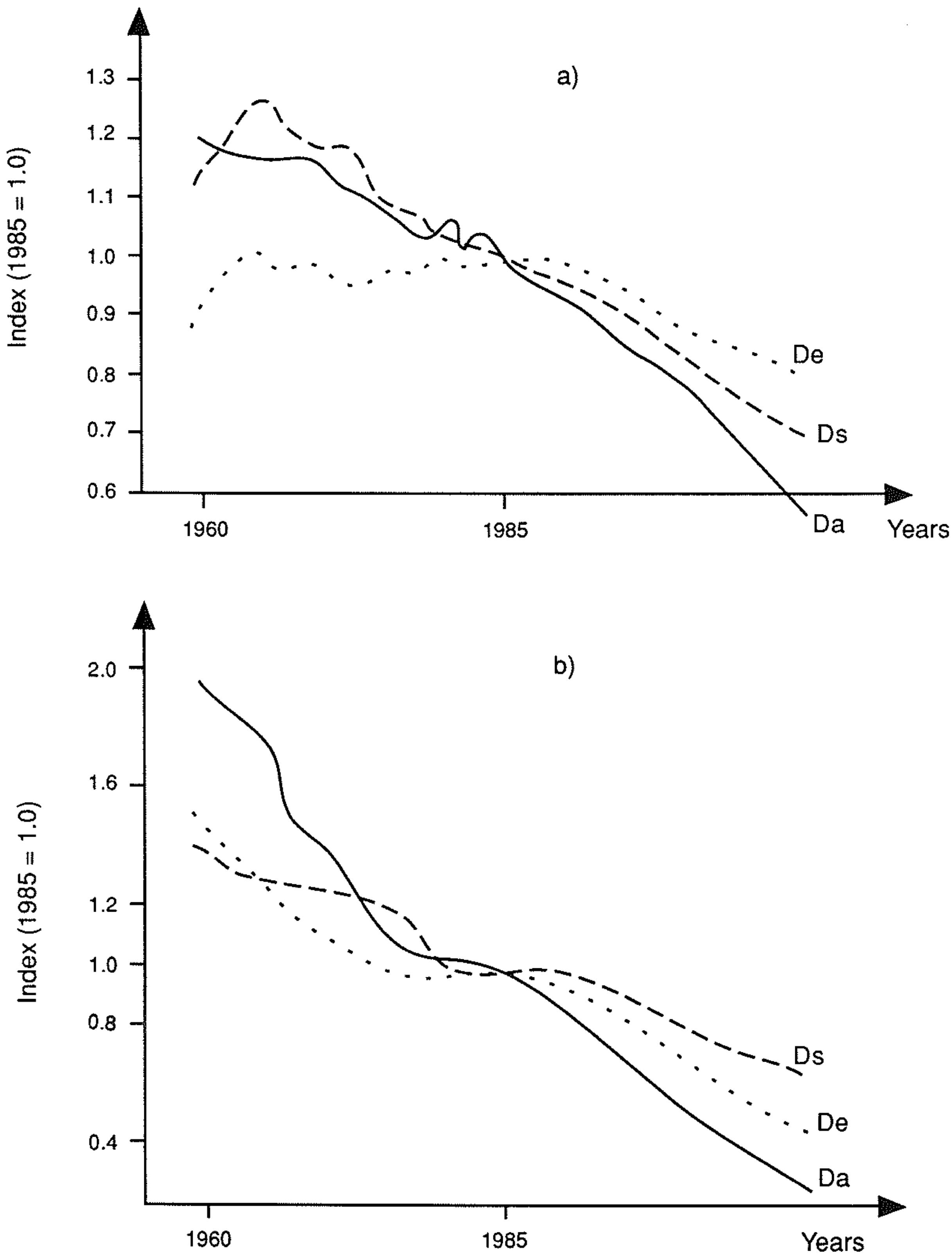

Figure 5: Changes in Electricity (a) and fuel (b) intensities of industrial output (Da).
Ds - sectoral shifts;
De - changes in real electricity and fuel intensities

by the decrease in real energy intensity; the share of sectoral shift is 13 percent in 1960 and drops to 9 percent at the end of the period.

The electricity intensity of industrial output (see Figure 5a) decreases by 1.4 percent per year in 1965-1985 and is expected to fall by 1.6 percent per year in the future. Sectoral shift plays an essential role in declining aggregate electricity intensity, accounting for 62 percent in the 1960s and 68 percent at the end of the historical period. It should be emphasized that during 1967-1979 the real electricity intensity of industry did not change and almost all of the decrease in aggregate electricity intensity was due to sectoral shifts.

A similar situation is observed in fuel consumption. Figure 5b shows that between 1973 and 1985 the real fuel intensity changed very little; therefore, the decline in the aggregate index was caused principally by sectoral shifts. The total decrease in the fuel-industrial output ratio amounted to about 4 percent per year in 1960-1985 and is estimated approximately at 3 percent in the future. The contribution of sectoral shift increases from 40 percent at the early 1960s to 52 percent at the end of the historical period.

Changes in the composition of output within the industrial sector have a greater effect on aggregate energy intensity of the economy than do shifts among major macrosectors (e.g., industry, agriculture, and transportation). As revealed in Table 1, shifts among the major macrosectors actually increase the economy's energy intensity during the 1965-85 period. In the projections, the economy's energy intensity is expected to decline dramatically in the future, with structural shift, both among the major macrosectors and within industry, accounting for almost 60 percent of this decline. As the USSR shifts towards a market economy, it is likely that these shifts, if they are to occur, will be induced by a set of factors different than those that determine trends in real energy intensity.

Table 1
Impact of Structural Shifts and Other Factors
on Changes in the Energy-NMP Ratio (%): USSR

	1965-1985	1986-2010
Structural shifts - total	- 3 (15)	-29 (57)
among 4 macrosectors	6 (-30)	- 6 (12)
among 10 industries	- 9 (45)	-23 (45)
Changes within industries (composition of outputs, energy conservation,...)	-17 (85)	-22 (43)
Aggregate	-20 (100%)	-51 (100%)

Note: Percent contribution to total effect appears in parenthesis.

Soviet studies in the coming years will examine in greater detail the effect of sectoral shift on energy demand in the economy for the next 25 years. This analysis is being based upon a set of simulation models described in Medvedeva (1986). It comprises models of the economy and energy demand as well as models of energy demand by separate sectors. Each model is based on three groups of relations: technological (intersectoral) flows of product, financial flows, and energy demand of a sector or of the economy as a whole.

THE U.S. EXPERIENCE

In the United States energy use has been maintained practically level from 1973 to 1985, while economic activity (GNP) has increased about 30 percent. This trend of declining use per dollar of output holds for total energy, for fossil fuels, and for electricity. In the case of fossil fuels, this decrease represented an acceleration of the pre-embargo trend of declining fuel intensity. For electricity, on the other hand, the post-embargo trend represented a reversal of the increasing electrification observed before 1973.

A significant portion of this decline was due to shifts among sectors of the economy, among industries (measured at various levels of disaggregation), and among products. We estimate that these changes in the composition of economic output account for almost one-half of the decline in energy use per unit of output in manufacturing since the embargo. These new estimates are based upon recently available data from U.S. Bureau of the Census, updated through 1985. Moreover, this may be a conservative estimate because even greater effects can be found when feedstocks are included (Werbos, 1986).

This section analyzes the impact of changes in the composition of economic output (sectoral shift) on U.S. energy demand in the manufacturing sector. We confine the analysis to this particular sector due to the lack of reliable time series data covering all sectors of the economy. We initially discuss the historical trends, followed by some projections of sectoral shift and U.S. energy demand.

Using the Divisia index, we constructed time series for output, energy use, and several measures of energy intensity and sectoral shift. Annual data on energy use and real shipments were used for the 1958-85 period. Rates of change were expressed in index number form with 1985 as the base year.

In calculating energy intensities, the measure used for output was real shipments[4] (1982 dollars). The study decomposed manufacturing into 71 industries, roughly 3-digit SIC level for the energy-intensive sectors. Energy use was taken from the National Energy Accounts (NEA) and reflects purchased fuels and electricity as well as cogeneration for internal use.[5] The units of measure were British thermal units (Btu) for fossil fuels and kilowatt-hours for electricity.

Historical Trends in Energy Intensity

Electricity and purchased fossil fuel were treated separately in analyzing the effect of sectoral shift on energy intensity, because they exhibited quite different trends. This separation avoids some of the biases introduced by using BTU rather than the price weights as well as the issue of whether to value electricity at the primary or secondary (including losses) level.

Fuel Intensity

Figure 6 presents the indexes of aggregate and real energy intensity over time. Real fuel intensity fell approximately 1.8 percent per year in the pre-embargo (1958-1973) period. A slight shift away from energy-intensive industries occurred in 1964-1967 and back in 1968-1974. Part of the reason for this sectoral shift was the strong growth in primary metals in the period 1967-1974. During the 1974-1975 recession, real energy intensity rose, due to a short-run capacity

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[4]The U.S. Bureau of Labor Statistics, Productivity Measures for Selected Industries, and unpublished supporting data tape. Real shipments is a gross output concept that includes energy and materials in addition to labor and capital (value added). It is more appropriate to measure U.S. energy intensity with respect to an output variable that includes energy.

[5]Jack Fawcett Associates (1984), National Energy Accounts 1958-1981, U.S. Dept. of Commerce, PB85-142024. Detailed data on by-product fuel use in industry are not readily available.

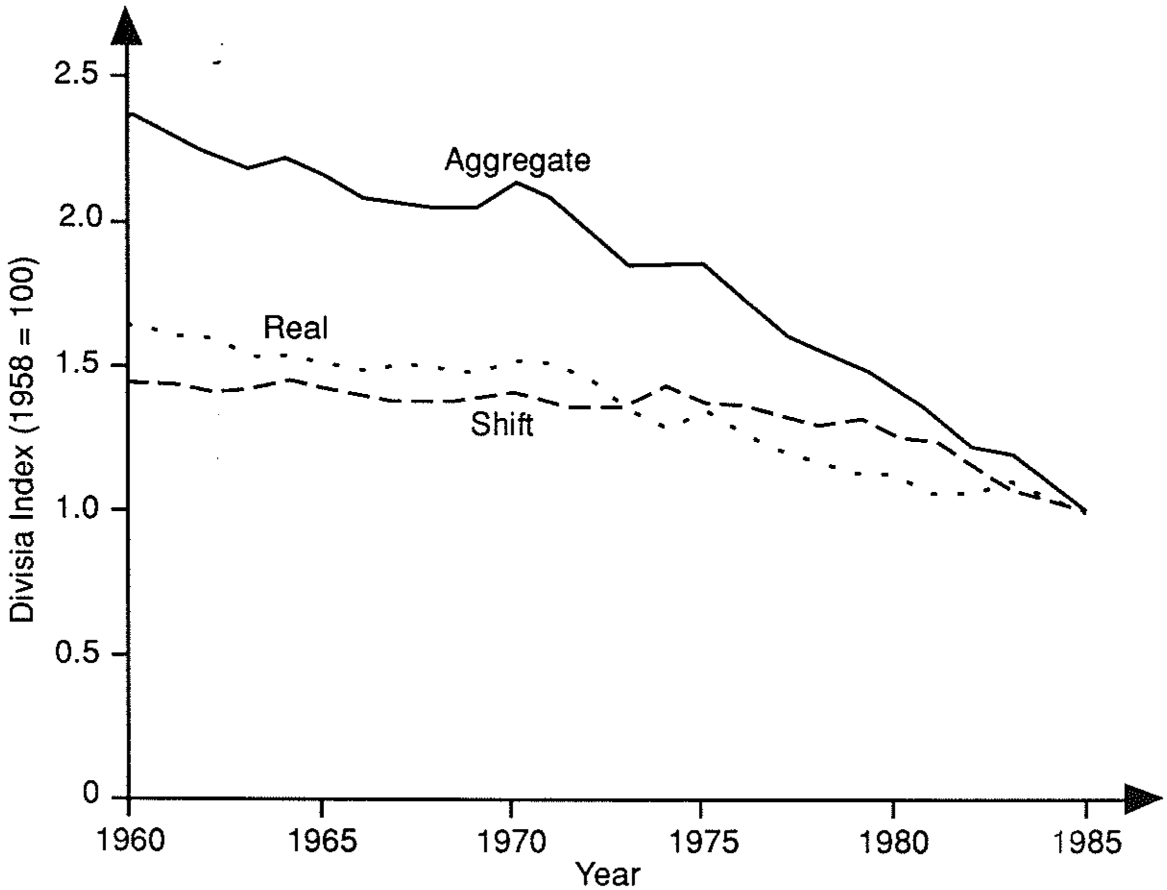

Figure 6: Fuel Intensity Decomposition for US Manufacturing

utilization effect. That is, if output falls, but energy use does not fall proportionately, the energy/output ratio rises. This effect is quite pronounced in energy-intensive industries.

During 1974-1981, the sectoral shift caused real energy intensity improvements to be less than the aggregate index would suggest. While the real energy intensity averaged -3.0 percent per year, sectoral shift contributed an additional -1.2 percent to the aggregate trend.

For purchased fossil fuels, the sectoral shift effect is largely captured by disaggregation to only two sectors (materials and non-materials industry groups). The change in aggregate energy intensity from 1974 to 1981 was 33.4 percent, of which 9.2 percent (equivalent to 27.6 percent of the change) can be accounted for by sectoral shifts among 20 two-digit SIC industries. Of this 9.2 percent, 5.5 percent can be attributed to shifts away from the materials sector. Thus, about half of this sectoral shift is captured by a two-sector disaggregation. The remaining effect is largely between the energy-intensive industries themselves.

Electricity Intensity

The overall picture for electricity[6] is quite different from that for fuels (see Figure 7). The '60s were characterized by an aggregate 2.5 percent per year electrification trend. This trend was composed of a 0.8 percent shift toward electricity intensive industries--a sectoral shift very similar to that for fuel--and a 1.7 percent change in real energy intensity. After 1970 the aggregate electric intensity began to decline. This was the result of a fluctuating real electric intensity,

[6]Includes purchased electricity and cogeneration for on-site use.

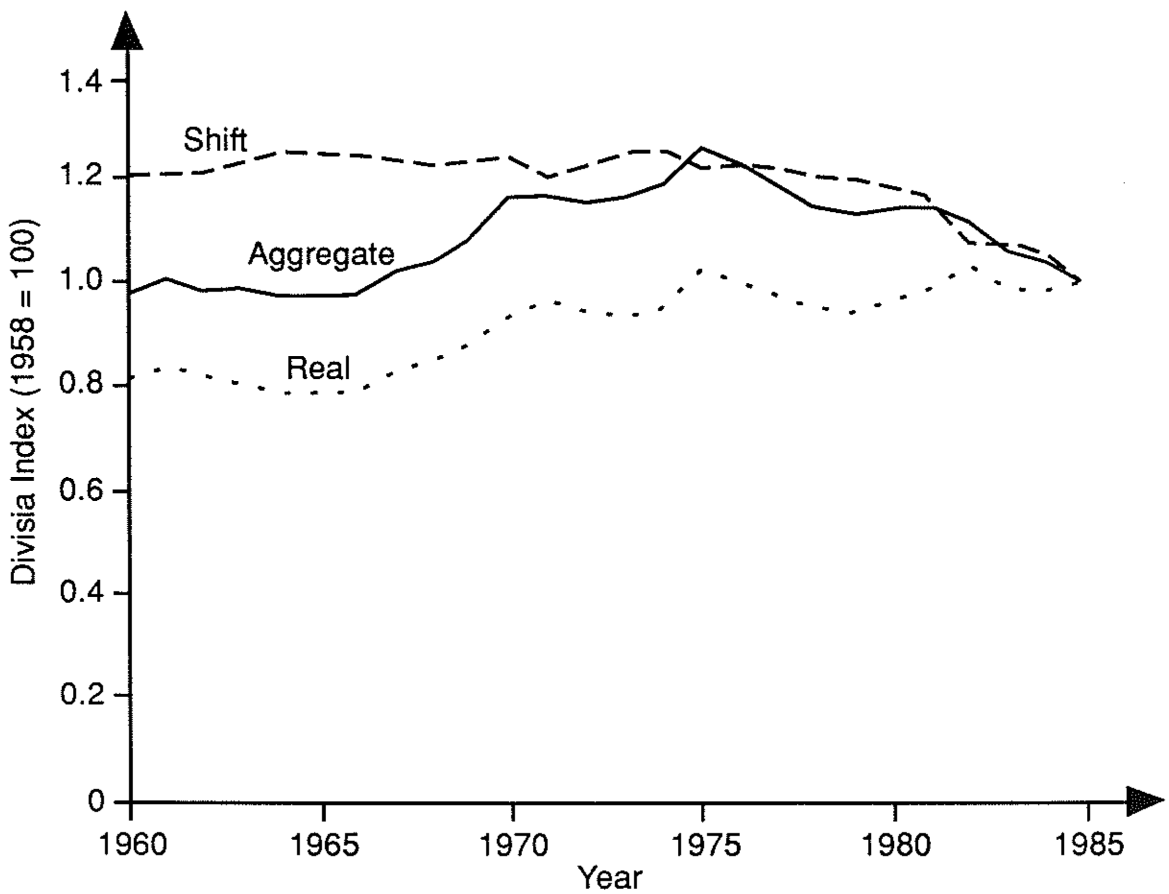

Figure 7: Electricity Intensity Decomposition for US Manufacturing

characterized by large peaks in intensity as the result of capacity utilization effects. However, the composition shift effect on electric intensity reversed itself, averaging -0.5 percent over the 1970-1981 period, then accelerating sharply to -2.8 percent from 1981-1985. The sectoral shift away from electricity-intensive industries is a marked reversal of the pre-1970 trend.

There is evidence of shifts among the materials and nonmaterials industry groups during 1971-81. Hence, a two-sector disaggregation incorporates only some of the total sectoral shift effect. However, after 1981 the decline is largely attributable (68 percent) to a two-sector disaggregation.

Projected Trends in Energy Intensity

There exists no official forecast of the U.S. economy and the associated energy demands. Moreover, projections of changes in the U.S. economy's structure can often differ by a substantial amount and that these differences can result in widely different outlooks for energy demand, as discussed in Boyd et al (1987b). Nevertheless, for the purposes of comparing with the USSR projections, we have selected a forecast and have shown it together with our historical analysis in Table 2, much as we did for the USSR in Table 1. We restrict Table 2 to manufacturing only, because reliable data on the other sectors is not available. In addition, we have separated the trends in fuels and electricity because this distinction is critical for the U.S. trends. And finally, we have reported the 1965-85 period as well as the 1979-85 period, because of the dramatic acceleration in the sectoral shift effect during the latter period.

Most economic projections show that the energy-intensive sectors do not grow as rapidly as the rest of the economy. The projections from the Wharton Annual Model, maintained by the

Wharton Econometric Forecasting Associates (WEFA), are representative of such trends. These projections were used to standardize the industrial energy demand projections of several models compared in an Energy Modeling Forum (1986) study.

Table 2

Impact of Structural Shifts and Other Factors
on Changes in the Energy-GNP Ratio (%): US

	1965-85	1979-85	1985-2010
Fuels			
Structural Shifts Among Industries	-36 (47)	-28 (70)	- 9 (22)
Changes Within Industries	-40 (53)	-12 (30)	-31 (78)
Aggregate	-76 (100%)	-40 (100%)	-40 (100%)
Total Electricity			
Structural Shifts Among Industries	-21	-18	- 9
Changes within Industries	17	6	- 2
Aggregate	- 4	-12	-11

Notes: Percent contribution to total effect appears in parenthesis.
Total electricity includes self-generated power.

They reveal a continuing trend towards less energy-intensive sectors, although at a slower rate than during the historical 1973-85 period. Durable manufacturing, chemicals, and miscellaneous manufacturing grow more rapidly than aggregate industry in these projections, while paper, petroleum refining, and primary metals grow more slowly. The slower decline in the shift away from energy-intensive sectors is due to more widespread economic growth than during the last twelve years. This growth stimulates the demand for capital goods production, which is very energy intensive relative to other manufacturing sectors.

Shifts among six major manufacturing sectors contribute about 22 percent of the total decline in fossil fuel use per dollar of output in the reference case projections reported for the ISTUM-II model in the EMF study.[7] Aggregate fossil fuels intensity falls by 2 percent per annum between 1985-2010 (Table 2). Meanwhile, sectoral shift causes aggregate intensity to decline by 0.4 percent over this same 25-year horizon. The rate of decline due to sectoral shift is about one-fourth of that observed for the historical 1965-85 period. Table 2 also shows that most of the historical shift effect occurred during the 1980s.

The dampening of sectoral shift contributes importantly to the slower decline in aggregate energy intensity for all manufacturing. Fossil fuel use per dollar of output declines by 36 percent less in the projections than in the historical 1965-85 period. The decline due to changes in fuel intensity within the major sectors--shift in product mix, new processes and improved operation of existing facilities--appears to be somewhat slower in these projections than during the historical period.

The ISTUM-II estimates for electricity show the electricity intensity decreasing slightly in the future. This trend was not robust across all models, some of which projected electricity use rising faster than manufacturing output in the future.[8]

Electricity intensity in this model decreases by about 0.5 percent per annum over the next 25 years. There is little change in the real intensity because the increasing efficiency of electrical

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[7]The fossil fuel trends for this model were representative of those for the other models in the EMF study.

[8]These findings are discussed in Huntington and Myers (1987).

equipment essentially offsets the effect of new applications within a sector. Aggregate intensity is reduced primarily by shifting towards less electric-intensive sectors.

CONCLUSION

Studies in both countries confirm the importance of structural economic change on future energy demand patterns. This paper has provided an initial perspective on past USSR trends as well as one possible transitional path in a highly uncertain future. Relevant US trends based upon a separate US study have also been discussed in order to provide some context for the USSR trends.

Future work on this issue should focus on the various channels through which changes in the economy's consumption and production patterns influence energy use and the causes for these shifts. The use of models of the economy and its interactions with energy supply and demand will allow researchers to better understand these often complicated relationships. Moreover, there exists a need for standardizing data on energy consumption and economic output in the two countries.

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