

# Soviet Regions Revisited: A Note on Trends in Regional TFP\*

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## Abstract

This paper examined TFP growth-rate differentials across Soviet regions and the percentage share of TFP contribution to industrial development by region.

TFP can be regarded as an indicator of technological development; hence, it may be supposed that high TFP growth rates would be observed in advanced areas. However, such regions as Russia and the Baltic states

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showed rather low TFP growth, whereas the percentage share of TFP contribution to growth in these areas was large. This may be attributable to the equalization-oriented Soviet governmental policy, which brought about the introduction of newly developed technology to peripheral regions. On the other hand, these developed regions were already abundant in social capital but had very low population growth rates; therefore, these material inputs played only a limited role in development processes in Slavic / Baltic states. In this regard, this paper somewhat clarified the inefficient development policy implemented during the Soviet era.

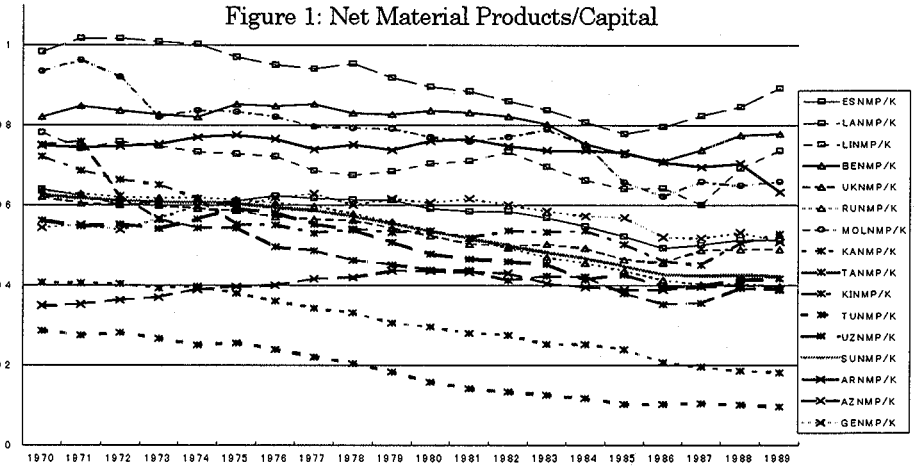
## 1. Introduction

The Soviet industry is characterized by the co-existence of a high capital/output ratio and a low output growth rate (See Figure 1 and Table 1). Soviet extensive growth was not so different from East Asian extensive growth during the period 1960-1990; however, it was unusual that Soviet growth declined while an extensive growth strategy was being implemented (Easterly and Fischer, 1995; See Table 1). Comparatively, in the USA, the capital/output ratio was almost stable after the 1950s (Sakai, 2000, p.64), which implicitly shows that technological development more than offset decreasing returns to scale in the United States

In this paper, regional differentials in total factor productivity (TFP) across Soviet regions are discussed. As presented in previous analyses (Kumo, 1999a, 2001; See Figure 2), Soviet industries concentrated in European regions of the USSR throughout the Soviet era. There probably were many reasons behind this phenomenon: geographical conditions (climate, distance from Moscow, the capital of the Soviet Union), military or policy-based considerations, high labor turnover rates in frontier regions, and others.

In this paper, we concentrate our analysis on the examination of differentials in the role of TFP in economic growth across Soviet regions. Of course, TFP is something like a black box, but it has been accepted that this measure reflects the level of technology in specific areas. The word

'technology' has a broad sense in this context. In some cases, it is treated as a proxy for the contribution of R&D investment to economic growth; in others, Solow residuals are regarded as indicators of external economies, monopolistic power, working rates of operation, and so on. Statistical inadequacies can also



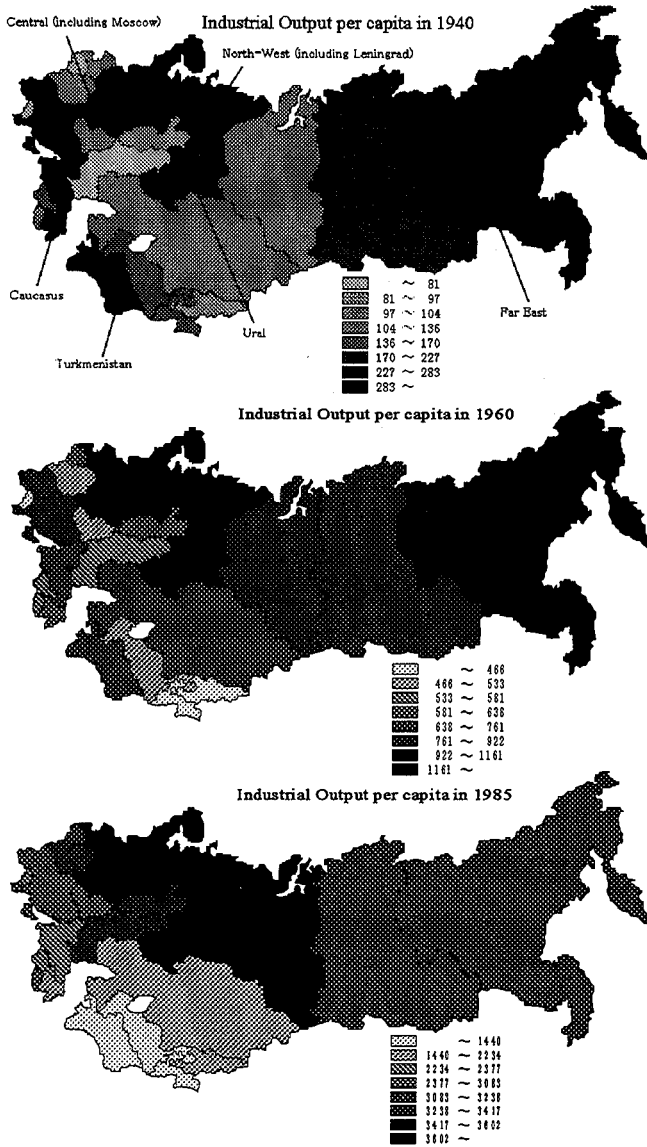
Data Source: World Bank Estimation (calculated by the author)

Table 1: Soviet Growth Data, 1928-1985 (in percent)

|                | CIA Estimate | Soviet Official Statistics |
|----------------|--------------|----------------------------|
| GNP            |              |                            |
| 1928-85        | 4.3          | 8.8                        |
| 1928-41        | 5.8          | 13.9                       |
| 1950s          | 6            | 10.1                       |
| 1960s          | 5.2          | 7.1                        |
| 1970s          | 3.7          | 5.3                        |
| 1980-85        | 2            | 3.2                        |
| Capital Growth |              |                            |
| 1928-66        | 7.4          | 7.2                        |
| 1960-81        | 7.6          | 8.1                        |

Source: Fischer (1994)

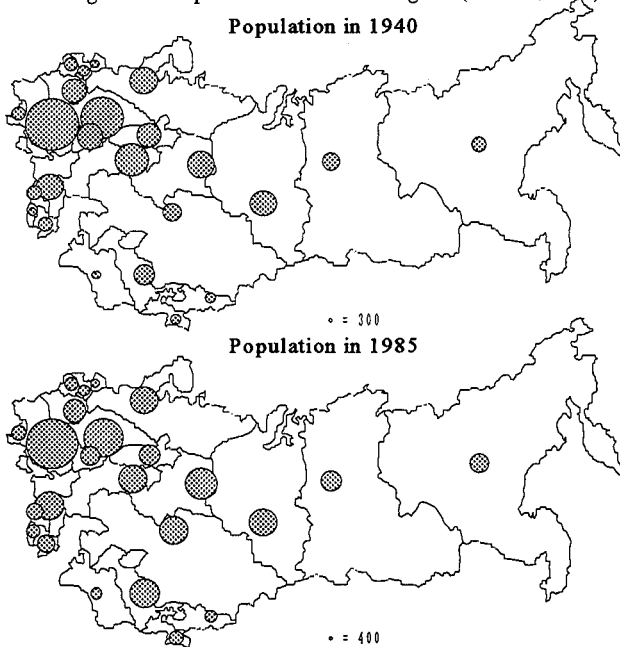
Figure 2: Industrial Output per Capita, in 10 rubles (Source: Kumo, 2001)



play a critical role in TFP calculations, especially in cross-country studies (Barro and Sala-i-Martin, 1995). However, by means of long-term analysis of a specific area, we may be able to identify some realistic features of technological development (Solow, 1957)

As shown in the previous analysis, regions nearer to Moscow are more productive than others in the former Soviet Union are (Kumo, 1999a: See Appendix A). The existence of a large market in Moscow (See Figure 3) and accessibility to the political center of the Soviet government may have attracted industrial firms to this location. In this paper, interregional differentials in the economic development process in the former Soviet Union were investigated from the point of view of productivity

Figure 3. Population in Each Region (in thousand)



First, analytical methods are explained in the next section. The data sets utilized in the analysis are shown in Section 3. Statistical problems in Soviet official data are also mentioned. The estimated percentage share of TFP contribution to industrial development and TFP growth rates are examined in Section 4. Then, in the final section, a summary and concluding remarks are presented, and some problems included in this analysis are introduced.

## 2. Analytical Models

The output is determined by the capital, labor, and productivity growth. A conventional growth-accounting equation can be derived from the neoclassical production function<sup>1</sup>

$$Y_t = F(A_t, K_t, L_t), \quad (1)$$

where  $A$  is the level of technology and  $K$  and  $L$  are capital stock and quantity of labor, respectively. Differentiating Equation (1) with respect to time and dividing all the terms by  $Y$ , we can get

$$\frac{\dot{Y}}{Y} = \left( \frac{F_A A}{Y} \right) * \frac{\dot{A}}{A} + \left( \frac{F_K K}{Y} \right) * \frac{\dot{K}}{K} + \left( \frac{F_L L}{Y} \right) * \frac{\dot{L}}{L} \quad (2)$$

The dot over a variable represents its time derivative. If technological changes occur in a Hicks-neutral manner, then it can be shown that  $F(A, K, L) = Af(K, L)$  and  $(F_A A/Y)=1$ . If labor and capital are paid their marginal products, that is, if  $F_K$ =rental price of capital and  $F_L$ =wages, by rearranging,

<sup>1</sup> This derivation follows Barro (1998) and Ghani *et al.*(1999)

we would get the growth equation:

$$\gamma = \frac{\dot{A}}{A} = \frac{\dot{Y}}{Y} - \alpha * \frac{\dot{K}}{K} - \beta * \frac{\dot{L}}{L} \quad (3)$$

Based on Equation (3), we calculate Solow residuals in Soviet regions by non-econometric methods, as is usual in studies concerning TFP growth rates.

The labor share estimated in the previous study (Kumo, 1999a) is around 0.565, which is a very similar result from that of previous Western studies such as McCants (1988; estimated labor share = 0.50), Rutgaizer (1970; 0.60), Bergson (1979; 0.58), and Sakai (2000; 0.52). In our analysis, estimated labor share and capital share are 0.57 and 0.34, respectively. Hence, it can be accepted that the Soviet industry has Cobb-Douglas-type technology, and, in the following analysis, labor share is assumed to be 0.6 for all regions.

### 3. Data

The industrial output and governmental investment estimated in Kumo (2001) were used in the analysis for the whole period of 1940-1985. Industrial labor power statistics in each Union republic from 1940 to 1970 and in 1975, 1980, and 1985 were obtained from the official statistical yearbook, *Narodnoe Khozyaystvo SSSR 19xx* (National Economy of the USSR), and *Promyshlennost SSSR 1988* (Industry of the USSR). As for the analysis regarding the later period, 1970-1985, the data estimated by the World Bank (Easterly and Fischer, 1996) were also utilized for comparison.

As is well known, the Soviet terminology concerning statistics is different from that used in Western countries. In addition, computational errors are quite large, possibly yielding unreliable figures. The reason for our

use of Soviet official data should be clarified. First, in this kind of interregional study, only relative evaluation across regions is required; therefore, examining on an absolute scale is not necessary. Second, estimations of the former Soviet industry are now being carried out by Western researchers (Kuboniwa, 1996, a, b), which would substantiate the need for using official data in the present study. The most critical factor is that data by regions in Russia, the largest republic in the Union, have never been collected.

In Soviet official statistics, no branch-based capital/investment figures by republic have been reported; therefore, in the analysis using official statistics, we utilized the total governmental investment in each Union republic/region in Russia as a proxy for capital stock in the industrial sector.

#### 4. Results

Estimated results are shown in Figure 4, Table 2 and Figure 5, Table 3. The analysis in Figure 4 / Table 2 is based on World Bank estimation data (Union Republic-based), and Figure 5 / Table 3 shows the results according to our estimation data obtained from Soviet official statistics (results for Union Republics and regions in Russia). For details, see Appendix C (full tables).

#### Percentage Share of TFP Contribution to Growth (Figure 4, Figure 5, Table 2-a, and Table 3-a)

In Figure 4 / Table 2-a (Union Republic-based World Bank data, 1970-1984), the role of TFP in development processes shows weakening trends in almost all republics. Among them, Union republics showing a comparatively higher percentage share of TFP contribution to growth are: Slavic States (Russia, Ukraine, Belarus), Baltic States, and Caucasus (Azerbaijan, Armenia, Georgia). Advantageous location (easier access to the Union capital, Moscow,



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## Percentage Share of TFP Contribution to Growth: Estimation Results

Table 2-a

| Armenia    | Azerbaijan  | Georgia      |        |
|------------|-------------|--------------|--------|
| 1970-74    | 0.454       | 0.605        | 0.588  |
| 1975-79    | 0.255       | 0.444        | 0.454  |
| 1980-84    | 0.175       | -0.206       | 0.178  |
| Kazakhstan | Tazhikistan | Turkmenistan |        |
| 1970-74    | 0.328       | -0.388       | 0.135  |
| 1975-79    | -1.439      | -1.107       | -3.318 |
| 1980-84    | -1.979      | -2.446       | -1.726 |
| Kyrgyzia   | Uzbekistan  |              |        |
| 1970-74    | -0.146      | 0.433        |        |
| 1975-79    | 0.189       | -0.438       |        |
| 1980-84    | -0.452      | -0.881       |        |
| Lithuania  | Latvia      | Estonia      |        |
| 1970-74    | 0.357       | 0.52         | 0.496  |
| 1975-79    | 0.245       | 0.349        | 0.371  |
| 1980-84    | -0.542      | -0.54        | -0.192 |
| Moldova    |             |              |        |
| 1970-74    | -2.156      |              |        |
| 1975-79    | 0.223       |              |        |
| 1980-84    | -0.225      |              |        |
| Belorus    | Russia      | Ukraine      |        |
| 1970-74    | 0.471       | 0.472        | 0.35   |
| 1975-79    | 0.374       | 0.16         | 0.052  |
| 1980-84    | 0.141       | -0.224       | -0.472 |

Table 3-a

| Armenia    | Azerbaijan  | Georgia      |        |
|------------|-------------|--------------|--------|
| 1950-59    | 0.448       | 0.526        | 0.507  |
| 1960-64    | -0.078      | 0.222        | 0.238  |
| 1965-69    | 0.308       | 0.345        | 0.442  |
| 1970-74    | 0.665       | 0.618        | 0.769  |
| 1975-79    | 0.516       | 0.526        | 0.294  |
| 1980-84    | 0.425       | 0.211        | 0.33   |
| Kazakhstan | Tazhikistan | Turkmenistan |        |
| 1950-59    | 0.034       | 0.179        |        |
| 1960-69    | 0.187       | -0.21        | -0.036 |
| 1965-69    | 0.472       | 0.403        | 0.339  |
| 1970-74    | 0.59        | 0.433        | 0.441  |
| 1975-79    | 0.243       | 0.363        | 0.517  |
| 1980-84    | 0.299       | 0.126        | -1.298 |
| Kyrgyzstan | Uzbekistan  |              |        |
| 1950-59    | 0.259       | -0.048       |        |
| 1960-64    | 0.226       | -0.067       |        |
| 1965-69    | 0.443       | -0.25        |        |
| 1970-74    | 0.644       | 0.466        |        |
| 1975-79    | 0.509       | 0.112        |        |
| 1980-84    | 0.462       | 0.531        |        |
| Estonia    | Lithuania   | Latvia       |        |
| 1950-59    | 0.496       | 0.459        | 0.412  |
| 1960-64    | 0.365       | 0.085        | 0.221  |
| 1965-69    | 0.532       | 0.324        | 0.491  |
| 1970-74    | 0.741       | 0.595        | 0.504  |
| 1975-79    | 0.605       | 0.732        | 0.92   |
| 1980-84    | 0.449       | 0.287        | 0.249  |
| Moldova    |             |              |        |
| 1950-59    | 0.281       |              |        |
| 1960-64    | 0.203       |              |        |
| 1965-69    | 0.055       |              |        |
| 1970-74    | 0.429       |              |        |
| 1975-79    | 0.549       |              |        |
| 1980-84    | 0.497       |              |        |
| Russia     | Ukraine     | Belorus      |        |
| 1950-59    | 0.374       | 0.436        | 0.487  |
| 1960-64    | 0.428       | 0.409        | 0.217  |
| 1965-69    | 0.471       | 0.421        | 0.341  |
| 1970-74    | 0.411       | 0.559        | 0.607  |
| 1975-79    | 0.568       | 0.436        | 0.562  |
| 1980-84    | 0.494       | 0.582        | 0.509  |

Percentage Share of TFP Contribution to Growth: Estimation Results  
Table 3-a (Continued: Regions in Russia)

| Europe-Russia |              |           |              |                     |       |                |        |       |
|---------------|--------------|-----------|--------------|---------------------|-------|----------------|--------|-------|
|               | North West * | Central * | Volga-Vyatka | Central Black Earth | Volga | North Caucasus | Ural * |       |
| 1970-79       | 0.512        | 0.525     | 0.498        |                     | 0.481 | 0.684          | 0.459  | 0.577 |
| 1980-84       | 0.934        | 0.564     | 0.593        |                     | 0.44  | 0.531          | 0.775  | 0.608 |
| 1985-89       | 0.63         | 0.813     | 0.543        |                     | 0.753 | 0.729          | 0.568  | 0.666 |

| Siberia and Far East |                |              |          |
|----------------------|----------------|--------------|----------|
|                      | West Siberia * | East Siberia | Far East |
| 1970-79              | 0.293          | 0.535        | 0.364    |
| 1980-84              | 0.107          | 0.673        | 0.447    |
| 1985-89              | 0.732          | 0.494        | 0.232    |

Figure 4. Percentage Share of TFP Contribution to Growth: Estimation Results (World Bank Data)

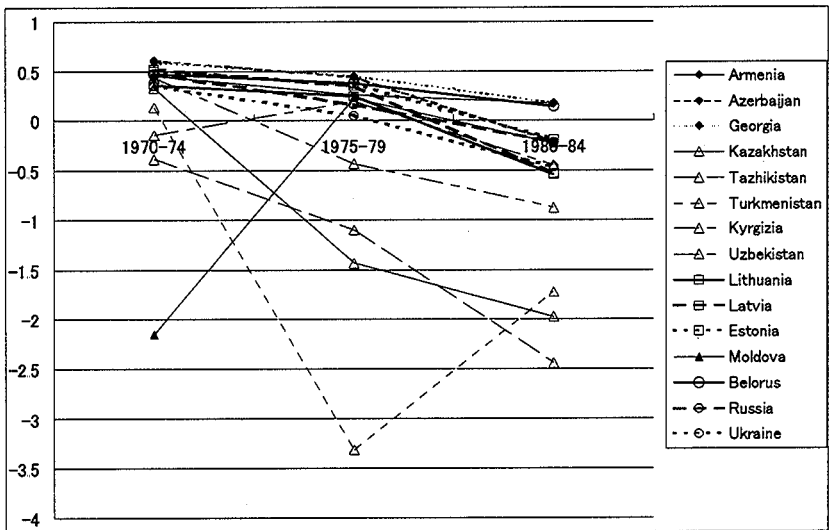
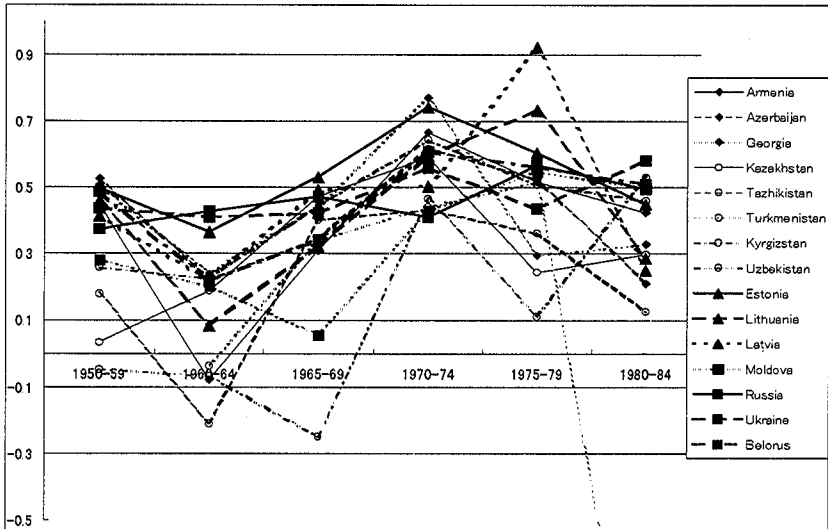


Figure 5. Percentage Share of TFP Contribution to Growth: Estimation Results (Official Data)



closeness to the East European market, and large ports in the Baltic and North Seas) may have resulted in higher industrial productivity in Slavic and Baltic States. The existence of a well-educated labor pool and a comparatively highly developed infrastructure in these areas also had some effects.

Caucasus states may have shown the second highest percentage share of TFP contribution to growth. This may be a surprising result, considering their distance from Moscow and the comparatively underdeveloped social capital in these areas. However, the important role TFP has played in Caucasus states may be attributable to their product variety. Caucasus areas are abundant in natural resources, especially crude oil. Resource-oriented development had been one of the most remarkable features of the Soviet government, and it is

natural that new (mainly imported) technology may have been constantly introduced in these peripheral areas

In Figure 5 / Table 3-a (estimation based on official statistics), absolute values are quite different from the results in Figure 4 / Table 2-a obtained by using Western estimation data. Statistical errors contained in Soviet official data may have had an effect. In agreement with previous studies, capital share was around 0.4 in the Soviet industry, and this assumption regarding capital/labor share did not change in this analysis. However, only near a half of governmental investment was spent on the industrial sector; thus, the percentage share of TFP contribution to industrial development may have been overestimated.

Although the data used in Figure 5 / Table 3-a are quite different, the percentage share of TFP contribution shows decreasing trends after the 1970s, which can be seen as comparable results with those in Figure 4. In European areas of Russia, TFP contribution did not weaken even after the 1970s, indicating the positive effects of industrial concentration into these regions.

From 1950s to 1964, the role of TFP in economic growth was not critical, but it increased during the second half of the 1960s. Kosygin's<sup>2</sup> reforms, which were implemented in the mid-1960's, introducing self-supporting accounting systems, expansion of percentage of revenues reserved to firms, reward for the completion of planned indices, and so on, may have increased productivity.

After the 1970s, the results obtained from our estimation using Soviet official statistics (Figure 5) are ambiguous, but World Bank data (Figure 4) clearly show decreasing trends. This discrepancy may also be attributable to our usage of USSR official statistics. Recalculating the data by assuming a capital share=0.6 or 0.7, Soviet official data also show decreasing trends in the

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<sup>2</sup> He took the initiative in Soviet social reforms at the beginning of Brezhnev period. Gorbachev's Perestroika is often more intensely criticized than Kosygin's reforms.

percentage share of TFP contribution to growth after the 1970s, a similar result to the one obtained in the analysis using Western estimation data (results are not presented here)

The percentage share of TFP contribution to growth was the largest in Slavic, Baltic, and Caucasus states. Slavic and Baltic states were the most advanced areas in the Soviet Union. Social overhead capital and a well-educated labor pool may have been the most abundant in these regions. At the same time, population growth rates in these already developed areas were very low, and the growth rates of capital stock may also have been low because of Soviet equalization policy. These facts must have weakened the role of labor/capital stock growth in development processes.

In summary, high percentage shares of TFP contribution to industrial development are observed in the Slavic, Baltic, and Caucasus states, and this phenomenon could be explained by high productivity induced by their large market / desirable location (Slavic and Baltic states) or preferable product variety / priority development systems implemented during the Soviet era.

### TFP Growth Rates (Table 2-b and Table 3-b)

In some aspects, our results are almost comparable with the previous ones shown in Figure 4, Figure 5, Table 2-a, and Table 3-a. TFP growth rates decreased in all regions from 1950s to 1964 but recovered in the second half of the 1960s, which may have been due to Kosygin's reforms cited above. After that, TFP growth rates continuously decreased.

However, several critical points remain unclear. High TFP growth areas are observed in regions other than Russia in the 1970-1979 total (Table 3-b). On the other hand, the percentage share of TFP contribution to industrial growth was the highest in European areas of Russia (Table 3-a). This, however, can be explained in the following way.

TFP Growth rates: Estimation results

Table 2-b

|         | Armenia | Azerbaijan | Georgia |
|---------|---------|------------|---------|
| 1970-74 | 0.229   | 0.259      | 0.305   |
| 1975-79 | 0.118   | 0.206      | 0.21    |
| 1980-84 | 0.059   | 0.015      | 0.081   |

|         | Kazakhstan | Tadzhikistan | Trukmenistan |
|---------|------------|--------------|--------------|
| 1970-74 | 0.158      | -0.023       | 0.121        |
| 1975-79 | -0.008     | -0.046       | 0.086        |
| 1980-84 | 0.063      | 0.191        | 0.109        |

|         | Kirgizia | Uzbekistan |
|---------|----------|------------|
| 1970-74 | -0.033   | 0.276      |
| 1975-79 | 0.09     | -0.053     |
| 1980-84 | 0.069    | 0.141      |

|         | Lihuania | Latvia | Estonia |
|---------|----------|--------|---------|
| 1970-74 | 0.172    | 0.222  | 0.192   |
| 1975-79 | 0.127    | 0.106  | 0.113   |
| 1980-84 | 0.042    | -0.001 | 0.026   |

|         | Moldva |
|---------|--------|
| 1970-74 | 0.074  |
| 1975-79 | 0.085  |
| 1980-84 | 0.21   |

|         | Belorus | Russia | Ukraine |
|---------|---------|--------|---------|
| 1970-74 | 0.317   | 0.2    | 0.127   |
| 1975-79 | 0.183   | 0.048  | 0.029   |
| 1980-84 | 0.041   | -0.018 | 0.09    |

Table 3-b

|         | ARMENIA | Azerbaijan | GEORGIA |
|---------|---------|------------|---------|
| 1950-59 | 0.968   | 0.552      | 0.754   |
| 1960-64 | -0.004  | 0.098      | 0.08    |
| 1965-69 | 0.206   | 0.124      | 0.208   |
| 1970-74 | 0.317   | 0.315      | 0.329   |
| 1975-79 | 0.233   | 0.234      | 0.098   |
| 1980-84 | 0.142   | 0.07       | 0.103   |

|         | Kazakhstan | TADGIK | TURKMEN |
|---------|------------|--------|---------|
| 1950-59 | 0.073      | 0.333  | 0.413   |
| 1960-64 | 0.067      | -0.037 | 0.011   |
| 1965-69 | 0.246      | 0.207  | 0.178   |
| 1970-74 | 0.248      | 0.179  | 0.207   |
| 1975-79 | 0.045      | 0.104  | 0.103   |
| 1980-84 | 0.047      | 0.028  | -0.108  |

|         | Kirgiz | Uzbekistan |
|---------|--------|------------|
| 1950-59 | 0.488  | -0.062     |
| 1960-64 | 0.13   | -0.021     |
| 1965-69 | 0.327  | 0.044      |
| 1970-74 | 0.339  | 0.246      |
| 1975-79 | 0.14   | 0.026      |
| 1980-84 | 0.112  | 0.166      |

|         | ESTONIA | LITVA | LATOVIA |
|---------|---------|-------|---------|
| 1950-59 | 1.173   | 2.013 | 1.085   |
| 1960-64 | 0.197   | 0.049 | 0.116   |
| 1965-69 | 0.234   | 0.204 | 0.255   |
| 1970-74 | 0.291   | 0.288 | 0.187   |
| 1975-79 | 0.14    | 0.191 | 0.199   |
| 1980-84 | 0.065   | 0.074 | 0.044   |

|         | MOLDVA |
|---------|--------|
| 1950-59 | 0.949  |
| 1960-64 | 0.158  |
| 1965-69 | 0.057  |
| 1970-74 | 0.24   |
| 1975-79 | 0.169  |
| 1980-84 | 0.136  |

|         | Russia | Ukraine | Belrus |
|---------|--------|---------|--------|
| 1950-59 | 0.68   | 0.941   | 1.314  |
| 1960-64 | 0.183  | 0.202   | 0.112  |
| 1965-69 | 0.208  | 0.189   | 0.224  |
| 1970-74 | 0.15   | 0.249   | 0.373  |
| 1975-79 | 0.151  | 0.073   | 0.214  |
| 1980-84 | 0.078  | 0.125   | 0.158  |

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## TFP Growth Rates: Estimation Results

Table 3-b (Continued: Regions in Russia)

| Europe-Russia |            |         |              |                     |       |                |       |
|---------------|------------|---------|--------------|---------------------|-------|----------------|-------|
|               | North West | Central | Volga-Vyatka | Central Black Earth | Volga | North Caucasus | Ural  |
| 1970-79       | 0.360      | 0.333   | 0.399        | 0.390               | 0.629 | 0.297          | 0.420 |
| 1980-84       | 0.150      | 0.087   | 0.141        | 0.114               | 0.101 | 0.129          | 0.098 |
| 1985-89       | 0.094      | 0.122   | 0.087        | 0.151               | 0.102 | 0.097          | 0.060 |

| Siberia and Far East |              |              |            |
|----------------------|--------------|--------------|------------|
|                      | West Siberia | East Siberia | North West |
| 1970-79              | 0.282        | 0.431        | 0.243      |
| 1980-84              | 0.025        | 0.120        | 0.088      |
| 1985-89              | 0.110        | 0.064        | 0.028      |

The interregional equalization policy implemented in the construction of Soviet socialism forced the government to invest and develop peripheral regions. New construction materials, which embody newly developed technology, were input in Central Asia or other underdeveloped areas. This resulted in high TFP growth rates in the peripheries, but, at the same time, it lowered TFP growth in comparatively advanced European regions (Table 3-b).

Looking at industrial output growth rates (See Table 3-a and 3-b in Appendix C), during the 1950s, Central Asian states grew rather more slowly compared with Slavic and Baltic states. From the beginning of the 1960s to the first half of the 1970s, however, the "Virgin Land Program" led by Khrushchev or other strategic development policies were implemented, and industrial growth rates in Central Asia rapidly increased. Then, the problems would be the lowered growth rates of the Russian Federation, which occupied vast areas of the Soviet Union, and those of the USSR as a whole (See Table 1). This may have induced the Soviet government to change its development policy from equalization-oriented to efficiency-oriented in the middle of the 1970s, as presented in detail in Kumo (1999b, See Appendix B).

## 5. Concluding Remarks

This paper examined TFP growth-rate differentials across Soviet regions and the percentage share of TFP contribution to industrial development by region.

TFP can be regarded as an indicator of technological development; hence, it may be supposed that high TFP growth rates would be observed in advanced areas. However, such regions as Russia and the Baltic states showed rather low TFP growth, whereas the percentage share of TFP contribution to growth in these areas was large. This may be attributable to the equalization-oriented Soviet governmental policy, which brought about the introduction of newly developed technology to peripheral regions. On the other hand, these developed regions were already abundant in social capital but had very low population growth rates; therefore, these material inputs played only a limited role in development processes in Slavic / Baltic states. In this regard, this paper somewhat clarified the inefficient development policy implemented during the Soviet era.

On the other hand, the analysis presented in this note contains several critical problems that cannot be ignored:

- 1) Governmental investment data are used as a proxy for capital stock. The amount of investment can fluctuate as a result of financial circumstances experienced by the government. The use of capital stock data is, if possible, more desirable.
- 2) Assumptions regarding with capital / labor share also are very problematic. Capital share is assumed to be identical across regions.
- 3) The kinds of factors that affect TFP growth rates are in no way clarified; we only offer our best estimation.<sup>3</sup> In addition, industrial concentration is

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<sup>3</sup> Although the correlation between TFP growth rates in each region and various factors is calculated, no critical effect is observed; hence, the results are not presented here.



not always determined by TFP growth-rate differentials.

In this regard, the appropriateness of the data used must be reconsidered. Capital flow data may be used to estimate capital stock data; then, the production function of each region may be estimated individually, so capital / labor share could be calculated for each region; finally, national economy-based analyses, rather than industry-based ones, may give clear-cut results when examining factors affecting TFP.

The reliability of original data should also be re-examined. Analyses based either on World Bank estimation data or on Soviet official data show ambiguous results. As long as Soviet regional economy is analyzed on the basis of official statistics, recalculation of data may be indispensable, as previous studies have shown (Bergson, 1979; McCants, 1983; Easterly and Fischer, 1995; Escoe, 1991).

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## Appendix A: Estimation of Production Function (Kumo, 1999a)

Here, a Cobb-Douglas production technology is assumed, and the equation estimated for time-series data of 17 years takes the logarithmic form. Because both investment and industrial output data are adjusted to constant 1985 prices, all data (15 republics  $\times$  17 years = 255) are pooled. To examine the differences between each republic, a dummy variable is introduced. In addition, the distance between Moscow and the capital city of each republic is introduced as a proxy for the primacy of European regions, i.e., population / market size or accessibility for labor pooling, etc. For simplicity, it is assumed that the distance variable enters this function linearly. Trend variables are also used because time-series data are pooled. First, a function without the distance variable is estimated to examine the effects of market accessibility on productivity differentials. Thus, the estimated equations will be as follows, and the results using the stepwise technique are shown in Table 1:

$$\log Q = A + \beta_1 \log L + \beta_2 \log K + \beta_3 \text{Region}_{1,14} + \beta_4 \text{Trend} + \beta_5 \text{Trend squared} + \varepsilon, \quad (1)$$

$$\log Q = A + \beta_1 \log L + \beta_2 \log K + \beta_3 \text{Region}_{1,14} + \beta_4 \text{Trend} + \beta_5 \text{Trend squared} + \beta_6 \log \text{Distance} + \varepsilon, \quad (2)$$

where  $Q$  = gross industrial output (in rubles);  $L$  = the number of industrial workers (in thousands);  $K$  = total investment by the central government (in rubles);  $\text{Region}_{1,14}$  = dummy variable for each republic, with Russia taken as the base;  $\text{Trend}$  = time trend variable;  $\text{Distance}$  = distance between Moscow and the capital city in each republic (km);  $\varepsilon$  = error term.

Cobb-Douglas Type Production Function : Estimation Results

| Variable                                | Results of Estimation Eq (1) |         |   | Results of Estimation Eq (2) |         |    |
|---|------------------------------|---------|---|------------------------------|---------|----|
|   | Coefficient                  | t-value |   | Coefficient                  | t-value |    |
| Workers                                 | 0.565                        | 13.123  | **                                      | 0.552                        | 12.311  | ** |
| Investment                              | 0.339                        | 8.674   | **                                      | 0.327                        | 7.651   | ** |
| Distance from Moscow                    | —                            | —       | —                                       | -0.00028                     | 3.553   | ** |
| Ukraine                                 | —                            | —       | —                                       | 0.191                        | 4.988   | ** |
| Belorus                                 | -0.151                       | 7.323   | **                                      | —                            | —       | —  |
| Latvia                                  | -0.135                       | 4.922   | **                                      | 0.051                        | 5.180   | ** |
| Estonia                                 | -0.134                       | 4.271   | **                                      | 0.054                        | 4.748   | ** |
| Lithuania                               | -0.173                       | 6.315   | **                                      | —                            | —       | —  |
| Moldova                                 | -0.144                       | 4.603   | **                                      | 0.124                        | 5.253   | ** |
| Kazakhstan                              | -0.153                       | 6.155   | **                                      | 0.673                        | 3.396   | ** |
| Turkmenistan                            | -0.121                       | 2.798   | **                                      | 0.517                        | 4.336   | ** |
| Kyrgyzstan                              | -0.251                       | 7.630   | **                                      | 0.522                        | 3.264   | ** |
| Uzbekistan                              | -0.116                       | 4.299   | **                                      | 0.617                        | 3.738   | ** |
| Tajikistan                              | -0.181                       | 4.837   | **                                      | 0.592                        | 3.770   | ** |
| Georgia                                 | -0.164                       | 5.970   | **                                      | 0.245                        | 3.751   | ** |
| Azerbaijan                              | -0.108                       | 3.639   | **                                      | 0.379                        | 4.385   | ** |
| Armenia                                 | -0.261                       | 8.619   | **                                      | 0.188                        | 2.614   | ** |
| Trend                                   | 0.026                        | 15.634  | **                                      | 0.027                        | 14.024  | ** |
| Trend Squared                           | -0.026                       | 3.984   | **                                      | -0.026                       | 3.908   | ** |
| constant                                | 1.186                        | 16.480  | **                                      | 1.293                        | 12.668  | ** |
| R <sup>2</sup> 0.9978 DF F-ratio        |                              |         | R <sup>2</sup> 0.9978 DF F-ratio        |                              |         |    |
| Adj R <sup>2</sup> 0.9976 236 6230.3 ** |                              |         | Adj R <sup>2</sup> 0.9976 236 6242.3 ** |                              |         |    |

\*\* : significant at 1% level; \* : significant at 5% level

Appendix B: Correlation between Net Migration Rates and Various Factors  
(Kumo, 1999b, p.18)

Definition of Variables in Correlation Analysis

Dependent Variable:

Net Migration Rate in Each Union Republic (Calculated from Population and Natural Increase Rate)

Independent Variable:

Investment: Per Capita Governmental Investment

Housing Investment: Per Capita Housing Investment

Railway Construction: Newly Constructed Railways, km/km2(divided by whole territory of each republic)

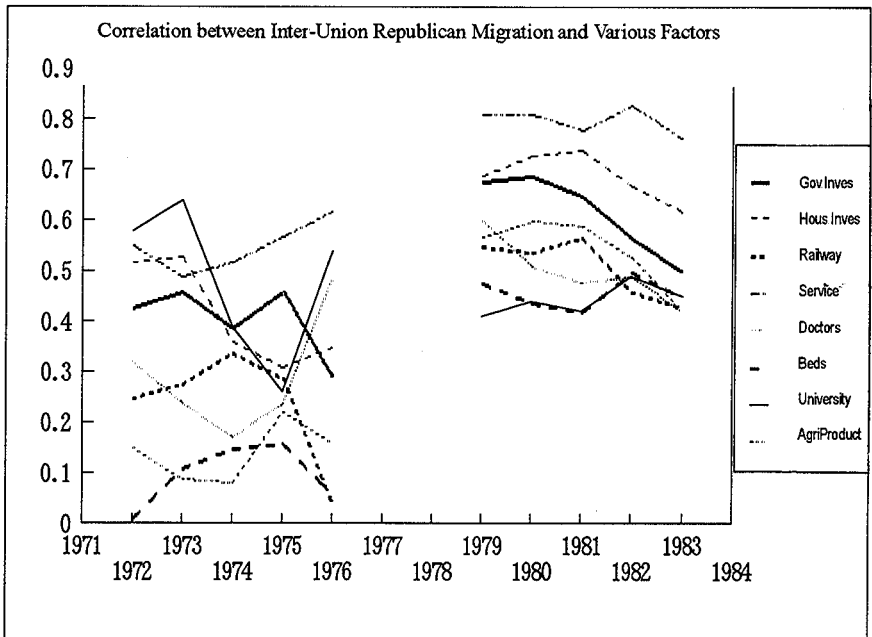
Service: Per Capita Service Consumption

Number of Doctors: Number of Doctors per Thousand Residents

Number of Hospital Beds: Number of Hospital Beds per Thousand Residents

Number of Universities: Number of Universities per Thousand Residents

Agricultural Output: Per Capita Output of Wheat



Soviet Regions Revisited:  
A Note on Trends in Regional TFP

Appendix C : Table 2.a

| Armenia |       |        |       | Azerbaijan |       |       |        | Georgia |        |        |        |        |       |        |       |
|---------|-------|--------|-------|------------|-------|-------|--------|---------|--------|--------|--------|--------|-------|--------|-------|
| Y'      | A/A   | A/Y'   |       | Y'         | A/A   | A/Y'  |        | Y'      | A/A    | A/Y'   |        |        |       |        |       |
| 1970    | 0.097 | 0.038  | 0.229 | 0.395      | 0.454 | 0.070 | 0.045  | 0.259   | 0.639  | 0.605  | 0.081  | 0.049  | 0.305 | 0.608  | 0.588 |
| 1971    | 0.084 | 0.042  |       | 0.496      |       | 0.059 | 0.044  |         | 0.755  |        | 0.031  | 0.010  |       | 0.334  |       |
| 1972    | 0.078 | 0.034  |       | 0.440      |       | 0.083 | 0.040  |         | 0.485  |        | 0.112  | 0.093  |       | 0.833  |       |
| 1973    | 0.105 | 0.055  |       | 0.518      |       | 0.102 | 0.065  |         | 0.632  |        | 0.126  | 0.087  |       | 0.689  |       |
| 1974    | 0.098 | 0.041  |       | 0.420      |       | 0.081 | 0.042  |         | 0.514  |        | 0.076  | 0.037  |       | 0.478  |       |
| 1975    | 0.086 | 0.022  | 0.118 | 0.257      | 0.255 | 0.098 | 0.043  | 0.206   | 0.439  | 0.444  | 0.104  | 0.063  | 0.210 | 0.605  | 0.454 |
| 1976    | 0.087 | 0.009  |       | 0.099      |       | 0.090 | 0.047  |         | 0.518  |        | 0.071  | 0.037  |       | 0.522  |       |
| 1977    | 0.105 | 0.044  |       | 0.420      |       | 0.067 | 0.022  |         | 0.327  |        | 0.100  | 0.025  |       | 0.253  |       |
| 1978    | 0.073 | 0.006  |       | 0.076      |       | 0.102 | 0.062  |         | 0.614  |        | 0.088  | 0.052  |       | 0.593  |       |
| 1979    | 0.079 | 0.033  |       | 0.423      |       | 0.056 | 0.018  |         | 0.322  |        | 0.057  | 0.017  |       | 0.298  |       |
| 1980    | 0.075 | 0.026  | 0.059 | 0.347      | 0.175 | 0.071 | 0.027  | 0.015   | 0.387  | -0.206 | 0.077  | 0.044  | 0.081 | 0.573  | 0.178 |
| 1981    | 0.038 | -0.007 |       | -0.190     |       | 0.030 | -0.004 |         | -0.144 |        | 0.025  | -0.011 |       | -0.446 |       |
| 1982    | 0.054 | 0.012  |       | 0.225      |       | 0.018 | -0.030 |         | -1.732 |        | 0.045  | 0.007  |       | 0.164  |       |
| 1983    | 0.059 | 0.017  |       | 0.293      |       | 0.052 | 0.011  |         | 0.221  |        | 0.057  | 0.011  |       | 0.196  |       |
| 1984    | 0.047 | 0.010  |       | 0.202      |       | 0.051 | 0.012  |         | 0.237  |        | 0.070  | 0.028  |       | 0.402  |       |
| 1985    | 0.047 | 0.005  |       | 0.106      |       | 0.063 | 0.029  |         | 0.463  |        | -0.028 | 0.053  |       | -1.862 |       |
| 1986    | 0.020 | -0.006 |       | -0.299     |       | 0.053 | 0.035  |         | 0.658  |        | 0.009  | -0.018 |       | -1.961 |       |

| Kazakhstan |        |        |        | Tadzhikistan |        |        |        | Turkmenistan |        |        |        |        |       |        |        |
|------------|--------|--------|--------|--------------|--------|--------|--------|--------------|--------|--------|--------|--------|-------|--------|--------|
| Y'         | A/A    | A/Y'   |        | Y'           | A/A    | A/Y'   |        | Y'           | A/A    | A/Y'   |        |        |       |        |        |
| 1970       | 0.093  | 0.043  | 0.158  | 0.463        | 0.328  | 0.103  | 0.054  | -0.023       | 0.525  | -0.388 | 0.028  | -0.013 | 0.121 | -0.486 | 0.135  |
| 1971       | 0.072  | 0.033  |        | 0.453        |        | 0.047  | -0.073 |              | -1.568 |        | 0.101  | 0.062  |       | 0.617  |        |
| 1972       | 0.074  | 0.025  |        | 0.334        |        | 0.035  | -0.040 |              | -1.144 |        | 0.081  | 0.004  |       | 0.055  |        |
| 1973       | 0.105  | 0.055  |        | 0.528        |        | 0.044  | -0.006 |              | -0.143 |        | 0.059  | -0.004 |       | -0.072 |        |
| 1974       | 0.047  | -0.007 |        | -0.136       |        | 0.124  | 0.049  |              | 0.391  |        | 0.124  | 0.070  |       | 0.562  |        |
| 1975       | 0.020  | -0.029 | -0.008 | -1.487       | -1.439 | 0.011  | -0.061 | -0.046       | -5.520 | -1.107 | 0.032  | -0.023 | 0.086 | -0.733 | -3.318 |
| 1976       | 0.016  | -0.029 |        | -1.764       |        | 0.052  | -0.017 |              | -0.326 |        | 0.005  | -0.053 |       | -      |        |
| 1977       | 0.035  | -0.006 |        | -0.159       |        | 0.049  | -0.010 |              | -0.193 |        | 0.021  | -0.031 |       | -1.495 |        |
| 1978       | -0.015 | 0.056  |        | -3.833       |        | 0.084  | 0.022  |              | 0.266  |        | -0.033 | 0.084  |       | -2.521 |        |
| 1979       | 0.047  | 0.002  |        | 0.048        |        | 0.084  | 0.020  |              | 0.237  |        | -0.070 | 0.117  |       | -1.685 |        |
| 1980       | 0.014  | -0.028 | 0.063  | -2.088       | -1.979 | 0.050  | 0.009  | 0.191        | 0.181  | -2.446 | -0.027 | 0.085  | 0.109 | -3.205 | -1.726 |
| 1981       | 0.056  | 0.014  |        | 0.261        |        | -0.006 | 0.050  |              | -8.601 |        | 0.014  | -0.035 |       | -2.403 |        |
| 1982       | -0.024 | 0.063  |        | -2.650       |        | 0.086  | 0.044  |              | 0.518  |        | 0.021  | -0.010 |       | -0.485 |        |
| 1983       | 0.069  | 0.041  |        | 0.597        |        | 0.046  | 0.009  |              | 0.200  |        | 0.031  | -0.021 |       | -0.683 |        |
| 1984       | 0.004  | -0.025 |        | -6.016       |        | -0.015 | 0.067  |              | -4.526 |        | -0.050 | 0.093  |       | -1.856 |        |
| 1985       | -0.087 | 0.115  |        | -1.318       |        | 0.001  | -0.047 |              | -33.70 |        | 0.076  | 0.036  |       | 0.477  |        |
| 1986       | 0.001  | -0.026 |        | -            |        | 0.046  | 0.021  |              | 0.456  |        | 0.056  | 0.024  |       | 0.430  |        |

| Kirgizia |        |        |        | Uzbekistan |        |        |        |        |        |        |
|----------|--------|--------|--------|------------|--------|--------|--------|--------|--------|--------|
| Y'       | A/A    | A/Y'   |        | Y'         | A/A    | A/Y'   |        |        |        |        |
| 1970     | 0.042  | -0.014 | -0.033 | -0.325     | -0.146 | 0.095  | 0.028  | 0.276  | 0.288  | 0.433  |
| 1971     | 0.059  | 0.007  |        | 0.121      |        | 0.095  | 0.049  |        | 0.515  |        |
| 1972     | 0.066  | 0.018  |        | 0.272      |        | 0.093  | 0.023  |        | 0.242  |        |
| 1973     | 0.064  | -0.009 |        | -0.134     |        | 0.144  | 0.079  |        | 0.548  |        |
| 1974     | 0.054  | -0.036 |        | -0.665     |        | 0.127  | 0.073  |        | 0.572  |        |
| 1975     | 0.067  | 0.024  | 0.090  | 0.358      | 0.189  | 0.065  | 0.014  | -0.053 | 0.218  | -0.438 |
| 1976     | 0.035  | -0.015 |        | -0.434     |        | 0.034  | -0.019 |        | -0.564 |        |
| 1977     | 0.094  | 0.050  |        | 0.528      |        | 0.047  | -0.002 |        | -0.046 |        |
| 1978     | 0.036  | 0.001  |        | 0.015      |        | 0.021  | -0.032 |        | -1.539 |        |
| 1979     | 0.062  | 0.030  |        | 0.476      |        | 0.055  | -0.014 |        | -0.259 |        |
| 1980     | 0.046  | -0.001 | 0.069  | -0.015     | -0.452 | 0.062  | -0.002 | 0.141  | -0.025 | -0.881 |
| 1981     | 0.091  | 0.056  |        | 0.609      |        | 0.072  | 0.018  |        | 0.249  |        |
| 1982     | 0.051  | 0.019  |        | 0.368      |        | 0.042  | -0.003 |        | -0.084 |        |
| 1983     | 0.050  | 0.028  |        | 0.553      |        | -0.012 | 0.061  |        | -5.163 |        |
| 1984     | 0.009  | -0.032 |        | -3.773     |        | 0.100  | 0.062  |        | 0.620  |        |
| 1985     | -0.042 | -0.071 |        | 1.697      |        | 0.000  | -0.076 |        | 2.708  |        |
| 1986     | 0.032  | 0.002  |        | 0.054      |        | 0.017  | -0.013 |        | -0.767 |        |

Appendix c (continues): Table 2 b

| Lithuania |       |        |       | Latvia |        |       |        | Estonia |        |        |        |        |       |        |        |
|-----------|-------|--------|-------|--------|--------|-------|--------|---------|--------|--------|--------|--------|-------|--------|--------|
| Y         | A/A   | A/Y    |       | Y      | A/A    | A/Y   |        | Y       | A/A    | A/Y    |        |        |       |        |        |
| 1970      | 0.071 | 0.002  | 0.172 | 0.024  | 0.357  | 0.115 | 0.080  | 0.222   | 0.696  | 0.520  | 0.069  | 0.028  | 0.192 | 0.409  | 0.496  |
| 1971      | 0.110 | 0.064  |       | 0.582  |        | 0.074 | 0.045  |         | 0.613  |        | 0.071  | 0.023  |       | 0.328  |        |
| 1972      | 0.078 | 0.032  |       | 0.413  |        | 0.062 | 0.033  |         | 0.536  |        | 0.084  | 0.049  |       | 0.582  |        |
| 1973      | 0.075 | 0.025  |       | 0.337  |        | 0.063 | 0.029  |         | 0.459  |        | 0.066  | 0.037  |       | 0.564  |        |
| 1974      | 0.091 | 0.039  |       | 0.430  |        | 0.059 | 0.018  |         | 0.298  |        | 0.069  | 0.041  |       | 0.596  |        |
| 1975      | 0.067 | 0.023  | 0.127 | 0.343  | 0.245  | 0.069 | 0.027  | 0.106   | 0.391  | 0.349  | 0.077  | 0.046  | 0.113 | 0.601  | 0.371  |
| 1976      | 0.033 | -0.014 |       | -0.429 |        | 0.050 | 0.015  |         | 0.302  |        | 0.041  | 0.012  |       | 0.302  |        |
| 1977      | 0.045 | 0.005  |       | 0.110  |        | 0.067 | 0.048  |         | 0.718  |        | 0.060  | 0.030  |       | 0.492  |        |
| 1978      | 0.073 | 0.040  |       | 0.555  |        | 0.040 | 0.005  |         | 0.131  |        | 0.046  | 0.019  |       | 0.409  |        |
| 1979      | 0.106 | 0.069  |       | 0.645  |        | 0.037 | 0.007  |         | 0.204  |        | 0.036  | 0.002  |       | 0.051  |        |
| 1980      | 0.064 | 0.034  | 0.042 | 0.540  | -0.542 | 0.042 | 0.018  | -0.001  | 0.427  | -0.540 | 0.040  | 0.017  | 0.026 | 0.430  | -0.192 |
| 1981      | 0.095 | 0.064  |       | 0.676  |        | 0.029 | 0.001  |         | 0.030  |        | 0.060  | 0.032  |       | 0.524  |        |
| 1982      | 0.018 | -0.019 |       | -1.055 |        | 0.022 | -0.002 |         | -0.093 |        | 0.027  | 0.001  |       | 0.052  |        |
| 1983      | 0.010 | -0.024 |       | -2.305 |        | 0.016 | -0.007 |         | -0.406 |        | 0.016  | -0.008 |       | -0.507 |        |
| 1984      | 0.020 | -0.011 |       | -0.563 |        | 0.004 | -0.011 |         | -2.659 |        | 0.010  | -0.015 |       | -1.460 |        |
| 1985      | 0.053 | 0.028  |       | 0.521  |        | 0.067 | 0.051  |         | 0.759  |        | -0.007 | -0.030 |       | 4.582  |        |
| 1986      | 0.091 | 0.018  |       | 0.197  |        | 0.061 | 0.056  |         | 0.925  |        | 0.045  | 0.041  |       | 0.901  |        |

| Moldva |        |        |       |         |        |
|--------|--------|--------|-------|---------|--------|
| Y      | A/A    | A/Y    |       |         |        |
| 1970   | 0.133  | 0.072  | 0.074 | 0.546   | -2.156 |
| 1971   | 0.048  | -0.017 |       | -0.354  |        |
| 1972   | 0.005  | -0.061 |       | -11.722 |        |
| 1973   | 0.131  | 0.081  |       | 0.463   |        |
| 1974   | 0.082  | 0.023  |       | 0.286   |        |
| 1975   | 0.071  | 0.018  | 0.085 | 0.248   | 0.223  |
| 1976   | 0.065  | 0.001  |       | 0.012   |        |
| 1977   | 0.081  | 0.027  |       | 0.336   |        |
| 1978   | 0.074  | 0.031  |       | 0.421   |        |
| 1979   | 0.056  | 0.006  |       | 0.100   |        |
| 1980   | 0.055  | 0.011  | 0.210 | 0.196   | -0.225 |
| 1981   | 0.089  | 0.053  |       | 0.597   |        |
| 1982   | 0.094  | 0.060  |       | 0.641   |        |
| 1983   | 0.026  | -0.017 |       | -0.629  |        |
| 1984   | -0.046 | 0.090  |       | -1.929  |        |
| 1985   | -0.016 | 0.029  |       | -1.808  |        |
| 1986   | 0.074  | 0.061  |       | 0.825   |        |

| Belorus |       |        |       | Russia |       |       |        | Ukraine |        |        |        |        |       |        |        |
|---------|-------|--------|-------|--------|-------|-------|--------|---------|--------|--------|--------|--------|-------|--------|--------|
| Y       | A/A   | A/Y    |       | Y      | A/A   | A/Y   |        | Y       | A/A    | A/Y    |        |        |       |        |        |
| 1970    | 0.158 | 0.069  | 0.317 | 0.435  | 0.471 | 0.073 | 0.032  | 0.200   | 0.446  | 0.472  | 0.053  | 0.007  | 0.127 | 0.125  | 0.350  |
| 1971    | 0.096 | 0.044  |       | 0.460  |       | 0.070 | 0.032  |         | 0.449  |        | 0.063  | 0.030  |       | 0.472  |        |
| 1972    | 0.103 | 0.044  |       | 0.422  |       | 0.083 | 0.043  |         | 0.520  |        | 0.084  | 0.040  |       | 0.475  |        |
| 1973    | 0.107 | 0.046  |       | 0.428  |       | 0.091 | 0.047  |         | 0.517  |        | 0.064  | 0.022  |       | 0.348  |        |
| 1974    | 0.134 | 0.081  |       | 0.608  |       | 0.075 | 0.032  |         | 0.430  |        | 0.069  | 0.023  |       | 0.332  |        |
| 1975    | 0.083 | 0.029  | 0.183 | 0.346  | 0.374 | 0.069 | 0.024  | 0.048   | 0.347  | 0.160  | 0.045  | -0.001 | 0.029 | -0.025 | 0.052  |
| 1976    | 0.104 | 0.047  |       | 0.449  |       | 0.055 | 0.017  |         | 0.313  |        | 0.061  | 0.020  |       | 0.322  |        |
| 1977    | 0.069 | 0.014  |       | 0.196  |       | 0.044 | 0.005  |         | 0.117  |        | 0.061  | 0.022  |       | 0.358  |        |
| 1978    | 0.093 | 0.034  |       | 0.362  |       | 0.036 | 0.002  |         | 0.059  |        | 0.033  | -0.006 |       | -0.185 |        |
| 1979    | 0.094 | 0.049  |       | 0.519  |       | 0.034 | -0.001 |         | -0.036 |        | 0.026  | -0.005 |       | -0.208 |        |
| 1980    | 0.058 | 0.022  | 0.041 | 0.371  | 0.141 | 0.037 | 0.003  | -0.018  | 0.091  | -0.224 | 0.016  | -0.013 | 0.090 | -0.790 | -0.472 |
| 1981    | 0.060 | 0.018  |       | 0.298  |       | 0.021 | -0.011 |         | -0.534 |        | 0.052  | 0.021  |       | 0.405  |        |
| 1982    | 0.047 | 0.007  |       | 0.151  |       | 0.022 | -0.008 |         | -0.388 |        | 0.061  | 0.035  |       | 0.577  |        |
| 1983    | 0.045 | -0.008 |       | -0.183 |       | 0.033 | 0.007  |         | 0.206  |        | 0.035  | 0.012  |       | 0.347  |        |
| 1984    | 0.039 | 0.003  |       | 0.070  |       | 0.017 | -0.008 |         | -0.493 |        | -0.011 | 0.032  |       | -2.898 |        |
| 1985    | 0.031 | 0.003  |       | 0.102  |       | 0.002 | -0.022 |         | -13.96 |        | 0.023  | 0.005  |       | 0.204  |        |
| 1986    | 0.091 | 0.064  |       | 0.706  |       | 0.017 | 0.001  |         | 0.076  |        | 0.108  | 0.095  |       | 0.879  |        |



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Appendix C (continues): Table 3 a

|         | ARMENIA |        |        |        | 5-10   | Azerbaijan |       |       |       | 5-10  | GEORGIA |        |       |        | 5-10  |
|---------|---------|--------|--------|--------|--------|------------|-------|-------|-------|-------|---------|--------|-------|--------|-------|
|         | Y       | A/A    | A/A    | A/Y    |        | Y          | A/A   | A/A   | A/Y   |       | Y       | A/A    | A/A   | A/Y    |       |
| 1950-59 | 2.162   | 0.968  | 0.968  | 0.448  | 0.448  | 1.051      | 0.552 | 0.552 | 0.526 | 0.526 | 1.487   | 0.754  | 0.754 | 0.507  | 0.507 |
| 1960    | 0.110   | 0.068  | -0.004 | 0.620  | -0.078 | 0.120      | 0.060 | 0.098 | 0.500 | 0.222 | 0.060   | 0.082  | 0.080 | 1.366  | 0.238 |
| 1961    | 0.072   | -0.065 |        | -0.906 |        | 0.063      | 0.011 |       | 0.178 |       | 0.104   | 0.000  |       | 0.001  |       |
| 1962    | 0.101   | 0.018  |        | 0.177  |        | 0.059      | 0.018 |       | 0.306 |       | 0.051   | 0.000  |       | 0.004  |       |
| 1963    | 0.069   | -0.019 |        | -0.272 |        | 0.048      | 0.004 |       | 0.088 |       | 0.041   | -0.011 |       | -0.273 |       |
| 1964    | 0.121   | -0.001 |        | -0.010 |        | 0.068      | 0.003 |       | 0.038 |       | 0.102   | 0.009  |       | 0.089  |       |
| 1965    | 0.115   | 0.019  | 0.206  | 0.169  | 0.308  | 0.071      | 0.016 | 0.124 | 0.220 | 0.345 | 0.113   | 0.031  | 0.208 | 0.271  | 0.442 |
| 1966    | 0.137   | 0.066  |        | 0.479  |        | 0.073      | 0.044 |       | 0.606 |       | 0.076   | 0.020  |       | 0.260  |       |
| 1967    | 0.075   | 0.000  |        | 0.000  |        | 0.043      | 0.009 |       | 0.218 |       | 0.077   | 0.030  |       | 0.386  |       |
| 1968    | 0.107   | 0.061  |        | 0.566  |        | 0.053      | 0.015 |       | 0.291 |       | 0.077   | 0.052  |       | 0.671  |       |
| 1969    | 0.142   | 0.046  |        | 0.326  |        | 0.088      | 0.034 |       | 0.392 |       | 0.099   | 0.062  |       | 0.619  |       |
| 1970-74 | 0.476   | 0.317  | 0.317  | 0.665  | 0.665  | 0.509      | 0.315 | 0.315 | 0.618 | 0.618 | 0.429   | 0.329  | 0.329 | 0.769  | 0.769 |
| 1975-79 | 0.452   | 0.233  | 0.233  | 0.516  | 0.516  | 0.446      | 0.234 | 0.234 | 0.526 | 0.526 | 0.333   | 0.098  | 0.098 | 0.294  | 0.294 |
| 1980-84 | 0.333   | 0.142  | 0.142  | 0.425  | 0.425  | 0.333      | 0.070 | 0.070 | 0.211 | 0.211 | 0.343   | 0.103  | 0.103 | 0.330  | 0.330 |

|         | Kazakhstan |        |       |        | 5-10  | TADGIK |        |        |        | 5-10   | TURKMEN |        |        |        | 5-10   |
|---------|------------|--------|-------|--------|-------|--------|--------|--------|--------|--------|---------|--------|--------|--------|--------|
|         | Y          | A/A    | A/A   | A/Y    |       | Y      | A/A    | A/A    | A/Y    |        | Y       | A/A    | A/A    | A/Y    |        |
| 1950-59 | 2.175      | 0.073  | 0.073 | 0.034  | 0.034 | 1.855  | 0.333  | 0.333  | 0.179  | 0.179  | 1.354   | 0.413  | 0.413  | 0.305  | 0.305  |
| 1960    | 0.130      | -0.082 | 0.067 | -0.633 | 0.187 | 0.100  | -0.092 | -0.037 | -0.925 | -0.210 | 0.060   | 0.015  | 0.011  | 0.245  | -0.036 |
| 1961    | 0.115      | 0.151  |       | 1.310  |       | 0.118  | 0.133  |        | 1.129  |        | 0.038   | -0.006 |        | -0.147 |        |
| 1962    | 0.095      | 0.052  |       | 0.542  |       | 0.049  | -0.011 |        | -0.225 |        | 0.055   | 0.022  |        | 0.408  |        |
| 1963    | 0.065      | 0.008  |       | 0.120  |       | 0.124  | 0.026  |        | 0.213  |        | 0.103   | 0.024  |        | 0.232  |        |
| 1964    | 0.116      | -0.047 |       | -0.405 |       | 0.062  | -0.077 |        | -1.244 |        | 0.047   | -0.043 |        | -0.915 |        |
| 1965    | 0.079      | 0.025  | 0.246 | 0.313  | 0.472 | 0.104  | 0.047  | 0.207  | 0.452  | 0.403  | 0.097   | -0.010 | 0.178  | -0.107 | 0.339  |
| 1966    | 0.130      | 0.074  |       | 0.566  |       | 0.124  | 0.087  |        | 0.706  |        | 0.122   | 0.090  |        | 0.739  |        |
| 1967    | 0.090      | 0.059  |       | 0.661  |       | 0.058  | 0.005  |        | 0.089  |        | 0.055   | 0.031  |        | 0.561  |        |
| 1968    | 0.060      | 0.025  |       | 0.414  |       | 0.045  | 0.015  |        | 0.331  |        | 0.017   | 0.001  |        | 0.070  |        |
| 1969    | 0.106      | 0.043  |       | 0.409  |       | 0.091  | 0.040  |        | 0.437  |        | 0.133   | 0.058  |        | 0.434  |        |
| 1970-74 | 0.421      | 0.248  | 0.248 | 0.590  | 0.590 | 0.414  | 0.179  | 0.179  | 0.933  | 0.433  | 0.471   | 0.207  | 0.207  | 0.441  | 0.441  |
| 1975-79 | 0.185      | 0.045  | 0.045 | 0.243  | 0.243 | 0.286  | 0.104  | 0.104  | 0.363  | 0.363  | 0.200   | 0.103  | 0.103  | 0.517  | 0.517  |
| 1980-84 | 0.156      | 0.047  | 0.047 | 0.299  | 0.299 | 0.222  | 0.028  | 0.028  | 0.126  | 0.126  | 0.083   | -0.108 | -0.108 | -1.298 | -1.298 |

|         | Kirgiz |        |       |        | 5-10  | Uzbekistan |        |        |        | 5-10   |
|---------|--------|--------|-------|--------|-------|------------|--------|--------|--------|--------|
|         | Y      | A/A    | A/A   | A/Y    |       | Y          | A/A    | A/A    | A/Y    |        |
| 1950-59 | 1.885  | 0.488  | 0.488 | 0.259  | 0.259 | 1.304      | -0.062 | -0.062 | -0.048 | -0.048 |
| 1960    | 0.090  | -0.004 | 0.130 | -0.047 | 0.226 | 0.070      | -0.020 | -0.021 | -0.283 | -0.067 |
| 1961    | 0.110  | 0.077  |       | 0.698  |       | 0.065      | 0.033  |        | 0.506  |        |
| 1962    | 0.099  | 0.000  |       | -0.004 |       | 0.061      | -0.020 |        | -0.329 |        |
| 1963    | 0.098  | 0.034  |       | 0.347  |       | 0.140      | 0.019  |        | 0.133  |        |
| 1964    | 0.144  | 0.019  |       | 0.135  |       | 0.087      | -0.031 |        | -0.360 |        |
| 1965    | 0.144  | 0.077  | 0.327 | 0.533  | 0.443 | 0.087      | -0.017 | 0.044  | -0.198 | -0.250 |
| 1966    | 0.173  | 0.082  |       | 0.474  |       | 0.092      | 0.033  |        | 0.356  |        |
| 1967    | 0.112  | 0.019  |       | 0.169  |       | 0.039      | -0.005 |        | -0.137 |        |
| 1968    | 0.072  | 0.039  |       | 0.538  |       | 0.005      | -0.009 |        | -1.733 |        |
| 1969    | 0.151  | 0.076  |       | 0.501  |       | 0.095      | 0.044  |        | 0.460  |        |
| 1970-74 | 0.526  | 0.339  | 0.339 | 0.644  | 0.644 | 0.529      | 0.246  | 0.246  | 0.466  | 0.466  |
| 1975-79 | 0.276  | 0.140  | 0.140 | 0.509  | 0.509 | 0.231      | 0.026  | 0.026  | 0.112  | 0.112  |
| 1980-84 | 0.243  | 0.112  | 0.112 | 0.462  | 0.462 | 0.313      | 0.166  | 0.166  | 0.531  | 0.531  |

Appendix C (continues): Table 3 b

|         | ESTONIA |       |             |       |             | LITHUA |        |             |        |             | LATVIA |        |             |        |             |
|---------|---------|-------|-------------|-------|-------------|--------|--------|-------------|--------|-------------|--------|--------|-------------|--------|-------------|
|         | Y       | A/A   | 5-10<br>A/A | A/Y   | 5-10<br>A/Y | Y      | A/A    | 5-10<br>A/A | A/Y    | 5-10<br>A/Y | Y      | A/A    | 5-10<br>A/A | A/Y    | 5-10<br>A/Y |
| 1950-59 | 2.363   | 1.173 | 1.173       | 0.496 | 0.496       | 4.389  | 2.013  | 2.013       | 0.459  | 0.459       | 2.632  | 1.085  | 1.085       | 0.412  | 0.412       |
| 1960    | 0.100   | 0.044 | 0.197       | 0.437 | 0.365       | 0.110  | -0.061 | 0.049       | -0.552 | 0.085       | 0.080  | -0.003 | 0.116       | -0.038 | 0.221       |
| 1961    | 0.109   | 0.044 |             | 0.406 |             | 0.099  | 0.021  |             | 0.210  |             | 0.093  | 0.013  |             | 0.145  |             |
| 1962    | 0.107   | 0.046 |             | 0.428 |             | 0.115  | 0.059  |             | 0.515  |             | 0.093  | 0.046  |             | 0.497  |             |
| 1963    | 0.089   | 0.026 |             | 0.295 |             | 0.132  | 0.010  |             | 0.074  |             | 0.101  | 0.016  |             | 0.159  |             |
| 1964    | 0.088   | 0.023 |             | 0.262 |             | 0.130  | 0.023  |             | 0.181  |             | 0.113  | 0.039  |             | 0.344  |             |
| 1965    | 0.081   | 0.055 | 0.234       | 0.676 | 0.532       | 0.121  | 0.019  | 0.204       | 0.159  | 0.324       | 0.108  | 0.060  | 0.255       | 0.553  | 0.491       |
| 1966    | 0.092   | 0.032 |             | 0.341 |             | 0.128  | 0.033  |             | 0.259  |             | 0.109  | 0.050  |             | 0.457  |             |
| 1967    | 0.095   | 0.021 |             | 0.226 |             | 0.109  | 0.014  |             | 0.131  |             | 0.093  | 0.038  |             | 0.408  |             |
| 1968    | 0.072   | 0.077 |             | 1.067 |             | 0.119  | 0.080  |             | 0.675  |             | 0.066  | 0.031  |             | 0.475  |             |
| 1969    | 0.089   | 0.031 |             | 0.348 |             | 0.109  | 0.044  |             | 0.399  |             | 0.096  | 0.054  |             | 0.563  |             |
| 1970-74 | 0.393   | 0.291 | 0.291       | 0.741 | 0.741       | 0.484  | 0.288  | 0.288       | 0.595  | 0.595       | 0.370  | 0.187  | 0.187       | 0.504  | 0.504       |
| 1975-79 | 0.231   | 0.140 | 0.140       | 0.605 | 0.605       | 0.261  | 0.191  | 0.191       | 0.732  | 0.732       | 0.216  | 0.199  | 0.199       | 0.920  | 0.920       |
| 1980-84 | 0.146   | 0.065 | 0.065       | 0.449 | 0.449       | 0.259  | 0.074  | 0.074       | 0.287  | 0.287       | 0.178  | 0.044  | 0.044       | 0.249  | 0.249       |

|         | MOLDOVA |        |             |              |
|---------|---------|--------|-------------|--------------|
|         | Y       | A/A    | 5-10<br>A/A | 5-10<br>A/Y  |
| 1950-59 | 3.372   | 0.949  | 0.949       | 0.281 0.281  |
| 1960    | 0.110   | -0.016 | 0.158       | -0.146 0.203 |
| 1961    | 0.144   | 0.108  |             | 0.747        |
| 1962    | 0.094   | 0.035  |             | 0.373        |
| 1963    | 0.094   | -0.028 |             | -0.297       |
| 1964    | 0.164   | 0.055  |             | 0.337        |
| 1965    | 0.068   | -0.015 | 0.057       | -0.224 0.055 |
| 1966    | 0.116   | 0.001  |             | 0.008        |
| 1967    | 0.133   | 0.054  |             | 0.406        |
| 1968    | 0.092   | 0.039  |             | 0.426        |
| 1969    | 0.062   | -0.021 |             | -0.343       |
| 1970-74 | 0.560   | 0.240  | 0.240       | 0.429 0.429  |
| 1975-79 | 0.308   | 0.169  | 0.169       | 0.549 0.549  |
| 1980-84 | 0.275   | 0.136  | 0.136       | 0.497 0.497  |

|         | Russia |       |             |             | Ukraine |       |             |             | Belorus |        |             |              |
|---------|--------|-------|-------------|-------------|---------|-------|-------------|-------------|---------|--------|-------------|--------------|
|         | Y      | A/A   | 5-10<br>A/A | 5-10<br>A/Y | Y       | A/A   | 5-10<br>A/A | 5-10<br>A/Y | Y       | A/A    | 5-10<br>A/A | 5-10<br>A/Y  |
| 1950-59 | 1.818  | 0.680 | 0.680       | 0.374 0.374 | 2.160   | 0.941 | 0.941       | 0.436 0.436 | 2.701   | 1.314  | 1.314       | 0.487 0.487  |
| 1960    | 0.080  | 0.047 | 0.183       | 0.592 0.428 | 0.100   | 0.052 | 0.202       | 0.522 0.409 | 0.120   | -0.020 | 0.112       | -0.168 0.217 |
| 1961    | 0.093  | 0.053 |             | 0.575       | 0.100   | 0.049 |             | 0.486       | 0.107   | 0.091  |             | 0.853        |
| 1962    | 0.076  | 0.041 |             | 0.536       | 0.066   | 0.030 |             | 0.456       | 0.089   | 0.013  |             | 0.147        |
| 1963    | 0.063  | 0.014 |             | 0.216       | 0.070   | 0.011 |             | 0.154       | 0.104   | 0.027  |             | 0.285        |
| 1964    | 0.074  | 0.017 |             | 0.223       | 0.109   | 0.047 |             | 0.428       | 0.101   | -0.001 |             | -0.013       |
| 1965    | 0.083  | 0.039 | 0.208       | 0.469 0.471 | 0.078   | 0.018 | 0.189       | 0.234 0.421 | 0.140   | 0.034  | 0.224       | 0.240 0.341  |
| 1966    | 0.096  | 0.047 |             | 0.487       | 0.097   | 0.042 |             | 0.438       | 0.128   | 0.039  |             | 0.307        |
| 1967    | 0.081  | 0.030 |             | 0.370       | 0.083   | 0.026 |             | 0.312       | 0.123   | 0.040  |             | 0.328        |
| 1968    | 0.070  | 0.047 |             | 0.677       | 0.077   | 0.050 |             | 0.651       | 0.110   | 0.062  |             | 0.561        |
| 1969    | 0.084  | 0.030 |             | 0.352       | 0.085   | 0.040 |             | 0.469       | 0.118   | 0.032  |             | 0.269        |
| 1970-74 | 0.364  | 0.150 | 0.150       | 0.411 0.411 | 0.446   | 0.249 | 0.249       | 0.559 0.559 | 0.615   | 0.373  | 0.373       | 0.607 0.607  |
| 1975-79 | 0.267  | 0.151 | 0.151       | 0.568 0.568 | 0.167   | 0.073 | 0.073       | 0.436 0.436 | 0.381   | 0.214  | 0.214       | 0.562 0.562  |
| 1980-84 | 0.158  | 0.078 | 0.078       | 0.494 0.494 | 0.214   | 0.125 | 0.125       | 0.582 0.582 | 0.310   | 0.158  | 0.158       | 0.509 0.509  |

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Appendix C (continues): Table 3.c

| Europe-Russia              |                     |                     |       |       |       | Siberia and Far East |                     |                     |       |       |       |
|----------------------------|---------------------|---------------------|-------|-------|-------|----------------------|---------------------|---------------------|-------|-------|-------|
| <b>North West</b>          |                     |                     |       |       |       | <b>West Siberia</b>  |                     |                     |       |       |       |
| Y                          | 0.6 <sup>L</sup> /Y | 0.4 <sup>K</sup> /Y | A/A   | A/Y   |       | Y                    | 0.6 <sup>L</sup> /Y | 0.4 <sup>K</sup> /Y | A/A   | A/Y   |       |
| 1970-79                    | 0.702               | 0.075               | 0.413 | 0.360 | 0.512 | 1970-79              | 0.962               | 0.073               | 0.634 | 0.282 | 0.293 |
| 1980-84                    | 0.160               | -0.005              | 0.071 | 0.150 | 0.934 | 1980-84              | 0.230               | 0.118               | 0.775 | 0.025 | 0.107 |
| 1985-89                    | 0.150               | -0.655              | 1.025 | 0.094 | 0.630 | 1985-89              | 0.150               | -0.380              | 0.647 | 0.110 | 0.732 |
| <b>Central</b>             |                     |                     |       |       |       | <b>East Siberia</b>  |                     |                     |       |       |       |
| Y                          | 0.6 <sup>L</sup> /Y | 0.4 <sup>K</sup> /Y | A/A   | A/Y   |       | Y                    | 0.6 <sup>L</sup> /Y | 0.4 <sup>K</sup> /Y | A/A   | A/Y   |       |
| 1970-79                    | 0.633               | 0.056               | 0.418 | 0.333 | 0.525 | 1970-79              | 0.806               | 0.121               | 0.345 | 0.431 | 0.535 |
| 1980-84                    | 0.154               | -0.060              | 0.497 | 0.087 | 0.564 | 1980-84              | 0.178               | 0.119               | 0.208 | 0.120 | 0.673 |
| 1985-89                    | 0.150               | -0.569              | 0.755 | 0.122 | 0.813 | 1985-89              | 0.130               | -0.392              | 0.897 | 0.064 | 0.494 |
| <b>Volga-Vyatka</b>        |                     |                     |       |       |       | <b>North West</b>    |                     |                     |       |       |       |
| Y                          | 0.6 <sup>L</sup> /Y | 0.4 <sup>K</sup> /Y | A/A   | A/Y   |       | Y                    | 0.6 <sup>L</sup> /Y | 0.4 <sup>K</sup> /Y | A/A   | A/Y   |       |
| 1970-79                    | 0.800               | 0.101               | 0.401 | 0.399 | 0.498 | 1970-79              | 0.667               | 0.147               | 0.488 | 0.243 | 0.364 |
| 1980-84                    | 0.238               | 0.031               | 0.376 | 0.141 | 0.593 | 1980-84              | 0.198               | 0.142               | 0.410 | 0.088 | 0.447 |
| 1985-89                    | 0.160               | -0.311              | 0.767 | 0.087 | 0.543 | 1985-89              | 0.120               | -0.319              | 1.086 | 0.028 | 0.232 |
| <b>Central Black Earth</b> |                     |                     |       |       |       |                      |                     |                     |       |       |       |
| Y                          | 0.6 <sup>L</sup> /Y | 0.4 <sup>K</sup> /Y | A/A   | A/Y   |       |                      |                     |                     |       |       |       |
| 1970-79                    | 0.812               | 0.187               | 0.332 | 0.390 | 0.481 |                      |                     |                     |       |       |       |
| 1980-84                    | 0.258               | 0.091               | 0.469 | 0.114 | 0.440 |                      |                     |                     |       |       |       |
| 1985-89                    | 0.200               | -0.212              | 0.458 | 0.151 | 0.753 |                      |                     |                     |       |       |       |
| <b>Volga</b>               |                     |                     |       |       |       |                      |                     |                     |       |       |       |
| Y                          | 0.6 <sup>L</sup> /Y | 0.4 <sup>K</sup> /Y | A/A   | A/Y   |       |                      |                     |                     |       |       |       |
| 1970-79                    | 0.920               | 0.136               | 0.180 | 0.629 | 0.684 |                      |                     |                     |       |       |       |
| 1980-84                    | 0.190               | 0.088               | 0.382 | 0.101 | 0.531 |                      |                     |                     |       |       |       |
| 1985-89                    | 0.140               | -0.386              | 0.657 | 0.102 | 0.729 |                      |                     |                     |       |       |       |
| <b>North Caucasus</b>      |                     |                     |       |       |       |                      |                     |                     |       |       |       |
| Y                          | 0.6 <sup>L</sup> /Y | 0.4 <sup>K</sup> /Y | A/A   | A/Y   |       |                      |                     |                     |       |       |       |
| 1970-79                    | 0.648               | 0.191               | 0.350 | 0.297 | 0.459 |                      |                     |                     |       |       |       |
| 1980-84                    | 0.166               | 0.122               | 0.103 | 0.129 | 0.775 |                      |                     |                     |       |       |       |
| 1985-89                    | 0.170               | -0.301              | 0.733 | 0.097 | 0.568 |                      |                     |                     |       |       |       |
| <b>Ural</b>                |                     |                     |       |       |       |                      |                     |                     |       |       |       |
| Y                          | 0.6 <sup>L</sup> /Y | 0.4 <sup>K</sup> /Y | A/A   | A/Y   |       |                      |                     |                     |       |       |       |
| 1970-79                    | 0.727               | 0.083               | 0.340 | 0.420 | 0.577 |                      |                     |                     |       |       |       |
| 1980-84                    | 0.161               | 0.028               | 0.365 | 0.098 | 0.608 |                      |                     |                     |       |       |       |
| 1985-89                    | 0.090               | -0.859              | 1.193 | 0.060 | 0.666 |                      |                     |                     |       |       |       |

\* : regions showing highest per capita industrial output in 1985