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## Growth in Russia's federal districts, 1994–2003

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Russian macroeconomic growth in the transition era is analysed across federal districts using a neoclassical production function often found in studies of Soviet-era economic growth. An adjusted capital stock series for Russian regions is created and used in the aggregate production function for 1995–2003 to analyse growth across the 11 federal districts in Russia. Federal district output growth is found to be explained well by neoclassical growth theory, indicating that poorer regions may converge to richer regions, thereby strengthening the Russian Federation. Federal districts also have high capital/labour ratios, suggesting that expanded regional domestic and foreign investment across Russia in the future will enhance growth.

While economic growth in the former Soviet Union (FSU) was often measured using Solow's standard growth accounting framework, the growth of the individual 15 former Soviet republics was analysed to a much lesser degree. With the collapse of the Soviet Union, studies of the 15 newly independent former republics have increased but rarely use the production function framework employed to measure Soviet economic growth with few exceptions (e.g. Kushnirsky 2001). Recent work by Izyumov and Vahaly (2008) expands this literature and provides an adjusted capital stock series for each of the 15 former Soviet republics for 1991–2005 in the spirit of 'adjusted' net national product series developed by Bergson (e.g. Bergson 1989) and others during the Soviet era. Their work also adds to aggregate capital stock estimates used to compare market and planned economies (Moroney and Lovell 1997) as well as many countries with their institutions (Adkins *et al.* 2002). While some scholars believe the lack of regional capital stock data requires other methods to examine regional growth in a transition country (e.g. Ahrend 2005, 2008), adjusted regional capital stock data exist for large transition economies such as China (Wang and Szirmai 2008) and have been found to be useful in examining regional growth there (e.g. Perkins and Rawski 2008). Though analysis of Russia's regions has considered shock therapy vs. gradualism (Popov 2000, 2007) and inequality (Dolinskaya 2002, Solanko 2008), a production function approach to regional growth has been hampered by the lack of regional aggregate capital stock series, which is a problem not unique to Russia.

The purpose of this article is to create an adjusted capital stock series for Russia's regions and to examine federal district economic growth using the production function method that has been used for decades at the Russian national/republic level (Weitzman

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1970, Bairam 1987), single regions and raiony (e.g. Brock 1993, 2002) and even within a single city (Brock 1995) in the FSU.

Administrative areas above the level of the 89 ‘subjects of the federation’ or simply ‘regions’ have a long history in Russia. Khrushchev implemented a *sovnrarkhoz* reform in the late 1950s in an attempt to go around the vertical line ministries by empowering some regions more than others. With his ouster, regions (*oblasti, kraya, republics*) lost importance until the late 1990s when presidential representatives were assigned to oversee federal districts (FD), in part to better control elected regional governors who had increased regional power. Until recently, Russian statistical handbooks divided Russia into these 11 federal districts – North, North-west, Centre, Volga-Vyatka, Central Black Earth, Volga, North Caucasus, Urals, West Siberia, East Siberia and Far East. Cut off from the rest of Russia, Kaliningrad *oblast’* is listed separately but placed in the North-west district. These federal districts were merged again for political reasons into seven federal *okruga* by President Putin, though by now the regional governor issue is resolved by appointing rather than allowing elections for the post. We will use the older, 11 districts plus Kaliningrad division as this allows historical comparison and more detail.

When the adjusted regional capital stock data are aggregated at the FD level and compared with Soviet era data on FD capital stocks over a 30 year period, the FD capital shares remain fairly constant except for two shifts toward energy rich Western Siberia, in the late 1970s and around 2000 (Table 1).<sup>1</sup> Despite foreign direct investment (FDI) and domestic investment, the FD capital stock shares’ consistency suggests that the Soviet-era macro economy has not fundamentally restructured away from energy sector-led growth.

Table 1. Regional capital stock shares.

| Eral district       | 1972  | 1985  | 1990  | 1991  | 1992  | 1993  | 1994  | 1995  |
|---------------------|-------|-------|-------|-------|-------|-------|-------|-------|
| North-west          | 11.1% | 11.2% | 10.9% | 10.9% | 10.8% | 11.2% | 10.3% | 9.6%  |
| Centre              | 17.0% | 18.2% | 17.7% | 17.6% | 17.5% | 18.5% | 16.7% | 15.1% |
| Volga-Vyatka        | 4.5%  | 4.9%  | 4.9%  | 4.9%  | 4.6%  | 4.4%  | 4.6%  | 4.4%  |
| Central Black Earth | 4.1%  | 4.9%  | 4.7%  | 4.7%  | 4.9%  | 4.6%  | 5.4%  | 4.2%  |
| Volga               | 16.7% | 11.6% | 11.4% | 11.4% | 10.9% | 10.8% | 10.8% | 11.8% |
| North Caucasus      | 7.1%  | 8.4%  | 8.3%  | 7.9%  | 7.9%  | 7.7%  | 7.5%  | 4.8%  |
| Urals               | 15.7% | 13.7% | 13.4% | 13.2% | 13.3% | 13.3% | 13.5% | 16.8% |
| West Siberia        | 9.7%  | 12.3% | 14.4% | 14.7% | 15.7% | 15.2% | 16.6% | 17.8% |
| East Siberia        | 8.1%  | 7.1%  | 7.0%  | 6.9%  | 6.8%  | 6.5%  | 7.5%  | 8.7%  |
| Far East            | 6.1%  | 7.3%  | 7.5%  | 7.3%  | 7.0%  | 7.1%  | 6.7%  | 6.4%  |
|                     | 1996  | 1997  | 1998  | 1999  | 2000  | 2001  | 2002  | 2003  |
| North-west          | 10.8% | 10.4% | 10.4% | 10.6% | 10.2% | 9.7%  | 10.2% | 10.7% |
| Centre              | 18.7% | 19.2% | 20.5% | 21.4% | 20.4% | 19.9% | 19.6% | 21.9% |
| Volga-Vyatka        | 4.7%  | 4.7%  | 4.7%  | 4.7%  | 4.4%  | 4.1%  | 4.3%  | 4.0%  |
| Central Black Earth | 5.3%  | 5.0%  | 4.9%  | 4.9%  | 4.6%  | 4.3%  | 4.2%  | 4.0%  |
| Volga               | 11.6% | 11.0% | 11.1% | 11.1% | 11.1% | 10.5% | 10.7% | 10.6% |
| North Caucasus      | 7.5%  | 8.2%  | 8.0%  | 7.7%  | 8.2%  | 7.7%  | 7.4%  | 7.0%  |
| Urals               | 13.9% | 13.7% | 13.4% | 13.6% | 13.5% | 13.2% | 13.2% | 12.5% |
| West Siberia        | 13.9% | 14.0% | 14.6% | 13.1% | 14.7% | 18.3% | 18.8% | 17.5% |
| East Siberia        | 6.9%  | 7.0%  | 6.8%  | 6.5%  | 6.2%  | 6.0%  | 6.1%  | 5.7%  |
| Far East            | 6.8%  | 6.7%  | 6.1%  | 6.5%  | 6.6%  | 6.2%  | 5.7%  | 5.9%  |

Note: No estimate for Kaliningrad *oblast’* capital stock is available for 1972 so this region is excluded. In this table the North-west FD includes the North FD.

Sources: Gillula (19981, p. 18), Regions of Russia, Goskomstat (various years).

99 These data support the idea that there was and perhaps still is little overall  
100 technological progress in the Russian economy, perhaps owing to institutional factors  
101 locked in from the planned economy era (e.g. Narula and Jormanainen 2008) or simply  
102 procrastination because of temporarily high energy prices until very recently.

103 The first section describes the input/output data. Next we outline the production  
104 function methods. Then we discuss the results. The final section concludes.

### 106 The data

107  
108 The capital stock series begins with the all-Russia capital stock series presented in Izyumov  
109 and Vahaly (2008). They adjust the official capital stock series for inflation and depreciation  
110 using investment flows. We take their annual adjusted all-Russia capital stock number in a  
111 given year and create region-by-region capital stock numbers for that year by using the  
112 official *oblast'* capital stock *shares* reported by Rosstat (Regionii Rossii various years) to  
113 approximate the true but unknown regional capital stock. A similar approach is adopted by  
114 Moroney (1990) at a more aggregate level for the USSR to adjust for inflation and  
115 depreciation in the series. The use of such an adjusted series is similar to the US experience,  
116 where capital stock series for individual states also require various assumptions and  
117 adjustments as no official series exist. Once the US series were developed, state level  
118 economic growth analysis using an aggregate production function was possible (e.g. Holtz-  
119 Eakin 1993, Crain and Lee 1999, Mulligan and Sala-i-Martin 2000, Sharma *et al.* 2007).  
120 Derived physical capital stock data are also used in the general economic growth literature  
121 with a relatively new series for countries developed by Dhareshwar and Nehru (1993) being  
122 widely cited (e.g. Benhabib and Spiegel 1997).

123 Unlike these country studies, a region by region capital stock series for Russia needs  
124 only to be calculated back to 1994 as regional output series for Russia (gross regional  
125 product, GRP) are available only from 1994.<sup>2</sup> The GRP data series are adjusted for  
126 inflation using the official regional consumer price index series which, because of Soviet-  
127 era pricing controls, is also available only back to the early 1990s. The labour input is the  
128 number of economically active workers series found in the regional data handbooks of  
129 Roskomstat. The three series can then be used as inputs and output in a traditional  
130 production function analysis.

131 As regional output growth in the transition era has been well studied (e.g. Popov 2000),  
132 along with the impact of the declining population and labour force (e.g. Andrienko and  
133 Guriev 2004), we focus immediately on describing regional (*oblast'*) capital stock growth.  
134 Dividing the overall time period (1995–2003) into an early (1995–98) and a late (1999–  
135 2003) period separates the data at the natural break of the 1998 financial crisis. Capital  
136 stock growth was generally negative in both shorter periods as well as overall across  
137 federal districts and the nation (Table 2). The North, North-west, Volga-Vyatka, Central  
138 Black Earth, Volga, Urals, East Siberia and Far East FDs and Kaliningrad *oblast'* had  
139 consistently negative growth. The Centre, North Caucasus and West Siberia FDs had at  
140 least one period with positive growth, but only the Centre had positive growth overall.  
141 These descriptive results are not surprising given that the Centre includes Moscow city and  
142 Moscow *oblast'*, which received most foreign and domestic investment during this period.  
143 Only these two regions have consistently positive capital stock growth. West Siberia and  
144 to a lesser extent the North Caucasus are important militarily and with energy resources,  
145 which are the two biggest investment sectors. The Tyumen region swings from negative to  
146 positive by a huge 20%, reflecting the immense importance of the oil and gas industry in  
147 this large region. Interestingly, El'tsin's home region of Sverdlovsk has positive capital

Table 2. Average annual growth of capital, labour and output, 1995–2003.

|                      | Capital stock |           |           |         |           | Labour  |           |           |         |           | Output (GRP) |           |           |  |  |
|----------------------|---------------|-----------|-----------|---------|-----------|---------|-----------|-----------|---------|-----------|--------------|-----------|-----------|--|--|
|                      | 1995–98       | 1999–2003 | 1995–2003 | 1995–98 | 1999–2003 | 1995–98 | 1999–2003 | 1995–2003 | 1995–98 | 1999–2003 | 1995–98      | 1999–2003 | 1995–2003 |  |  |
|                      | <b>Russia</b> | -1.35     | -1.60     | -1.49   | -1.16     | 1.43    | 0.28      | 14.16     | 7.64    | 10.54     |              |           |           |  |  |
| <b>North</b>         | -3.63         | -0.99     | -2.16     | -2.22   | 0.10      | -0.93   | 10.14     | 5.52      | 7.57    |           |              |           |           |  |  |
| Karelia              | -5.87         | -3.32     | -4.46     | -0.94   | 0.01      | -0.41   | 5.06      | 7.63      | 6.49    |           |              |           |           |  |  |
| Komi                 | 0.94          | 0.23      | 0.55      | -3.51   | 0.04      | -1.54   | 12.31     | 2.85      | 7.06    |           |              |           |           |  |  |
| Arkhangelsk          | -1.89         | -0.24     | -0.97     | -2.10   | 0.34      | -0.75   | 9.96      | 8.46      | 9.13    |           |              |           |           |  |  |
| Vologda              | -6.15         | 0.47      | -2.47     | -0.92   | 0.62      | -0.06   | 9.78      | 10.28     | 10.06   |           |              |           |           |  |  |
| Murmansk             | -6.74         | -3.51     | -4.95     | -3.33   | -0.73     | -1.89   | 10.70     | -2.35     | 3.45    |           |              |           |           |  |  |
| <b>North-West</b>    | -0.47         | -1.13     | -0.84     | -1.05   | 1.35      | 0.28    | 17.60     | 8.44      | 12.51   |           |              |           |           |  |  |
| St Petersburg        | -0.91         | -0.52     | -0.69     | -1.24   | 1.60      | 0.34    | 18.87     | 7.94      | 12.80   |           |              |           |           |  |  |
| Leningrad            | 1.63          | -0.67     | 0.35      | -0.71   | 1.47      | 0.50    | 15.36     | 10.79     | 12.82   |           |              |           |           |  |  |
| Novgorod             | -3.86         | -2.26     | -2.97     | -0.12   | 0.50      | 0.23    | 17.17     | 6.44      | 11.21   |           |              |           |           |  |  |
| Pskov                | 0.04          | -5.73     | -3.16     | -1.49   | 0.21      | -0.55   | 9.76      | 9.24      | 9.47    |           |              |           |           |  |  |
| <b>Centre</b>        | 3.76          | -0.27     | 1.52      | -0.92   | 2.08      | 0.75    | 18.33     | 9.54      | 13.45   |           |              |           |           |  |  |
| Bryansk              | 4.59          | -9.00     | -2.96     | -1.69   | 0.71      | -0.36   | 6.77      | 4.25      | 5.37    |           |              |           |           |  |  |
| Vladimir             | 0.92          | -5.04     | -2.39     | -1.96   | 0.95      | -0.34   | 9.44      | 4.96      | 6.95    |           |              |           |           |  |  |
| Ivanovo              | -4.40         | -6.44     | -5.54     | -1.79   | -0.49     | -1.06   | 6.53      | 3.55      | 4.87    |           |              |           |           |  |  |
| Kaluga               | 3.08          | -5.24     | -1.54     | -1.95   | 1.65      | 0.05    | 6.52      | 7.49      | 7.06    |           |              |           |           |  |  |
| Kostroma             | 3.22          | -3.52     | -0.53     | -1.71   | 0.33      | -0.58   | 9.75      | 1.62      | 5.23    |           |              |           |           |  |  |
| Moscow               | 7.35          | 2.98      | 4.92      | 1.03    | 3.88      | 2.61    | 22.96     | 11.90     | 16.81   |           |              |           |           |  |  |
| <b>Moscow oblast</b> | 2.39          | 1.18      | 1.72      | -1.73   | 2.04      | 0.37    | 19.19     | 4.70      | 11.14   |           |              |           |           |  |  |
| Orel                 | -9.23         | -2.71     | -5.61     | -1.82   | 1.97      | 0.29    | 14.97     | 7.69      | 10.92   |           |              |           |           |  |  |
| Ryazan               | -0.38         | -1.46     | -0.98     | -2.78   | 0.88      | -0.75   | 4.60      | 7.06      | 5.97    |           |              |           |           |  |  |
| Smolensk             | -0.85         | -4.88     | -3.09     | -0.52   | 0.50      | 0.05    | 8.86      | 5.62      | 7.06    |           |              |           |           |  |  |
| Tver                 | 6.26          | -5.20     | -0.11     | -1.59   | 0.01      | -0.70   | 10.45     | 4.63      | 7.22    |           |              |           |           |  |  |
| Tula                 | -0.28         | -6.88     | -3.94     | -2.01   | -0.07     | -0.93   | 10.67     | 4.27      | 7.12    |           |              |           |           |  |  |
| Yaroslavl            | 3.71          | -2.49     | 0.26      | -2.34   | 1.54      | -0.19   | 8.08      | 6.22      | 7.05    |           |              |           |           |  |  |
| <b>Volga-Vyatka</b>  | -0.43         | -4.81     | -2.86     | -1.73   | 1.18      | -0.11   | 9.68      | 3.26      | 6.11    |           |              |           |           |  |  |
| Mary-El              | 2.47          | -7.98     | -3.34     | -2.95   | 2.26      | -0.05   | 10.11     | 2.33      | 5.79    |           |              |           |           |  |  |
| Mordva               | -0.15         | -1.35     | -0.82     | -2.82   | 1.02      | -0.69   | 16.24     | 2.82      | 8.78    |           |              |           |           |  |  |
| Chuvash              | -0.90         | -2.50     | -1.78     | -1.35   | 1.88      | 0.44    | 11.52     | 2.25      | 6.37    |           |              |           |           |  |  |



Table 2 – continued

|                     | Capital stock |              |              |              |             |              | Labour       |              |              | Output (GRP) |              |              |
|---------------------|---------------|--------------|--------------|--------------|-------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
|                     | 1995–98       | 1999–2003    | 1995–2003    | 1995–98      | 1999–2003   | 1995–2003    | 1995–98      | 1999–2003    | 1995–2003    | 1995–98      | 1999–2003    | 1995–2003    |
|                     | Chelyabinsk   | -2.09        | -1.41        | -1.71        | -1.11       | 1.07         | 0.10         | 8.25         | 8.34         | 8.30         | 8.25         | 8.34         |
| <b>West Siberia</b> | <b>-4.56</b>  | <b>2.04</b>  | <b>-0.89</b> | <b>-1.11</b> | <b>1.26</b> | <b>0.20</b>  | <b>15.54</b> | <b>11.46</b> | <b>13.27</b> | <b>15.54</b> | <b>11.46</b> | <b>13.27</b> |
| Altai Rep           | 26.99         | -35.76       | -7.87        | -0.38        | 1.95        | 0.91         | 15.57        | 8.27         | 11.51        | 15.57        | 8.27         | 11.51        |
| Altai Krai          | -3.01         | -10.11       | -6.95        | -1.32        | 1.48        | 0.24         | 9.10         | 6.57         | 7.70         | 9.10         | 6.57         | 7.70         |
| Kemerovo            | 1.30          | -7.91        | -3.82        | -0.70        | 0.36        | -0.11        | 6.82         | 6.25         | 6.50         | 6.82         | 6.25         | 6.50         |
| Novosibirsk         | 1.64          | -5.56        | -2.36        | -1.19        | 1.13        | -0.19        | 11.41        | 10.45        | 10.88        | 11.41        | 10.45        | 10.88        |
| Omsk                | -0.68         | -8.40        | -4.97        | -1.09        | 0.52        | -0.10        | 13.09        | 7.99         | 10.26        | 13.09        | 7.99         | 10.26        |
| Tomsk               | -2.37         | -4.96        | -3.81        | -1.50        | 0.57        | -0.35        | 14.37        | 5.71         | 9.56         | 14.37        | 5.71         | 9.56         |
| Tyumen              | -10.58        | 10.54        | 1.15         | -1.20        | 2.55        | 0.88         | 20.51        | 14.03        | 16.91        | 20.51        | 14.03        | 16.91        |
| <b>East Siberia</b> | <b>-3.80</b>  | <b>-4.94</b> | <b>-4.43</b> | <b>-1.97</b> | <b>0.72</b> | <b>-0.48</b> | <b>11.15</b> | <b>2.58</b>  | <b>6.39</b>  | <b>11.15</b> | <b>2.58</b>  | <b>6.39</b>  |
| Buryatia            | -3.57         | -2.27        | -2.85        | -3.75        | 1.52        | -0.83        | 5.55         | 8.31         | 7.08         | 5.55         | 8.31         | 7.08         |
| Tuva                | -3.76         | -12.72       | -8.74        | -4.28        | 3.20        | -0.13        | 6.43         | 11.16        | 9.06         | 6.43         | 11.16        | 9.06         |
| Khakasia            | -3.53         | -4.18        | -3.89        | -3.11        | 2.62        | 0.08         | 7.55         | 3.68         | 5.40         | 7.55         | 3.68         | 5.40         |
| Krasnoyarsk         | -1.90         | -7.00        | -4.73        | -0.10        | -0.28       | -0.20        | 13.29        | 0.05         | 5.93         | 13.29        | 0.05         | 5.93         |
| Irkutsk             | -5.48         | -5.21        | -5.33        | -2.97        | 1.60        | -0.43        | 12.38        | 2.87         | 7.10         | 12.38        | 2.87         | 7.10         |
| Chita               | -5.70         | 1.16         | -1.89        | -2.47        | -0.56       | -1.41        | 5.24         | 5.52         | 5.40         | 5.24         | 5.52         | 5.40         |
| <b>Far East</b>     | <b>-3.59</b>  | <b>-2.22</b> | <b>-2.83</b> | <b>-2.99</b> | <b>0.05</b> | <b>-1.30</b> | <b>12.83</b> | <b>5.48</b>  | <b>8.74</b>  | <b>12.83</b> | <b>5.48</b>  | <b>8.74</b>  |
| Sakha               | 3.84          | -1.85        | 0.68         | -3.08        | -0.11       | -1.43        | 12.55        | 9.51         | 10.86        | 12.55        | 9.51         | 10.86        |
| Jewish              | -10.47        | -1.62        | -5.55        | -4.03        | 0.33        | -1.61        | -1.36        | 11.45        | 5.75         | -1.36        | 11.45        | 5.75         |
| Primorskii          | -13.78        | 2.05         | -4.99        | -1.75        | -0.05       | -0.81        | 12.93        | 6.25         | 9.22         | 12.93        | 6.25         | 9.22         |
| Khabarovsk          | 4.21          | -1.40        | 1.09         | -3.09        | 1.00        | -0.82        | 17.24        | 1.78         | 8.65         | 17.24        | 1.78         | 8.65         |
| Amur                | -1.04         | -0.46        | -0.72        | -1.80        | -0.51       | -1.09        | 7.24         | 5.73         | 6.40         | 7.24         | 5.73         | 6.40         |
| Kamchatka           | -5.69         | -9.06        | -7.52        | -4.03        | 0.10        | -1.74        | 16.52        | -6.03        | 4.00         | 16.52        | -6.03        | 4.00         |
| Magadan             | -5.69         | -11.54       | -8.94        | -6.21        | -3.04       | -4.45        | 8.92         | 4.69         | 6.57         | 8.92         | 4.69         | 6.57         |
| Sakhalin            | -5.44         | -6.38        | -5.96        | -6.24        | 0.38        | -2.56        | 10.73        | 9.06         | 9.80         | 10.73        | 9.06         | 9.80         |
| Kaliningrad         | -7.50         | -0.59        | -3.66        | 0.59         | 1.05        | 0.84         | 8.51         | 11.93        | 10.41        | 8.51         | 11.93        | 10.41        |



295 stock growth while he is president (early period) but swings negative in the early Putin era  
 296 (1999–2003). A few regions known for more extensive reforms, such as Yaroslavl and  
 297 Samara, behave somewhat differently from the FD of which they are a part, but these are  
 298 exceptions. The lack of growth in the Russian capital stock can be expected to have long-  
 299 term consequences for productivity and economic growth. Economic growth can be  
 300 analysed using the Solow neoclassical model recently applied by Izyumov and Vahaly  
 301 (2008).

### 303 Methods

304 The method used to analyse growth has two parts. First, a non-statistical Cobb–Douglas  
 305 production function is assumed with ‘ $a$ ’ as the capital share and ‘ $1 - a$ ’ being the labour  
 306 share;  $dY/Y$ ,  $dK/K$  and  $dL/L$  are the average annual growth rates of output, capital and  
 307 labour and  $dA/A$  is the average annual growth rate of total factor productivity (TFP). The  
 308 capital share is assumed to be 0.4 with a sensitivity test done by adjusting the share to 0.3.  
 309

$$310 \quad dY/Y = a^*dK/K + (1 - a)^*dL/L + dA/A \quad (1)$$

311  
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 314 The production function is used by grouping the regions into the 11 FDs found until  
 315 recently in regional statistical handbooks. This first part follows the same method as  
 316 Izyumov and Vahaly (2008) and is simply computational, requiring no regressions. The  
 317 0.4 capital share is commonly found in studies of developing countries as a reasonable  
 318 estimate of capital’s contribution to growth.

319 The second part is to apply a statistical Cobb–Douglas production function to these  
 320 same data using Solow’s standard formulation.<sup>3</sup> The production function is

$$321 \quad \text{Ln}(Y/L)_{it} = a_{it} + b_{it}\text{Trend} + c_{it}\text{Ln}(K/L)_{it} + e_{it} \quad (2)$$

322  
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 325 A panel production function is estimated with all ‘ $i$ ’ regions and ‘ $t$ ’ years for each FD  
 326 separately. ‘Ln’ is natural logarithm and ‘ $e$ ’ is a classical error term corrected for  
 327 heteroskedasticity using White’s standard correction. Within some FDs dummy variables  
 328 are used for a few exceptional regions. These are in the, North-west, City of St Petersburg  
 329 (the second city) and Kaliningrad (isolated from the rest of Russia); in the Centre, Moscow  
 330 city (the first city and the region receiving most FDI in Russia) and Moscow city and  
 331 Moscow *oblast*’ together (a greater Moscow dummy reflecting the fact that the two regions  
 332 are closely linked); and in West Siberia, Tyumen (large size and energy resources). This  
 333 second part of the analysis uses only the full time period 1995–2003 to capture the most  
 334 variation with the sample size similar to that in such studies as Weitzman (1970) and  
 335 Moroney (1990). Technological progress or intensive growth is represented by the trend  
 336 term, which is expected to be insignificant, reflecting the inability of Russia to achieve  
 337 high, intensive economic growth despite reforms. Each of these FDs contains enough  
 338 pooled regional data to have a large sample as the transition period is still too short to  
 339 permit a region by region analysis using time series only. As most regions are similar to  
 340 others culturally and institutionally, dummy variables are used instead of a more complex  
 341 institutional difference index more appropriate to comparing across countries. No other  
 342 studies that treat the federal district as the core unit of analysis could be found in the  
 343 English language literature.

Table 3. Contributions to economic growth in federal districts of Russia, 1995–2003.

|                            | Output growth |           |           | Capital growth |           |           |
|----------------------------|---------------|-----------|-----------|----------------|-----------|-----------|
|                            | 1995–98       | 1999–2003 | 1995–2003 | 1995–1998      | 1999–2003 | 1995–2003 |
| Russia                     | 14.16         | 7.64      | 10.54     | -1.35          | -1.60     | -1.49     |
| North                      | 10.14         | 5.52      | 7.57      | -3.63          | -0.99     | -2.16     |
| North-West                 | 17.60         | 8.44      | 12.51     | -0.47          | -1.13     | -0.84     |
| Centre                     | 18.33         | 9.54      | 13.45     | 3.76           | -0.27     | 1.52      |
| Volga-Vyatka               | 9.68          | 3.26      | 6.11      | -0.43          | -4.81     | -2.86     |
| C Black Earth              | 10.72         | 7.75      | 9.07      | -3.53          | -5.54     | -4.65     |
| Volga                      | 13.08         | 5.60      | 8.93      | -0.56          | -2.67     | -1.73     |
| North Caucasus             | 14.38         | 6.70      | 10.11     | 0.24           | -4.18     | -2.22     |
| Urals                      | 10.77         | 5.34      | 7.75      | -1.54          | -2.91     | -2.30     |
| West Siberia               | 15.54         | 11.46     | 13.27     | -4.56          | 2.04      | -0.89     |
| East Siberia               | 11.15         | 2.58      | 6.39      | -3.80          | -4.94     | -4.43     |
| Far East                   | 12.83         | 5.48      | 8.74      | -3.59          | -2.22     | -2.83     |
| Kaliningrad <i>oblast'</i> | 8.51          | 11.93     | 10.41     | -7.50          | -0.59     | -3.66     |

  

|                            | Labour growth |           |           | TFP growth (capital share = 0.4) |           |           |
|----------------------------|---------------|-----------|-----------|----------------------------------|-----------|-----------|
|                            | 1995–1998     | 1999–2003 | 1995–2003 | 1995–1998                        | 1999–2003 | 1995–2003 |
| Russia                     | -1.16         | 1.43      | 0.28      | 15.39                            | 7.42      | 10.96     |
| North                      | -2.22         | 0.10      | -0.93     | 12.93                            | 5.86      | 9.00      |
| North-West                 | -1.05         | 1.35      | 0.28      | 18.42                            | 8.08      | 12.68     |
| Centre                     | -0.92         | 2.08      | 0.75      | 17.38                            | 8.40      | 12.39     |
| Volga-Vyatka               | -1.73         | 1.18      | -0.11     | 10.89                            | 4.47      | 7.33      |
| Central Black Earth        | -1.85         | 1.63      | 0.08      | 13.24                            | 8.98      | 10.88     |
| Volga                      | -1.18         | 1.04      | 0.05      | 14.01                            | 6.05      | 9.59      |
| North Caucasus             | -0.71         | 2.59      | 1.12      | 14.70                            | 6.82      | 10.32     |
| Urals                      | -1.23         | 1.18      | 0.11      | 12.13                            | 5.79      | 8.61      |
| West Siberia               | -1.11         | 1.26      | 0.20      | 18.04                            | 9.89      | 13.51     |
| East Siberia               | -1.97         | 0.72      | -0.48     | 13.85                            | 4.12      | 8.45      |
| Far East                   | -2.99         | 0.05      | -1.30     | 16.06                            | 6.33      | 10.65     |
| Kaliningrad <i>oblast'</i> | 0.59          | 1.05      | 0.84      | 11.16                            | 11.54     | 11.37     |

## Results

Real output growth was positive across FDs as the economy recovered from an initial slump in output following the collapse of the USSR (Table 3). Output also dipped during the 1998 recession across FDs but recovered strongly thereafter. The capital stock declined in almost all FDs while labour declined in the early period but then showed mostly positive growth in the later period. Growth results using the computational method that forces the capital stock share to be equal to 0.4 indicate that capital never contributed to growth except in the Centre, North Caucasus and West Siberia FDs (Table 4).<sup>4</sup> Capital growth in the Centre was strong enough to yield a positive contribution throughout the entire period 1995–2003. North Caucasus capital stock growth in the early period and West Siberia capital stock growth in the latter period were not sufficient to prevent negative growth overall. Labour's contribution (with a 0.6 weight) switches from negative to positive over the two shorter periods leading to a mixed impact for the overall period.

Somewhat unexpectedly, the dominant factor in output growth appears to be total factor productivity (TFP) during the transition period, suggesting intensive rather than extensive growth. While a similar result across FSU republics was found by Izyumov and Vahaly (2008) we do not accept their idea that this represents improving capital quality that is somehow not captured in the capital stock data. A more cautious view of TFP recalls that Solow's famous 'A' term has also been interpreted as a measure of what we do not know or cannot explicitly measure. TFP is best interpreted here as a measure of institutional changes and reforms that enabled the economy to grow after the initial shock therapy. Regional growth also became labour-extensive in the later period but with little improvement in technology and the capital stock in most regions. The growth results must be tempered with two known features of the output. First, some of the output was still 'value subtracting' as firms continued to produce output inefficiently as they had during the Soviet era. Second, low energy prices caused the energy sector to overproduce to maintain revenue in a period of declining world prices. A statistical production function now allows us to relax the fixed capital share of 0.4 to see whether the results are sensitive to the computational approach.

The statistical production function results support the computational results (Table 5). Except for the relatively backward Volga-Vyatka FD, technological progress represented by the trend term is positive and significant, supporting the first method's result of factors other than capital and labour causing growth. All dummy variables had the expected positive sign given that these regions are exceptional, though Kaliningrad's coefficient is insignificant, suggesting that being physically cut off from the rest of Russia has had no impact on economic growth there.<sup>5</sup> Great variation is found in how well the production function fits a FD, with adjusted *R*-squares ranging from 0.1 to 0.82.

Setting aside the outlying result for the Volga-Vyatka FD with a low *R*-squared and negative capital/labour (*K/L*) coefficient, the *K/L* ratio is always positive and significant as well except for West Siberia FD. A reversal of the negative capital stock growth rates found in most FDs would increase output. Most regions would benefit from additional investment to achieve larger capital stocks. Russia needs to expand domestic and foreign investment outside the greater Moscow area more to improve growth. A neoclassical production function is a useful method in understanding FD growth and fits some of the most important FDs (Centre and West Siberia) that have been the recent engines of Russian economic growth quite well.

Table 4. Contributions to economic growth in federal districts of Russia, 1995–2003.

| Capital share = 0.4 | 1995–1998                   |                            |                         | 1995–2003                   |                            |                         | 1995–2003                   |                            |                         |
|---------------------|-----------------------------|----------------------------|-------------------------|-----------------------------|----------------------------|-------------------------|-----------------------------|----------------------------|-------------------------|
|                     | Contribution of capital (%) | Contribution of labour (%) | Contribution of TFP (%) | Contribution of capital (%) | Contribution of labour (%) | Contribution of TFP (%) | Contribution of capital (%) | Contribution of labour (%) | Contribution of TFP (%) |
| Russia              | -4                          | -5                         | 109                     | -8                          | 11                         | 97                      | -6                          | 2                          | 104                     |
| North               | -14                         | -13                        | 127                     | -7                          | 1                          | 106                     | -11                         | -7                         | 119                     |
| North-West          | -1                          | -4                         | 105                     | -5                          | 10                         | 96                      | -3                          | 1                          | 101                     |
| Centre              | 8                           | -3                         | 95                      | -1                          | 13                         | 88                      | 5                           | 3                          | 92                      |
| Volga-              | -2                          | -11                        | 113                     | -59                         | 22                         | 137                     | -19                         | -1                         | 120                     |
| Vyatka              |                             |                            |                         |                             |                            |                         |                             |                            |                         |
| Central             | -13                         | -10                        | 124                     | -29                         | 13                         | 116                     | -21                         | 1                          | 120                     |
| Black Earth         |                             |                            |                         |                             |                            |                         |                             |                            |                         |
| Volga               | -2                          | -5                         | 107                     | -19                         | 11                         | 108                     | -8                          | 0                          | 107                     |
| North               | 1                           | -3                         | 102                     | -25                         | 23                         | 102                     | -9                          | 7                          | 102                     |
| Caucasus            |                             |                            |                         |                             |                            |                         |                             |                            |                         |
| Urals               | -6                          | -7                         | 113                     | -22                         | 13                         | 109                     | -12                         | -1                         | 111                     |
| West                | -12                         | -4                         | 116                     | 7                           | 7                          | 86                      | -3                          | 1                          | 102                     |
| Siberia             |                             |                            |                         |                             |                            |                         |                             |                            |                         |
| East Siberia        | -14                         | -11                        | 124                     | -77                         | 17                         | 160                     | -28                         | -4                         | 132                     |
| Far East            | -11                         | -14                        | 125                     | -16                         | 1                          | 116                     | -13                         | -9                         | 122                     |
| Kaliningrad         | -35                         | 4                          | 131                     | -2                          | 5                          | 97                      | -14                         | 5                          | 109                     |

*oblast'*

Table 5. Federal district panel production function results, 1995–2003.

|                | Intercept              | Trend                | Redgum1          | Redgum2         | Log(K/L)             | Adj. R-sq. |
|----------------|------------------------|----------------------|------------------|-----------------|----------------------|------------|
| North          | ** - 91.06 (-4.7769)   | **0.048 (5.053)      |                  |                 | *0.495 (4.1423)      | 0.36       |
| North-West     | ** - 152.376 (-8.5925) | **0.079 (8.704)      | 0.0718 (0.638)   | **0.511 (7.428) | *0.582 (2.517)       | 0.69       |
| Centre         | ** - 83.559 (-6.383)   | **0.0447 (6.742)     | **1.156 (15.917) |                 | **0.598 (5.937)      | 0.82       |
| Volga-Vyatka   | ** - 81.752 (-2.206)   | * - 0.0402 (-2.1376) |                  |                 | ** - 0.7045 (-3.072) | 0.1        |
| C. Black Earth | ** - 142.814 (-3.6734) | **0.0751 (3.783)     |                  |                 | **1.0289 (3.629)     | 0.24       |
| Volga          | ** - 171.263 (-5.9227) | **0.0905 (6.184)     |                  |                 | **1.775 (9.246)      | 0.5        |
| North Caucasus | ** - 94.9299 (-3.186)  | **0.0503 (3.327)     |                  |                 | **0.593 (3.245)      | 0.16       |
| Urals          | ** - 78.435 (-3.937)   | **0.0432 (4.294)     |                  |                 | **1.197 (5.68)       | 0.27       |
| West Siberia   | ** - 65.311 (-2.638)   | **1.192 (3.703)      | **0.035 (2.818)  |                 | 0.325 (1.54)         | 0.81       |
| East Siberia   | ** - 109.917 (-4.392)  | **0.058 (4.641)      |                  |                 | **0.883 (6.404)      | 0.56       |
| Far East       | ** - 139.996 (-4.402)  | **0.073 (4.599)      |                  |                 | **0.782 (7.983)      | 0.42       |

Notes: \*\* = 1%, \* = 5% significant.

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## Conclusions

Analysis of economic growth in the FSU using the former republics as the observational base can be extended within Russia by using the federal districts as the unit of observation. Neoclassical growth theory using a production function at the federal district level of aggregation reveals that growth of output following the initial shock therapy was widespread regionally. Adjusted capital stock series embedded in both a computational and a statistical production function indicate that many FDs would derive further output growth from increases in their capital stocks. With the current population decline likely to continue and any future in-migration by Russians from former Soviet republics being small, the capital labour ratio will continue to be quite high. Wide variation is found in production function coefficients at the FD level, suggesting more research is needed to examine intra-FD economic growth. As the neoclassical model appears to explain FD growth well, poorer FDs can catch up with richer ones over time with the convergence the neoclassical theory predicts. Questions such as the future role of FDI, how efficient economic growth is, and the interaction of existing human capital with labour and physical capital are left for further research.

## Notes

1. Official capital stock data could not be obtained for 2004 and 2005 at the time of this study. The regions of Chechnya and Ingushetia are never included.
2. Kushnirsky's (2001) estimates of capital stock suggest that it may be possible to use Soviet-era regional data to create a capital stock series for both the FD and even regions themselves using work by Kantorovich and others on Soviet-era capital stock. It also may be possible to build a measure of aggregate capital stock from microeconomic firm data which were unavailable to these authors (e.g. see Uzun (2008) for farm capital stock data). However, we leave these tasks for further research.
3. Most aggregate studies of planned economies (e.g. Moroney 1990) and other studies of market economies at this aggregate level defend the use of the Cobb–Douglas (CD) functional form which imposes constant returns as reasonable given that returns to scale arguably have little meaning at an aggregate level. We find these arguments compelling but also tested Bairam's (1987) variable returns production function as a sensitivity test as at least one aggregate study rejects the CD function in favour of a more general form (Adkins *et al.* 2002). Results, perhaps because of some multicollinearity, either yielded no evidence of variable returns or an unrealistic estimate of the  $K/L$  coefficient.
4. As in Izyumov and Vahaly (2008), changing the capital share to 0.3 does not change the results, so those results are not reported here.
5. The dummy variable results shown for the Centre FD are for the combined Moscow city and Moscow *oblast'* region. Moscow city only results are similar and available from the author.

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