Productivity growth and the transition to market in China and Russia

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Motivation

- Different ways to market economy in China and Russia.
- How the difference influenced their productivity growth?
- New developments in theory and application of the normalized CES function and the Bayesian statistical method.
  - Decomposition of the technology progress is possible.
  - Consideration of the elasticity of substitution (ES) is possible.
  - Easy to model structural breaks (time-varying parameters: TVP).
  - Fundamental difficulty to estimate.

Structure of the presentation

- New methods to estimate TFP
  - Normalized CES(NCES) function
  - Extended Solow residuals method
  - Bayesian TVP-NCES and Malkov Chain Monte Carlo (MCMC) simulation
- Data
- Results
- Discussion

New methods to estimate TFP
-Normalized CES production function

$$Y_t = Y_0 \left[\pi_0 \left(\frac{K_t}{K_0} G_K^t \right)^{\frac{\sigma-1}{\sigma}} + (1-\pi_0) \left(\frac{L_t}{L_0} G_L^t \right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

- Looks not very different from the ordinary CES function.

$$Y_t = A_t Y_0 \left[\pi_0 \left(\frac{K_t}{K_0} \right)^{\frac{\sigma-1}{\sigma}} + (1-\pi_0) \left(\frac{L_t}{L_0} \right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

New methods to estimate TFP
-Normalized CES production function

- The normalization is necessary:
  - to properly measure the ES. The elasticity is defined as a point elasticity; thus, we need to fix the point (the normalization benchmark) to measure the elasticity.
  - to fix a share parameter which serves as the benchmark to determine the type of technology progress.
- The normalized CES production function includes all types of technical progress: Hicks, Solow, and Harrod.
- The relation between ES and the economic growth: a low ES may slow economic growth. If a production factor increases faster than the others and the ES is low, the output grows less because the low ES accelerates decrease in marginal productivity.

New methods to estimate TFP
-Normalized CES production function

- NCES tends to give very low ESs.
  - OECD average = 0.34 (Mallick, Lab.Eco., 2012), Japan and Finland=around 0.2 (Not particularly low. Nakamura and Korhonen, 2013)
- Intuitive explanation for the low ES.
  - K can grow faster than L and, sometime, than Y. As NCES is to take a weighted average of K and L which fits to Y. It needs to smash the faster K growth.
  - A low ES is good to discount the faster growth of K: K^s (s<1). Otherwise, we should have very small (may be decreasing) G_K.

New methods to estimate TFP
-Normalized CES production function

- A fundamental difficulty of NCES

$$Y_t^s = \pi_K \left(G_K^t K_t\right)^s + \left(\pi_L\right)\left(G_L^t L_t\right)^s$$

Assuming $G_i^t = Y^t / i_t$ (i=K,L),

$$Y_t^s = \pi_K \left(Y_t / K_t \cdot K_t\right)^s + \left(\pi_L\right)\left(Y_t / L_t \cdot L_t\right)^s$$

$$= \pi_K Y_t^s + \pi_L Y_t^s = Y_t^s \; .$$

Thus, *Y/K* and *Y/L* are, argibically, perfect solutions with any *s*. It's OK, but s is unidentifiable without additional information.

New methods to estimate TFP
-Extended Solow residual method

- Use NCES anyway! TFP can be calculated:

$$\hat{Y}_t^s = \pi_K \left(Y_{t-1} / K_{t-1} \cdot K_t\right)^s + \left(\pi_L\right)\left(Y_{t-1} / L_{t-1} \cdot L_t\right)^s$$

$$TFP_t = Y_t^s / \hat{Y}_t^s - 1$$

- If s=1, this method is just the Slow residulas method [$\mathrm{TFP}_t(1)$]. We can calculate TFPt(σ) for a plausible range of σ, although we do not know the true σ.
- This may be called ’extended Solow residuals method.’

New methods to estimate TFP
-Bayesian TVP-NCES and MCMC

- The best way to estimate NCES seems to be 'the system method' to use $dY/di=w_i$ ($i=K$ and L).
- However, it is often difficult to obtain data on w_i for economies such as Russia and China.
- In this study, NCESs are estimated under some soft additional constraints:
  - G_i follows random walk: smoothing
  - Truncation of the G_i random walk distributions

New methods to estimate TFP
-Bayesian TVP-NCES and MCMC

$$Y_t^s = \pi_K \left(G_K^t K_t\right)^s + \left(\pi_L\right)\left(G_L^t L_t\right)^s + e_Y$$

$$\ln\left(G_i^t\right) = \ln\left(G_i^{t-1}\right) + e_{Gi}$$

$$s \sim N(\overline{s}, \tau_s)\mathrm{T}(LB, -0.1)$$

$$e_Y \sim N(0, \tau_Y)$$

$$e_{Gi} \sim N(0, \tau_{Gi})\mathrm{T}(LB, +\infty)$$

- R and JAGS were used for the Bayesian MCMC simulation.

Data
-China

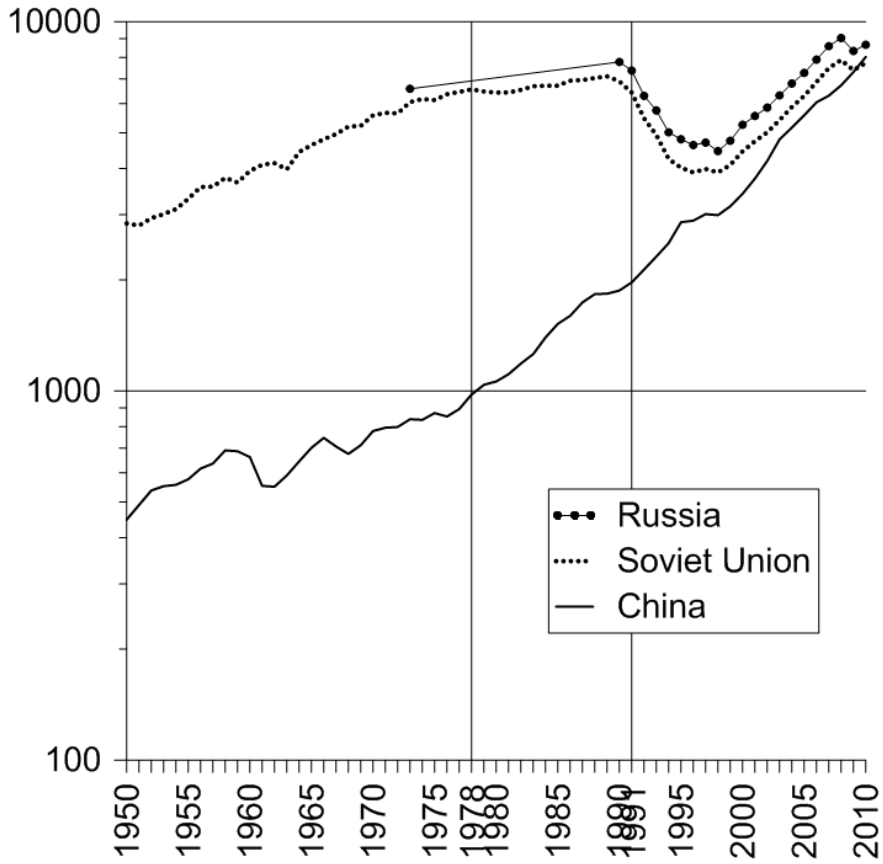
- Period: 1952-2011 annual.
- Y, K, L for 1952-2008: Wu(RIETI DP, 2011-E-003)
- Y and L are extended to 2011 with the official data.
- K for 2009-2011 are extended with the perpetual inventory method. The depreciation ratio follows Wu's. GFCF: UNSD, National Accounts Estimates of Main Aggregates. The deflator for GFCF is the property price index for investment in fixed assets.
- The share parameter: 2011 Regional accounting data.
- The normalisation base is 2011.

Data
-Russia

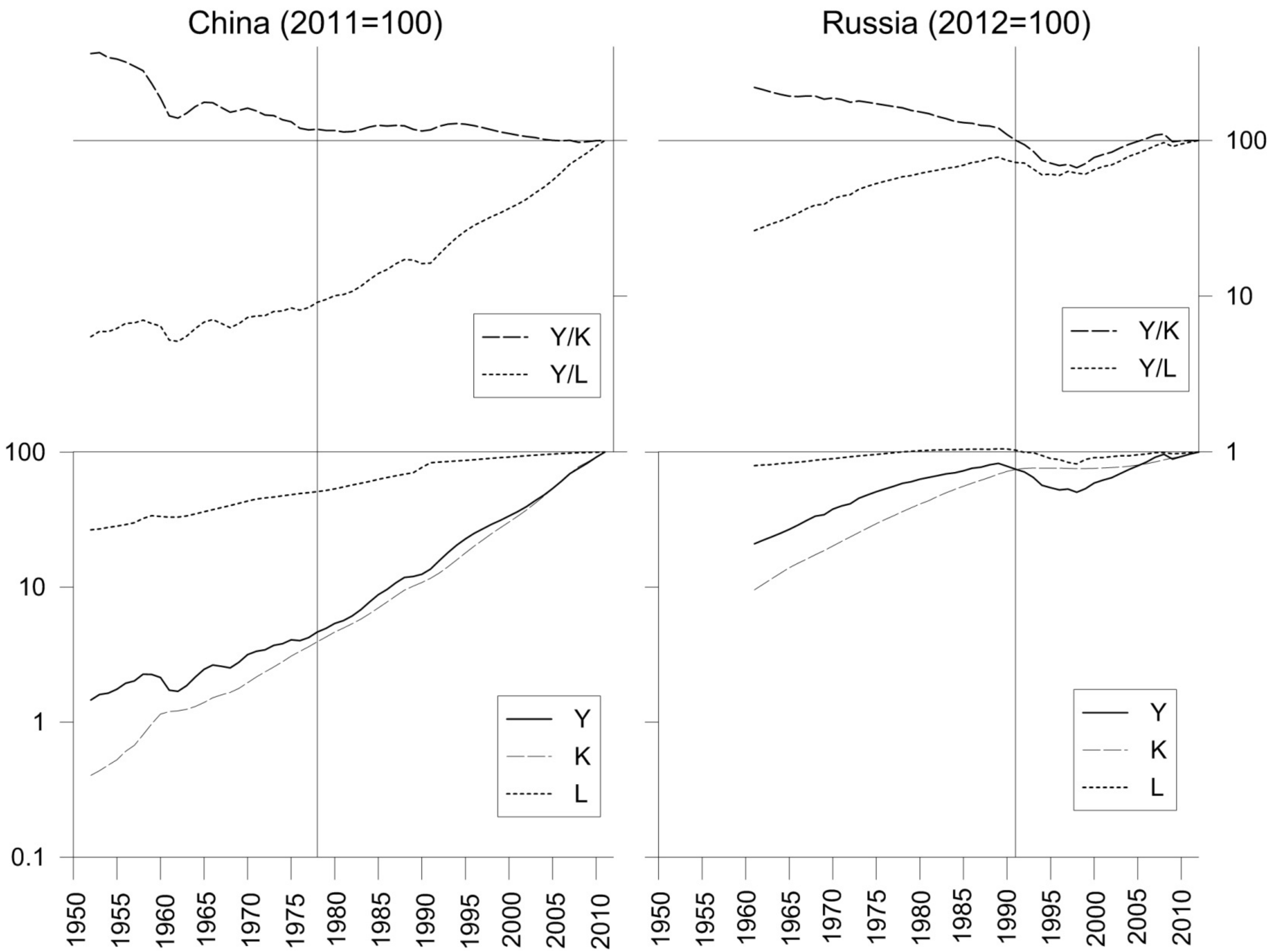
- Period: 1961-2012, annual.
- *Y*: GDP for 1961-2005 estimated by Kuboniwa and Ponmomalenko. 2005 and after: Official GDP.
- *L*: Official head count data.
- *K*: 1961-90: Official. 1990 and after: Official. Simply linked.
- Share parameter: 2011. Official national accoounting data. The Labor share=(Compensation of employees - indirect tax)/(GDP - indirect tax)
- The normlisation base is 2012.

Data
-The Benchmark year

- Russia 2012, China 2011.
- See Maddison's GDP per capita in the 1990 USD.

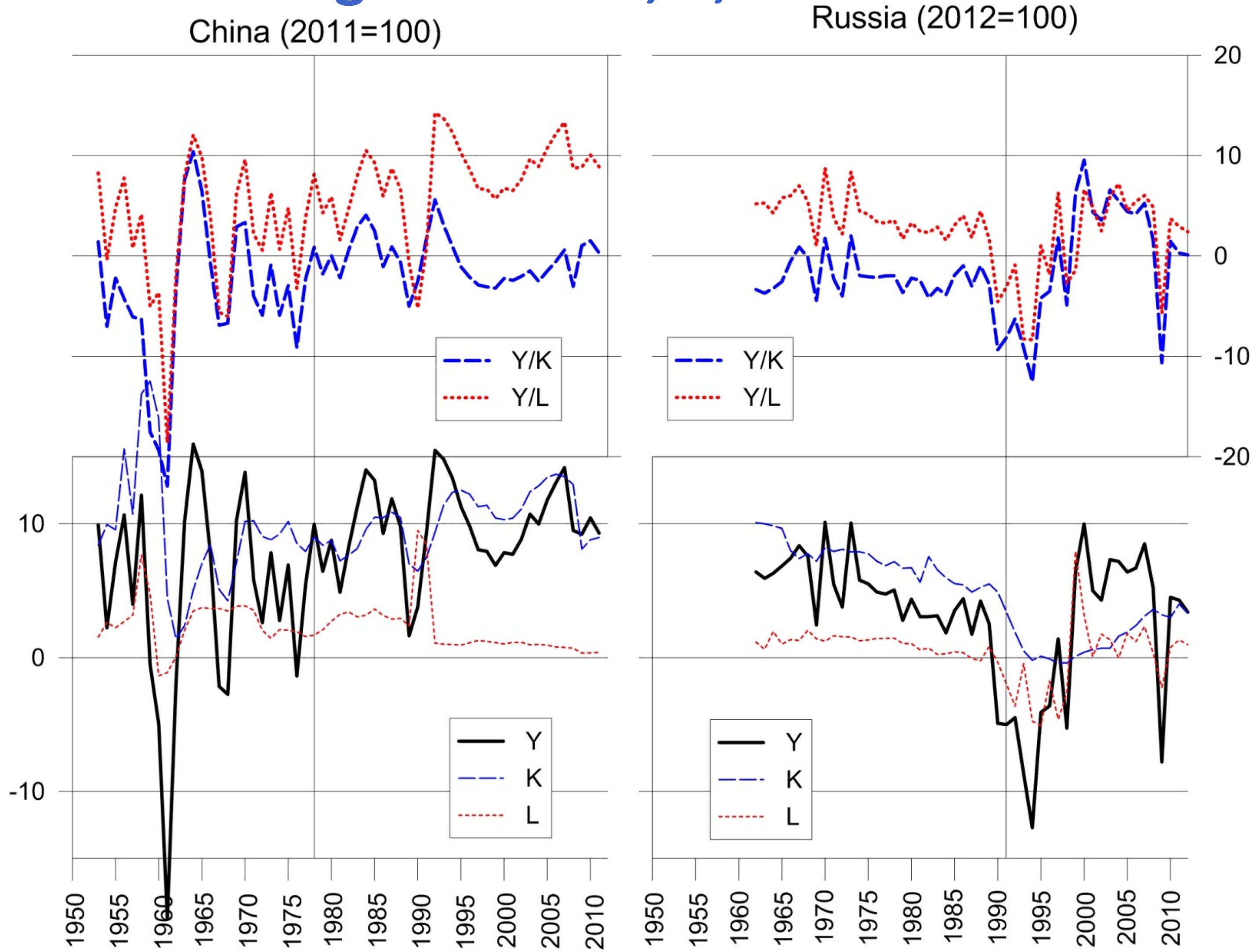


Data: The normalized time series of Y, K, and L



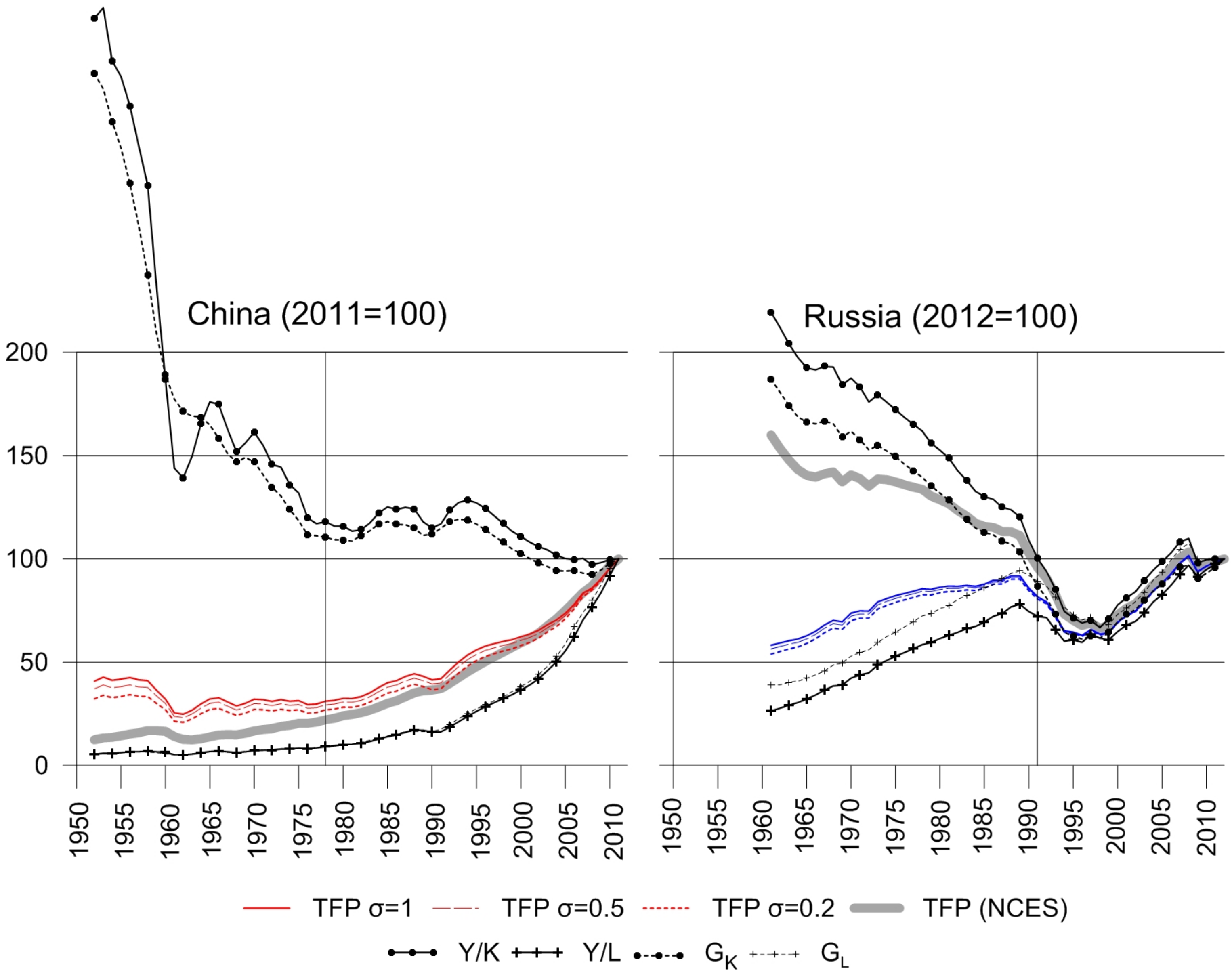
- The quality of data seems low for both China and Russia: the headcount of L, questionable K.
- Small fluctuations in China, big changes in Russia.

Data: Annual growth in Y, K, and L

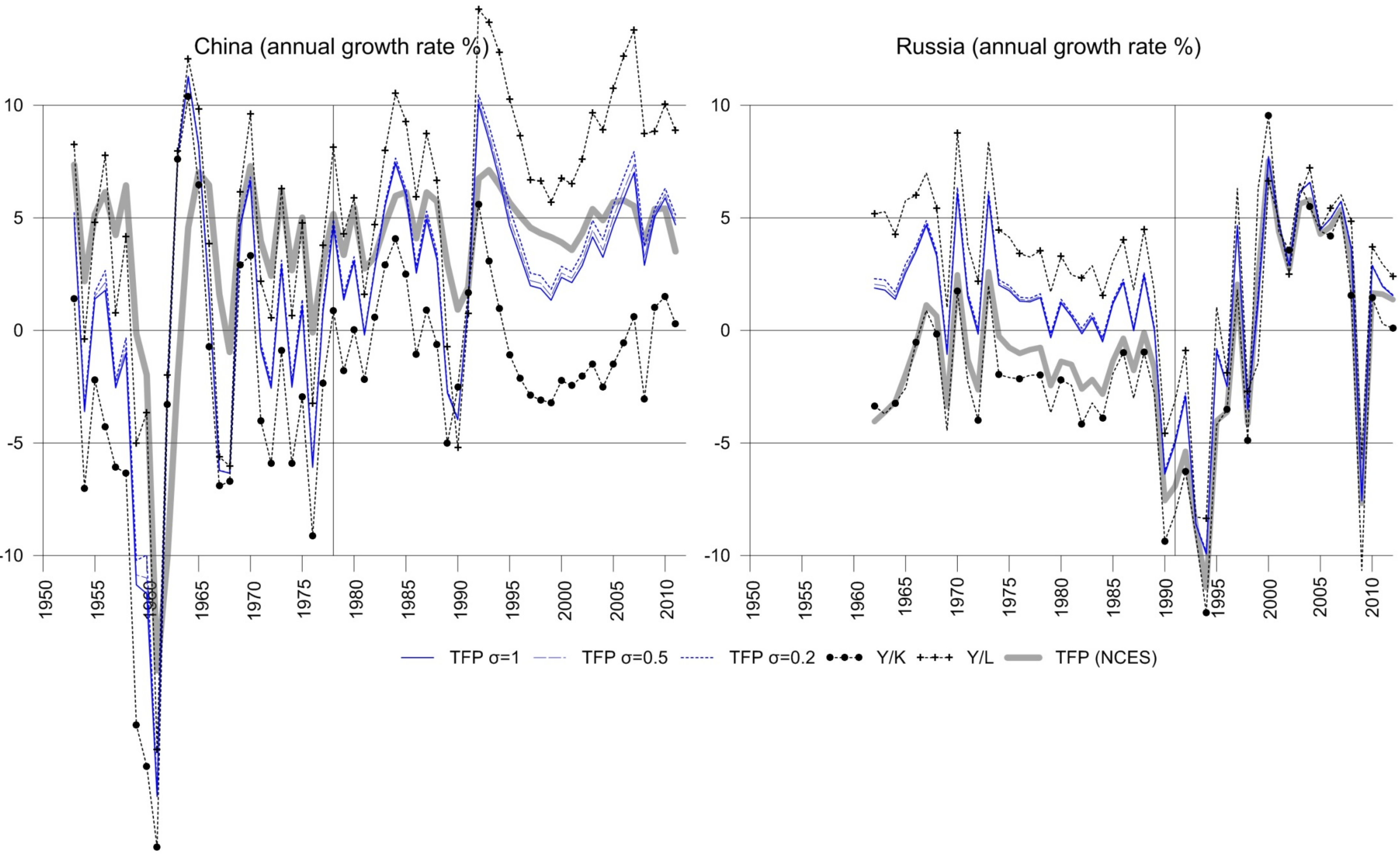


- China: Y/L increases relatively steadily after 1978, while Y/K increases only recently.
- Russia: The decreasing trend in Y/K was remarkable before 1991. A large drop both in Y/K and Y/L in 1990. The turning point was 1995.

Results
-Productivity level (ESR & NCES)



Results
-Annual growth rates (ExSR & NCES)

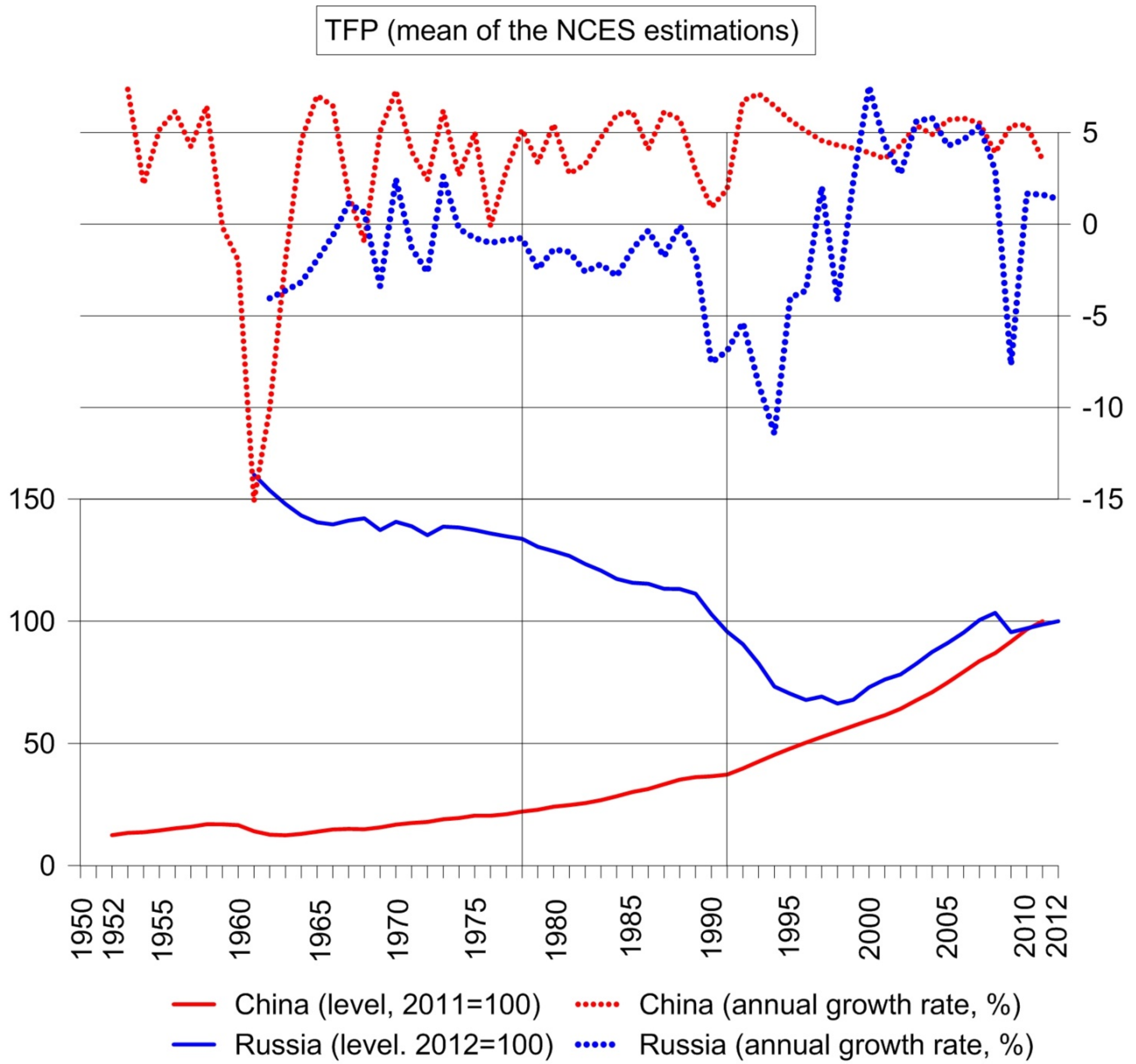


Results
-Comment on TVP-NCES results

- The estimates by TVP-NCES method fall in the middle of partial productivities (Y/K and Y/L) or the estimates by extended Slow residuals method.
- In this sense, the estimates by TVP-NCES seem reasonable. However, it is far from an accurate estimation. In particular, Russian TFP before 1991.

Results

-China and Russia compared (NCES estimation)



Wrap-up about the methods

- Extended Solow residuals method is easy to use.
- Estimation of TVP-NCES production function with time-varying parameters is easy. But, the accuracy is not guaranteed. This study showed not fundamentally different results between Extended Solow and TVP-NCES.
- Elasticity of substitution is low in both China (0.2) and Russia (0.16). However, it is not clear how significantly low they are.

Wrap-up about the productivity

- China has been increasing TFP steadily since the open-door in 1978. The problem of low capital productivity lingers. However, we see the sign of improving capital productivity in the latter half of the 2000s.
- Russia's decreasing trend in TFP was outstanding before 1991 (actually before 1995). The transition to market changed it. Both capital and labor productivities, and, thus, TFP turned to increase. However, the improvement seems vulnerable to the external (oil price) shock.