Industrialization in Russia through the lense of neoclassical growth theory

Millar Lecture

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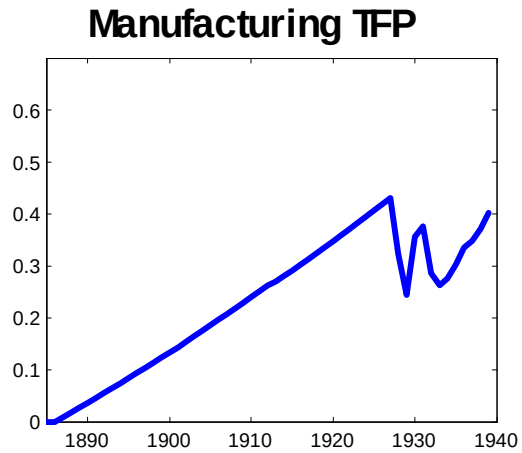
Russia's structural change

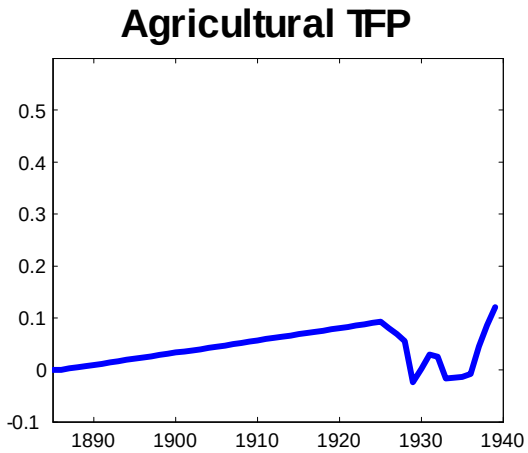
- Stalin's industrialization had a profound impact on Soviet and global economic and political development
  - Affected development economics thinking for many decades
  - E.g. Allen's "Global Economic History: A Very Short Introduction" (2011) lists Russian/Soviet growth as one of the very few non-Western success stories
- Debate amount historians, economists and political scientists about economic consequences of industrialization
  - How successful were economic policies of the Soviet Union in 1930es, e.g. industrialization and collectivization?
  - What would be a counterfactual?
- This paper
  - Builds and calibrates a general equilibrium model of Russian/Soviet economy since 1885
  - Uses the calibrated model to analyze counterfactuals for 1928-40 in order to identify contributions of policies and external factors

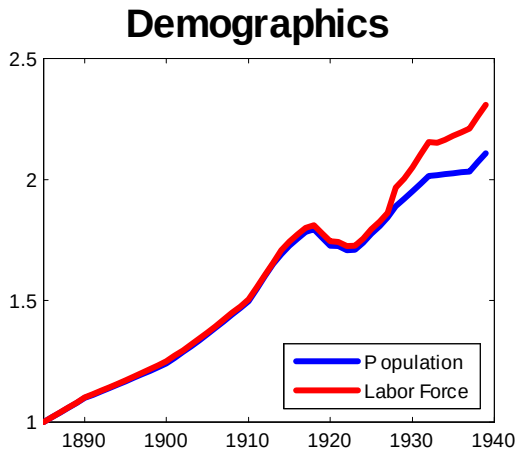
Why neoclassical growth theory

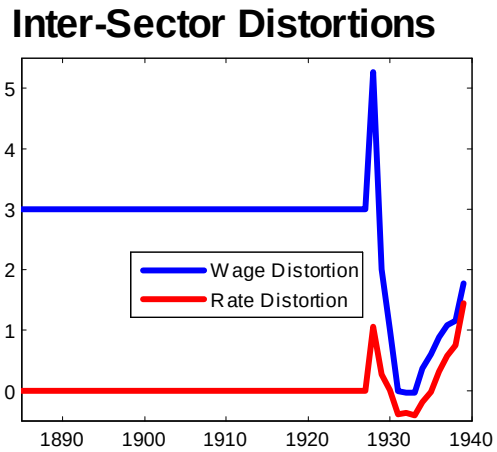
- Such models have been successfully used to understand industrialization and structural change in the US (Kongsamut-Rebello-Xie, Caselli-Coleman, Cole-Ohanian, Buera-Kaboski, Rogerson, etc), UK (Stokey), Japan (Hayashi-Prescott) and others
- Allows understanding the role of subsistence constraints, of foreign trade, and of frictions
- Helps answering two main questions:
  1. What were the distortions (if any) in the pre-1913 economy?
  2. What is the economic performance of the Soviet Union pre WWII and what are its likely causes?

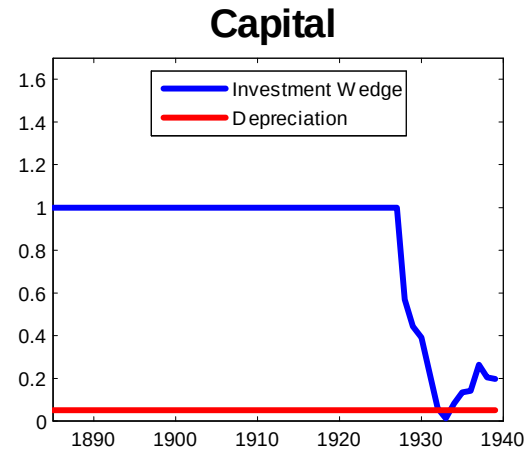
Best Fit Calibration of Shocks

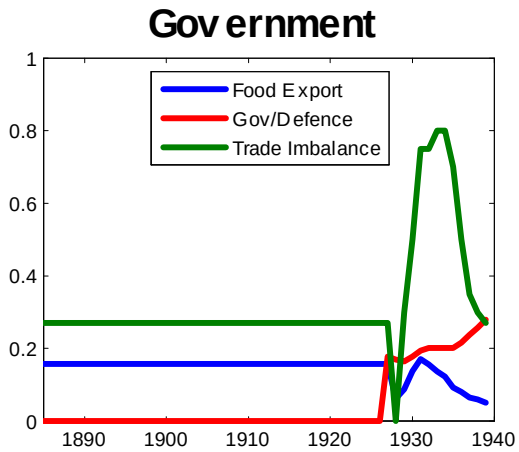












Preview of results

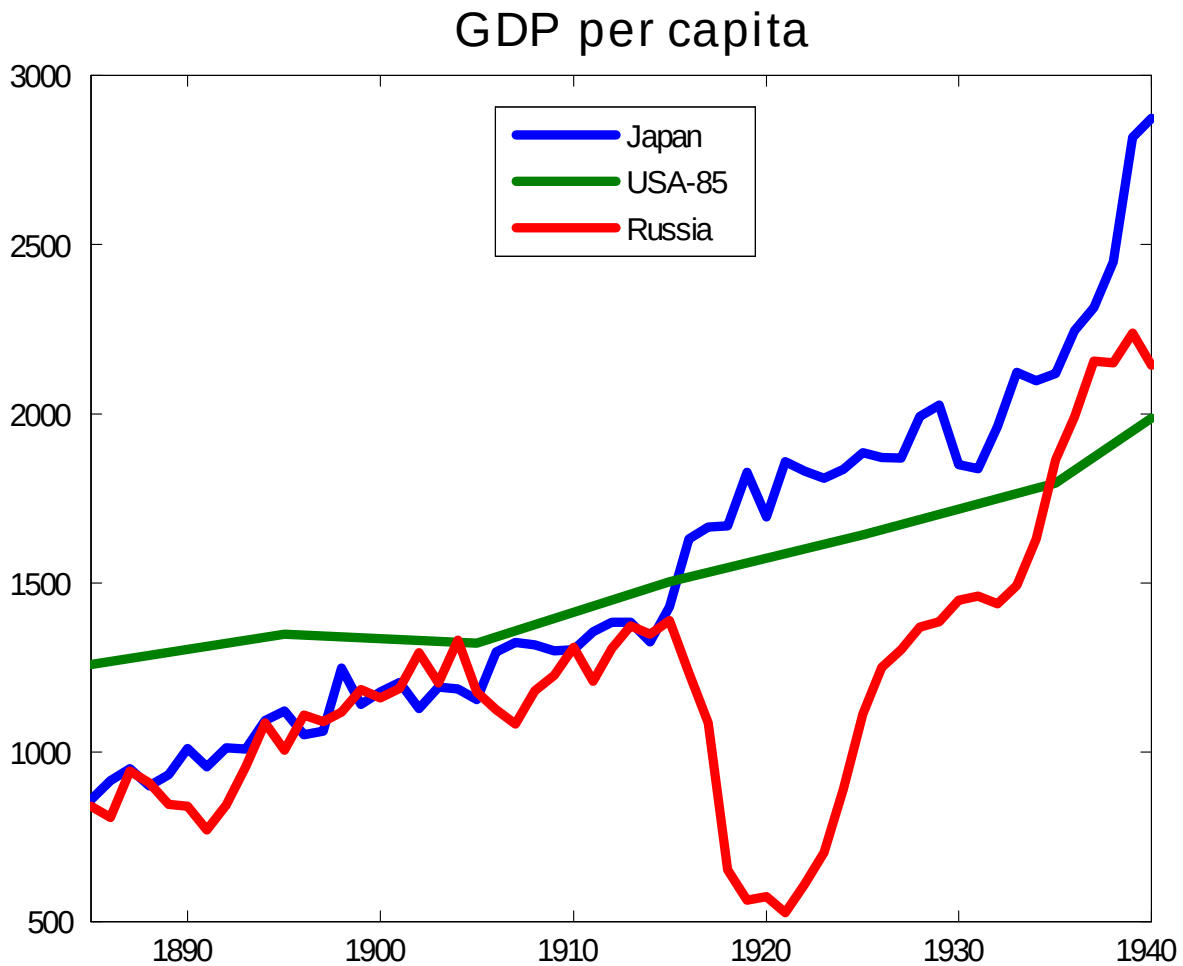
- New model combining non-homothetic preferences, frictions and foreign trade
- Pre 1917: Russia had a reasonable TFP growth in manufacturing and slow TFP growth in agriculture with little structural change
  - Slow rural-urban migration: labor market frictions (because lack of land property rights)
  - Low investment: capital market frictions (underdeveloped financial market)
- Soviet Russia 1928-40:
  - GDP per capita returned to pre-1917 trend
  - "Perspiration not inspiration":
    - Productivity below the trend but fast growth of production factors
    - Collectivization and 'price scissors' raised incentives to move to cities
    - Mobilization of labor force (as a share of population)
    - Mobilization of capital (less important)
  - We also show the important role of collapse in international trade
    - And show that growth in military spending did not matter much

James Millar on Agricultural Surplus

- Millar (1970) *Soviet Rapid Development and the Agricultural Surplus Hypothesis*
  - Questions the 'necessity of Stalin's agricultural policies' (conventional wisdom of the time)
  - Identifies other factors (including terms of trade) that might have affected industrialization
  - Calls for further analysis of counterfactuals with and without collectivization policies

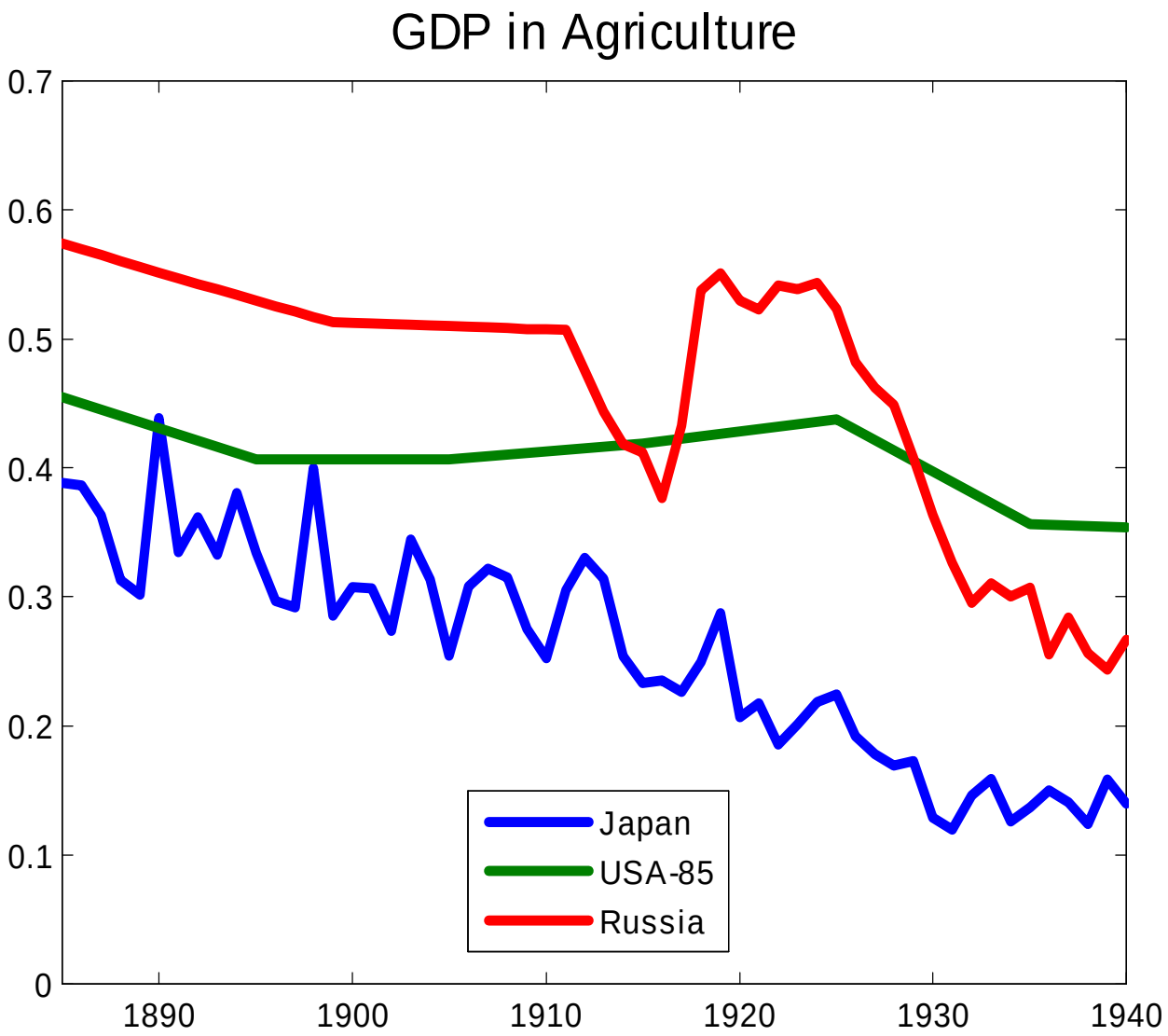
    "One possible approach to an objective standard of appraisal is to be found in the comparison of Soviet policies with those practised in support of successful industrialization elsewhere, e.g., Japan."

Real GDP per capita in Russia and Japan (and in the US lagged 85 years)

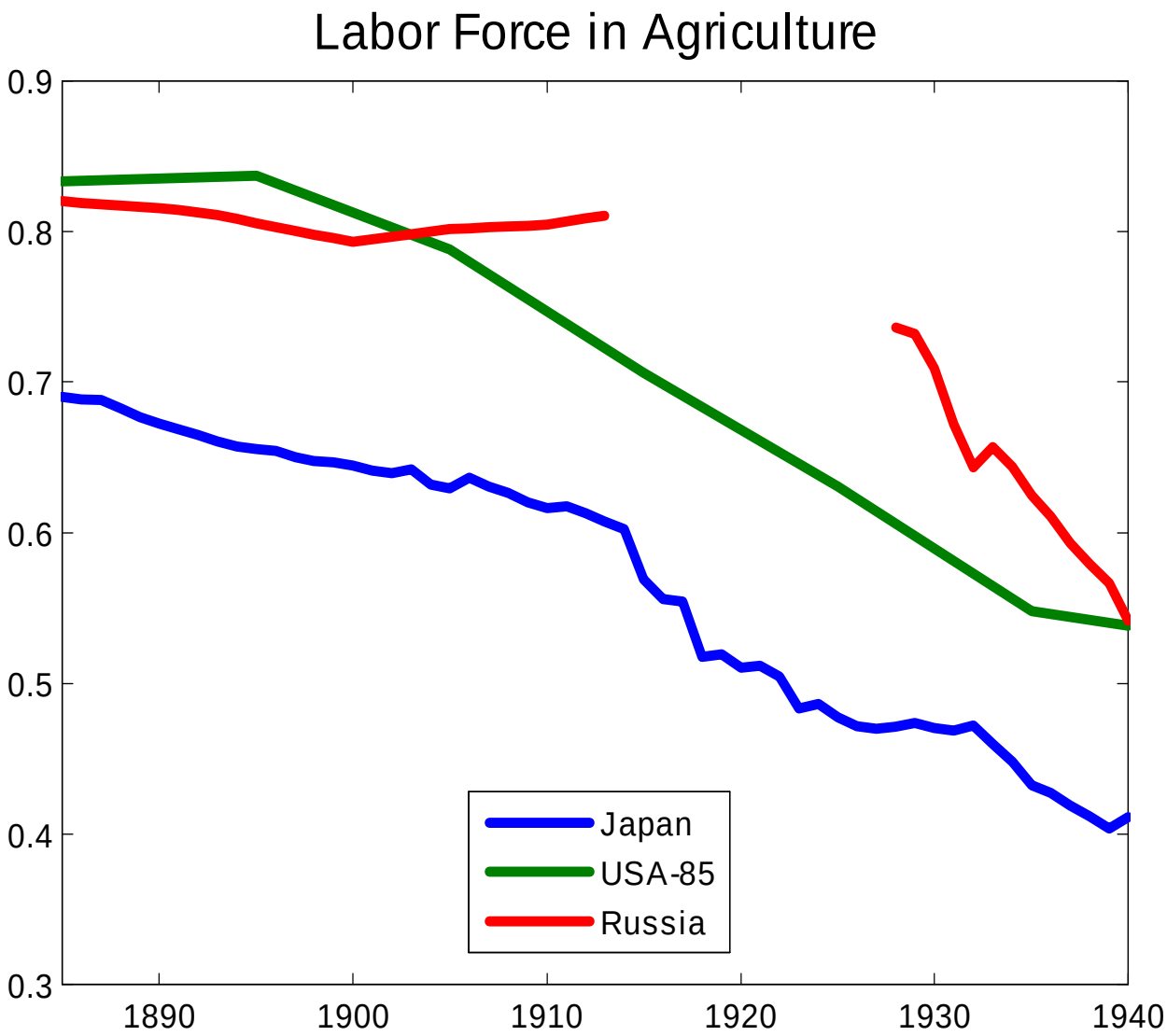


Source: Maddison

Fraction of agriculture in GDP in Russia and Japan



Fraction of labor force in agriculture in Russia and Japan



Russia vs Japan: Summary

- *Before 1917:*
  - Russian GDP per capita is about the same as that of Japan, about 1/3 of the US (same as in the US in 85 years earlier)
  - Russian GDP per capita grows at about 2% per year, about the same as Japan and US
  - Much higher fraction of labor force in agriculture, and fraction of agriculture of GDP than Japan (and US in 1800), much slower structural change

  After 1917:
  - After drop in GDP following WWI, revolution and Civil War – rapid GDP growth, reaching the pre WWI trend by 1940
  - Large transition of labor force from agriculture to manufacturing in 1928-40
  - Substantial structural change

Theoretical framework: 2-sector unbalanced growth model

- Consumers:

$$\max \sum_{t=0}^{\infty} \beta^t POP_t \left[\eta \log \left(c_t^A - \gamma^A \right) + (1-\eta) \log c_t^M \right]$$

subject to $p_t c_t^A POP_t + c_t^M POP_t + I_t \leq w_t^A N_t^A + w_t^M N_t^M + r_t^M K_t + T_t$

- Producers
  - manufacturing

$$Y_t^M = F_M \left(K_t^M, N_t^M \right) = A_t^M \left(K_t^M \right)^{\alpha_M} \left(N_t^M \right)^{\beta_M}$$

  - agriculture

$$Y_t^A = F_A \left(K_t^A, N_t^A \right) = A_t^A \left(K_t^A \right)^{\alpha_A} \left(N_t^A \right)^{\beta_A}$$

Trade and market clearing

- Let q_t be world price of agriculture to manufacturing, x_t fraction of agricultural exports
- Trade

$$ex_t^A = x_t Y_t^A$$

$$ex_t^A q_t + ex_t^M = 0$$

- Market clearing

$$\begin{aligned} c_t^A + ex_t^A + G_t^A &= Y_t^A \\ c_t^M + ex_t^M + G_t^M + I_t &= Y_t^M \\ K_{t+1} &= I_t + (1-\delta) K_t \\ K_t^A + K_t^M &= K_t \end{aligned}$$

(government spending G is treated as military expenditures)

Trade determination

- Following Stokey (2001) we treat terms of trade q_t and export share of agriculture x_t as exogenous
  - given transportation technology, hard to argue internal prices equalized with global
  - no reliable estimates of elasticity of x_t w.r.t. q_t
  - despite the fact that q_t significantly increased in 1885-1914, x_t did not change much
- In our simulations (pre-1914) behavior of p_t is roughly similar to q_t

Model helps describing unbalanced growth

- Subsistence constraints $\Longrightarrow$ growth implies structural change
  - The richer the consumers, the higher the demand for industrial goods relative to agricultural goods
  - Collectivization that impoverished peasants could have slowed down industrialization
  - Increased government's demand for non-agricultural goods may spur industrialization ...
    ... but not necessarily if financed through taxes on agriculture
- Limitations of the model
  - Subsistence constraint *must* hold
  - Can model *near-famine* but not *famine* $\Longrightarrow$ imprecise calibration in early 1930s

Model allows accounting for several important effects

- Frictions in the labor and capital markets
  - Wage wedge: manufacturing wedges were much higher than agricultural wedges
    - Because of costly rural-urban mobility
  - (Intertemporal) investment wedge: investment was 'taxed' by financial market imperfections and risks of expropriation
- Foreign trade and effects of terms of trade
  - Industrialization required exporting grain in order to buy equipment
  - But when grain price was high, no economic incentives to develop manufacturing ('Dutch disease')
  - When grain price went down, resources would move to industry

Analysis pre-1917

- Ideally would like to determine wedges from the FOCs of the households and firms to figure out distortions
- Not enough data to do that:
  - although we know I_t, do not know the split between I_t^A and I_t^M
  - no reason to assume that K_{1885} was close to balanced growth path (abolishment of serfdom in 1861, attempts for industrialization following defeat in the Crimean war)
- We will use data on structural change to deduce possible wedges in competitive equilibrium

Growth without structural change

- In 1885-1914 Russia experiences solid growth with little structural change
- Consumer's problem

$$\eta \log \left(c_t^A - \gamma^A \right) + (1 - \eta) \log c_t^M$$

subject to

$$p_t c_t^A + c_t^M = C_t$$

where

$$C_t = Y_t - I_t - G_t$$

- Under standard assumptions (e.g. Kongsamut et al) $C_t \propto Y_t$, $c_t^i \propto Y_t^i$ for $i \in \{M, A\}$, $p_t = const$
  - this model is inconsistent with Russian experience in 1885-1914
  - Y_t and Y_t^i increased a lot, while $p_t Y_t^A / Y_t^M$ changed little $\rightarrow$ C_t is high enough so that non-homotheticity does not matter
  - this implies that long-run share of $p_t c_t^A$ is about 40%, inconsistent with international and later Russian experience

Potential explanations

- Growth without structural change is possible if
  - role of government spending or investments increase over time (Gershenkron)
    - C_t grows slower than Y_t
  - export plays important role (Allen)
    - c_t^A grows slower than Y_t^A
  - TFP in agriculture grows slower than in manufacturing (Stolypin, Lenin, Gershenkron)
    - p_t increases
- All three stories have been proposed by scholars to explain lack of structural change in Russia
  - most of the empirical evidence is anecdotal or based on non-representative surveys
  - we use quantitative model to differentiate between the stories

Quantitative evidence

- Although qualitatively all three stories are consistent with Russian experience, two of them do not fit quantitatively
  - although both I_t and G_t slightly increased as a fraction of GDP, C_t decreased from 82% of GDP to 78%, still too large to explain lack of structural change
  - while Russia supplied 25% world international wheat, not more than 14% of Russian agricultural production was exported, and this fraction did not change much over time
- Increase in relative prices of agriculture by about 30% can easily reconcile lack of structural change
  - consistent with available data on relative agricultural prices (Allen, Gregory, Shiryaev)
  - world prices of wheat increased by about 30% over the same time (Williamson)
  - somewhat similar to the modern concepts of "Dutch disease" or "oil curse"

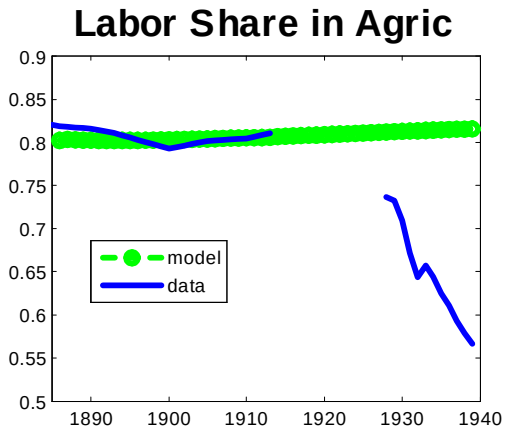
Calibration: Unique data challenges

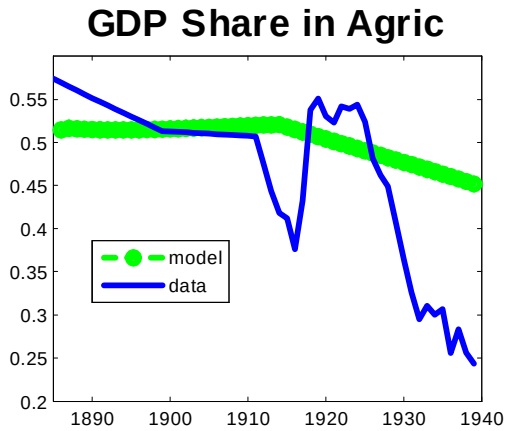
- There are severe data limitations to evaluate empirically Soviet performance pre and immediate post 1917 revolution
- Pre 1917: there is reasonably reliable data on aggregate quantities, but little sectorial/micro-level data
  - historians often use anecdotal evidence or very small samples to argue their points of view
- Post 1917: no price data in the command economy
  - historians typically use Soviet official prices which is especially problematic during structural change
- We use
  - Gregory 1982 on pre-1917
  - Harrison-Markevich 2011 on 1913-28
  - Davies et al. 1992 and Moorsteen-Powell 1962 on 1928-40
    - adjust to 1913 prices
    - following M&P, we count about 10% of rural residents as non-agricultural workers

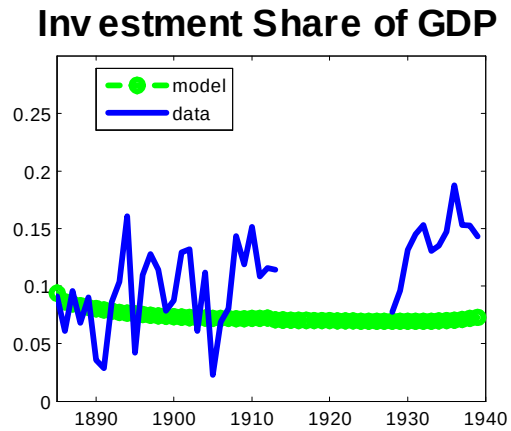
Calibration pre-1917

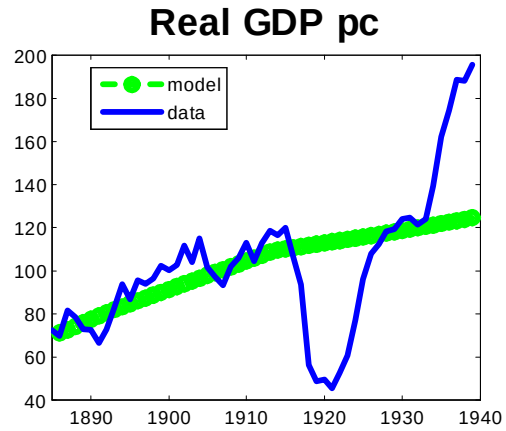
- Most parameters are standard, predictions are robust to their changes
- Focus on key elements:
  - fit G_t, x_t exogenously from the data
  - since no data on the sectoral capital stock, cannot construct sectoral capital and TFP $\Longrightarrow$ choose initial capital stock and sectoral TFPs for best fit
  - standard problem: Cobb-Douglas technology cannot explain the high *level* of agricultural employment (Caselli-Coleman, Hayashi-Prescott) $\Longrightarrow$ introduce a wedge on manufacturing wages to match the initial levels
  - choose best fit for agricultural and manufacturing TFP to fit structural change

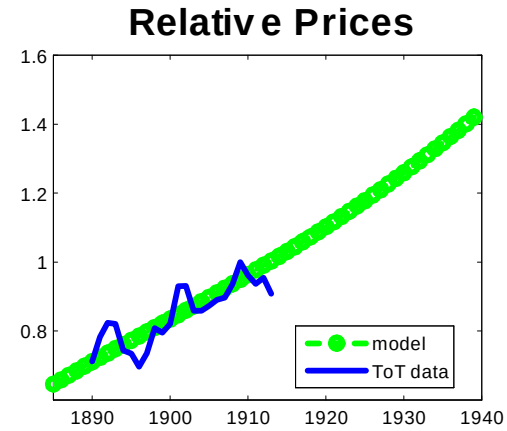
Best fit for pre-1917

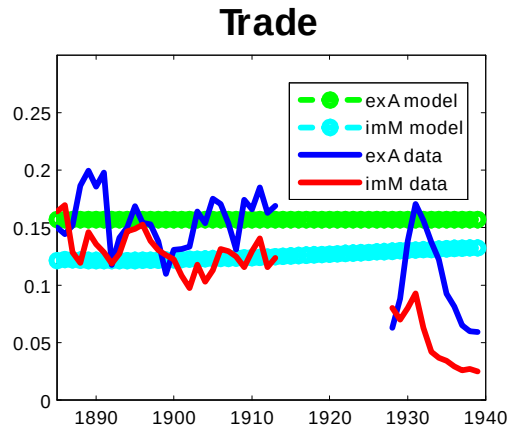












Summary

- Pre 1917:
  - world-level TFP growth in manufacturing
  - slow TFP growth in agriculture
- Possible culprit: archaic organization of agriculture in Russia
  - land is owned by a village (*obschina*) rather than individually
  - allocated equally per number of people in household
  - land holdings are frequently reshuffled to reflect changes in the household composition, migration to the cities, etc.
  - taxes are imposed on the village, but the village decides how to allocate tax burden among its members
  - recent evidence from Chernina-Dower-Markevich (2011): Stolypin's reforms resulted in higher labor mobility

Soviet Russia 1928-1940

- Long turmoil in Russia following 1917 communist revolution
  - Data for 1913-28 emerged only recently (Harrison and Markevich)
- Historians know reasonably well quantities produced and *official soviet prices*.
  - Use those to construct input-output matrices and national income accounts

Structural changes

- Using official Soviet figures can lead to misleading inferences about structural transformation of Soviet economy
- Consider famine years in early 1930s
  - Traditional approach (questioned by Millar): output Y_t^A decreased and Soviet official prices p_t^A decreased $\Longrightarrow$ fraction of agriculture, $p_t^A Y_t^A / \left(p_t^A Y_t^A + Y_t^M\right)$, must decrease
  - the greater the famine, the greater the perceived structural transformation
  - Economic theory: in famine marginal utility of food increases, with inelastic demand (non-homothetic preferences) p_t^A increases by *more* than Y_t^A decreases: $p_t^A Y_t^A / \left(p_t^A Y_t^A + Y_t^M\right) \uparrow$
    - famine leads to an increase in fraction of agriculture, negative structural transformation

Our approach

- Use quantities data and preferences calibrated to pre 1917 economy to construct prices and wedges
  - implicit assumption is that relative prices within sectors are not distorted
- Use those to evaluate effects of Soviet policies:
  construct counterfactuals with regard to
  - productivity (TFP) - lower because of inefficiency of central planning
  - wage wedges - lower because of collectivizaiton/famine
  - investment wedges - lower due to mobilizaiton of investment
  - labor force mobilization
  - trade collapse
  - increase in government spending

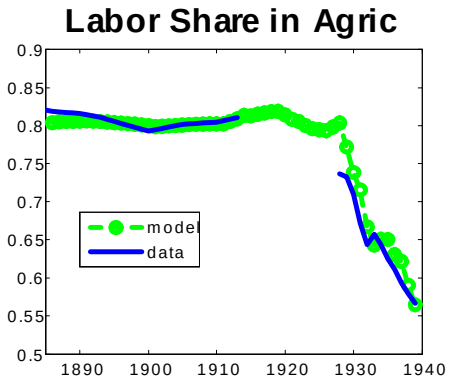
Calibration

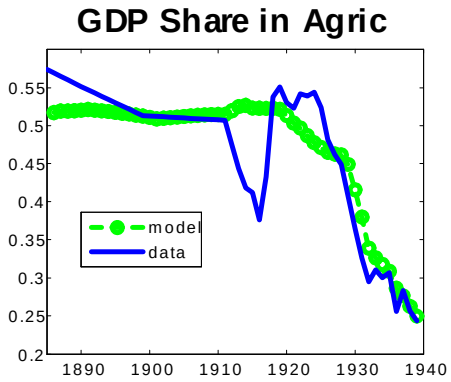
- Since we have estimates of the capital stock (Moorsteen-Powell), we can construct TFP.
- Choose the rest of the wedges to match available aggregate quantities exactly.
- Use marginal utility conditions to obtain prices
- Prices + quantities give Soviet national accounts

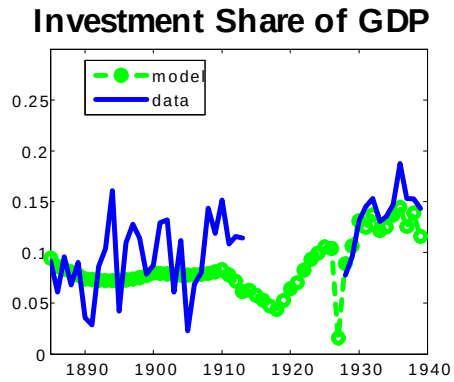
Main take-aways

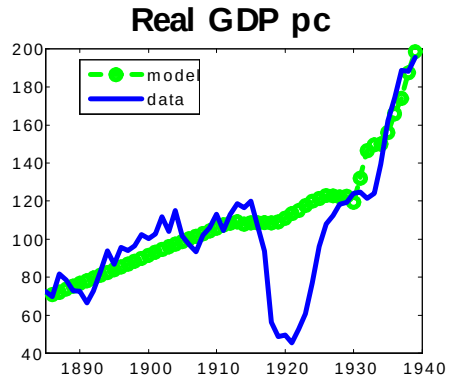
- Output of both manufacturing and agriculture as well as fraction of labor force in agriculture in 1928 is roughly the same as in 1913
- Fast growth in manufacturing in 1928-1940
- Fall in agricultural production, then increase to pre-WWI levels.
- Dramatic drop in exports
- Productivity was below the pre-1917 trend

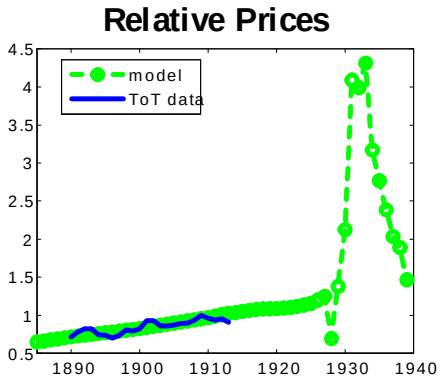
Best fit of the data

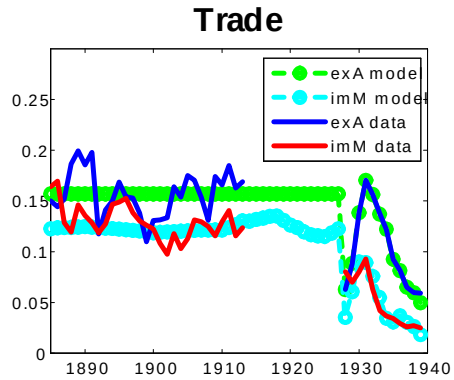












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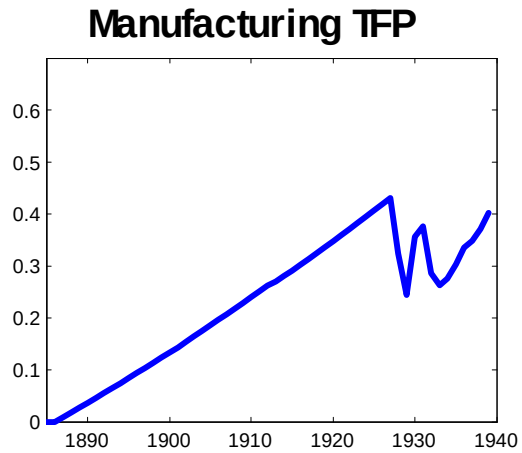
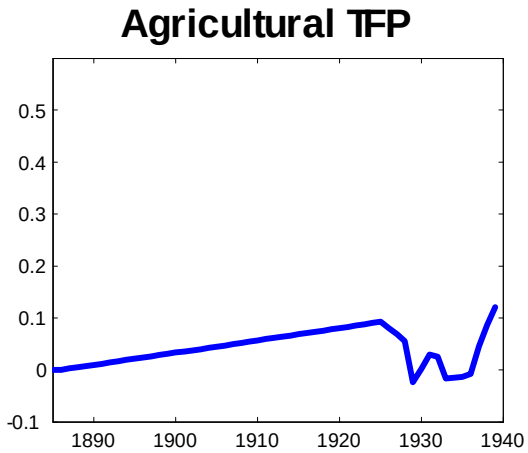
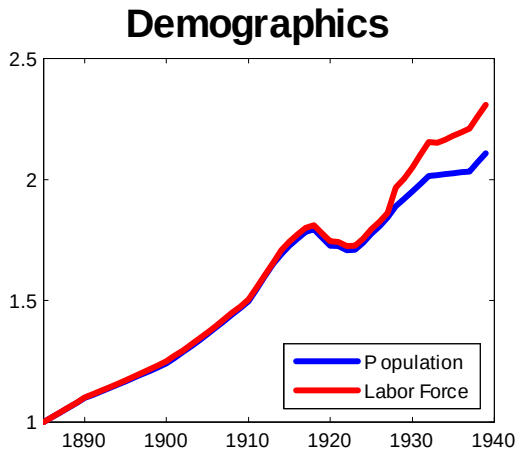
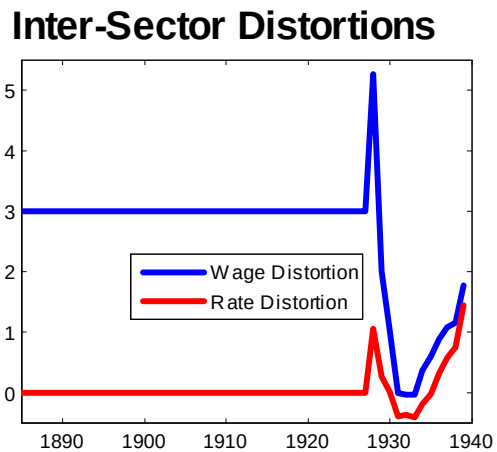
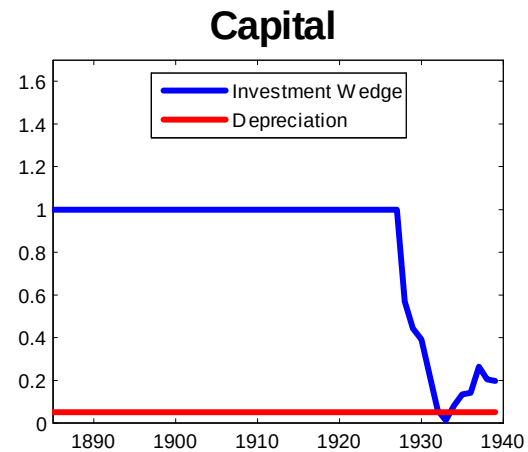
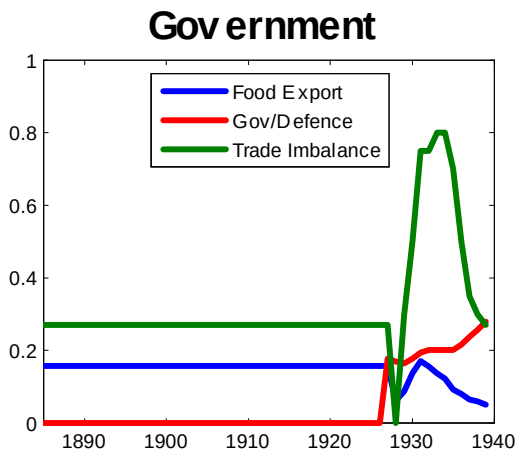








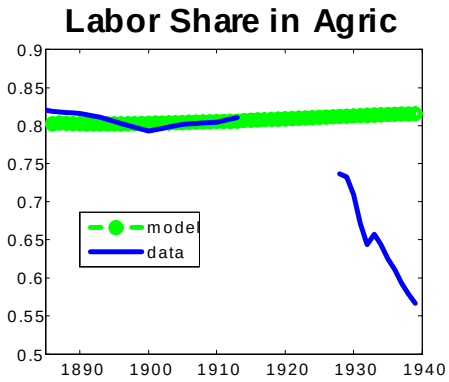


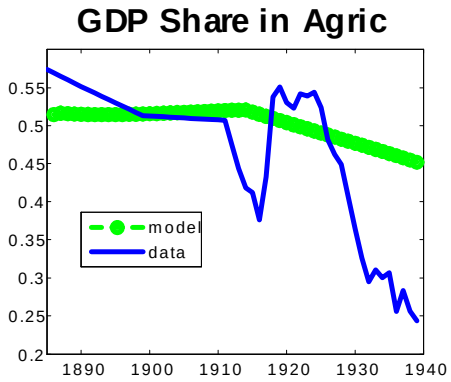


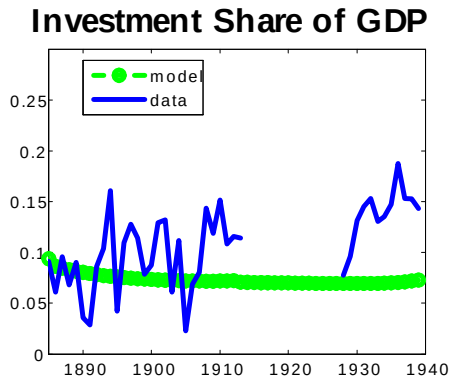
Main question:

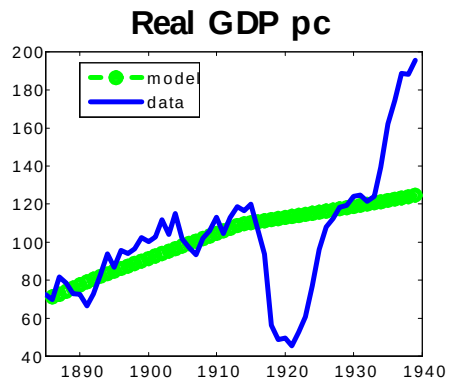
- How to decompose the difference between extrapolation of the pre-1917 trend and the actual 1928-40 data through adding policies and external factors
  - Distortion in productivity?
  - Collectivization pushing peasants to cities?
  - Collapse in foreign trade?
  - Mobilization of labor force and investment?
  - Raising government/military spending?
- *Our model allows carrying out counterfactuals!*

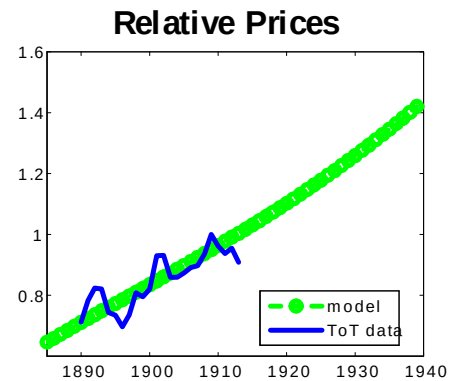
Take the pre-1917 trend...

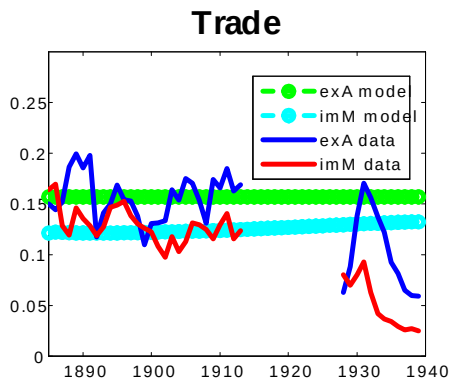




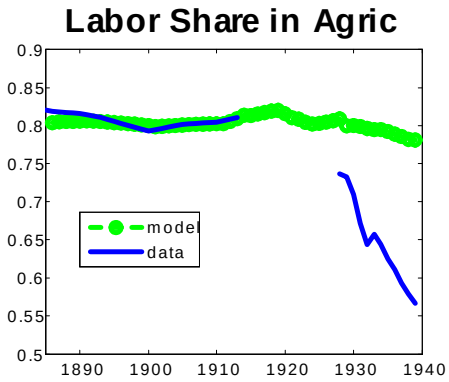


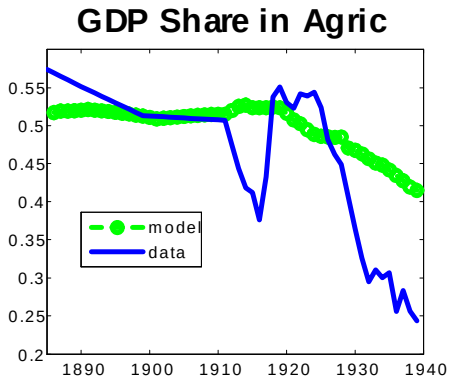


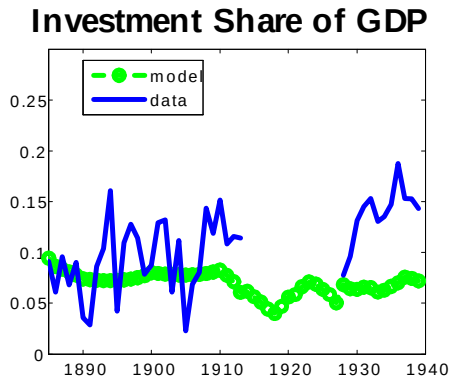


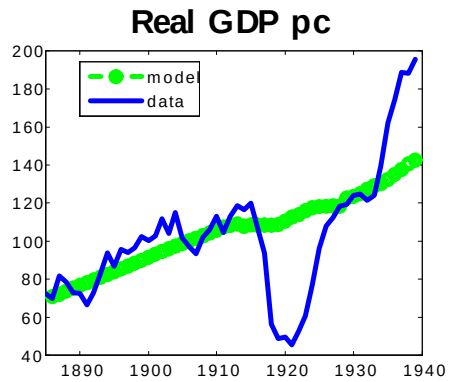


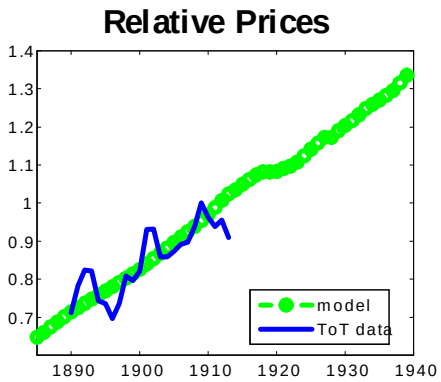
... add mobilization of labor force ...

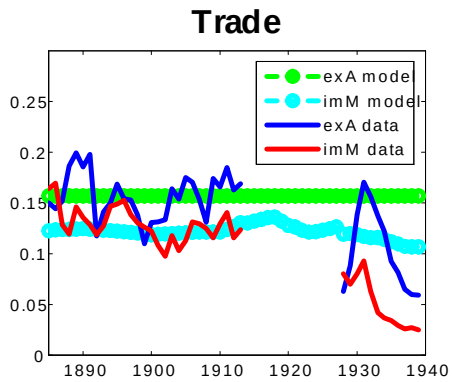




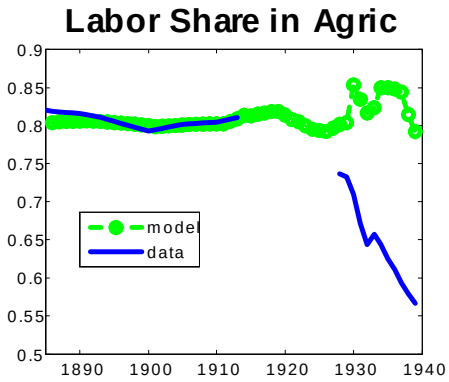


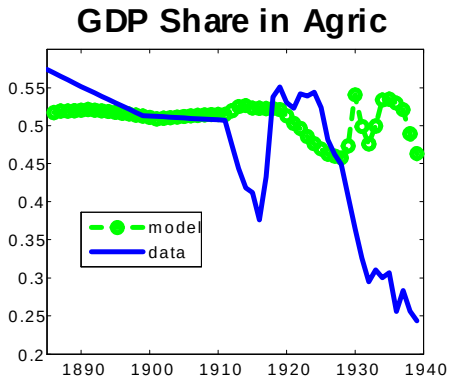


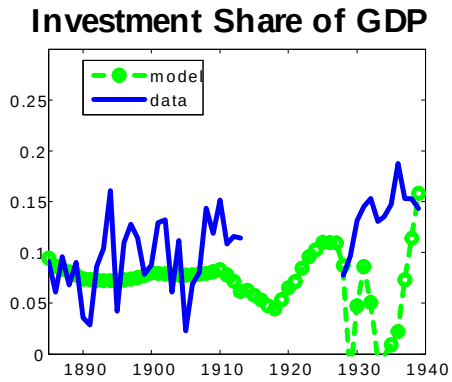


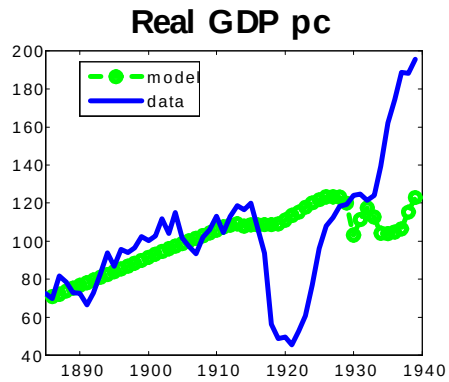


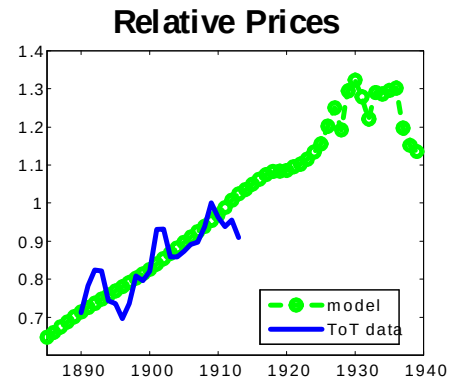
... substract lagging TFP ...

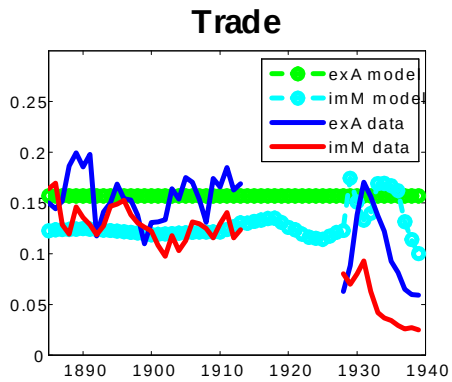




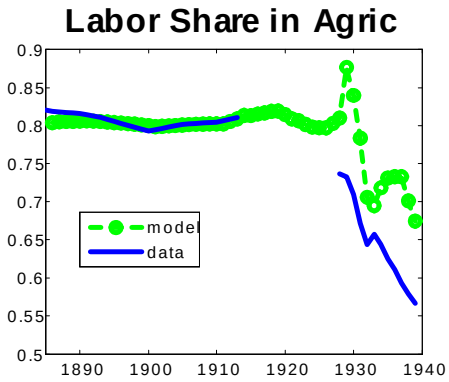


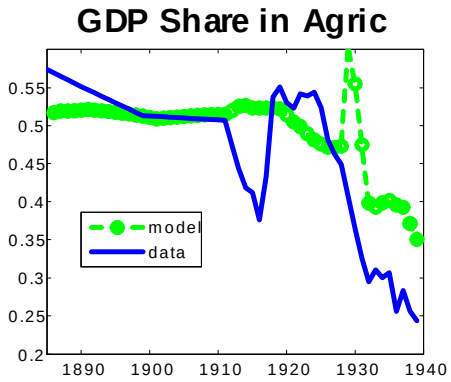


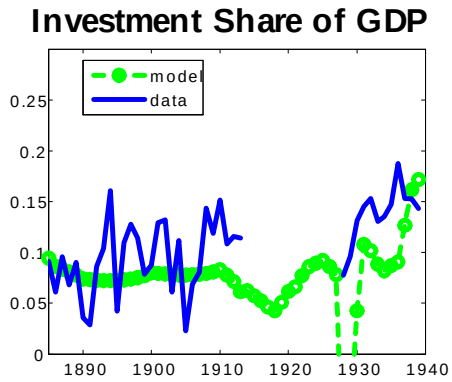


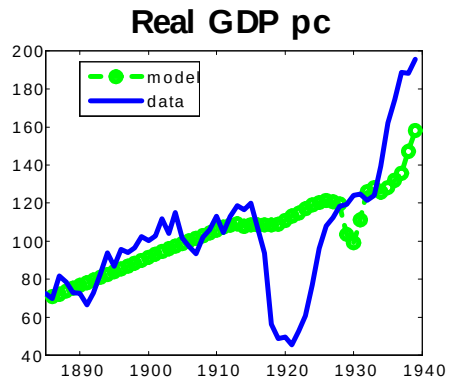


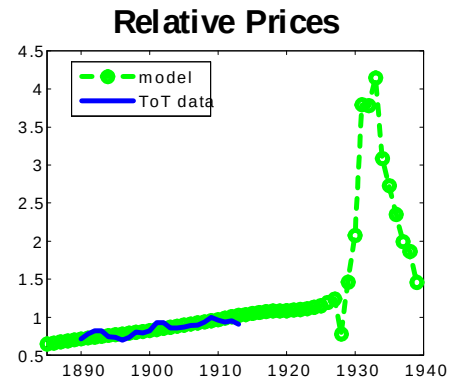
... add inter-sectoral wage distortions ...

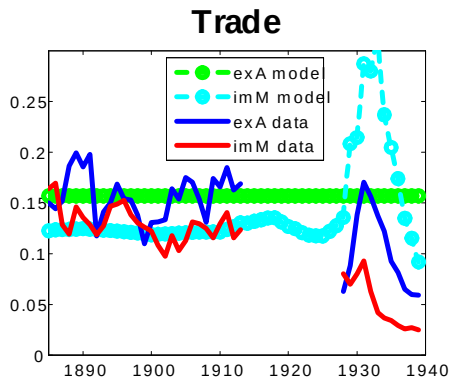




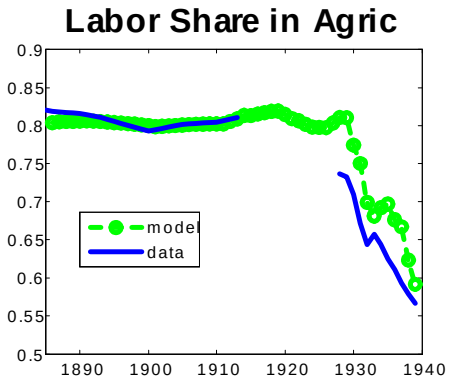


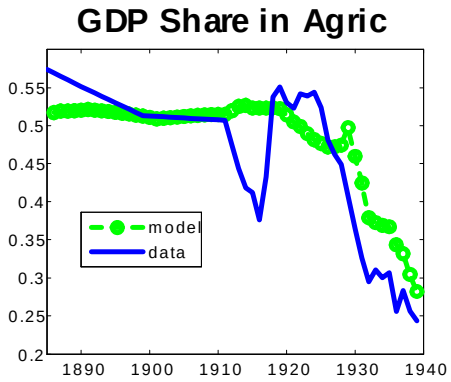


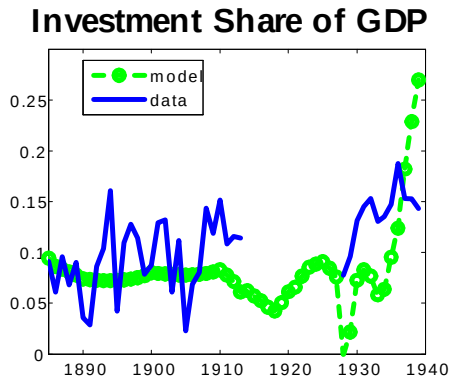


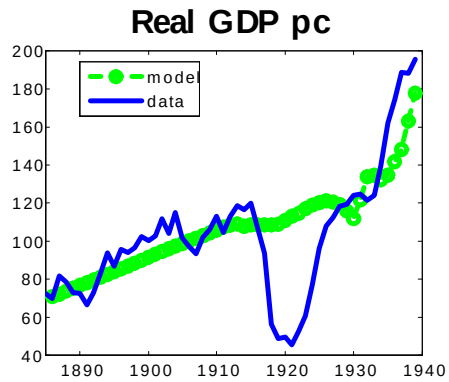


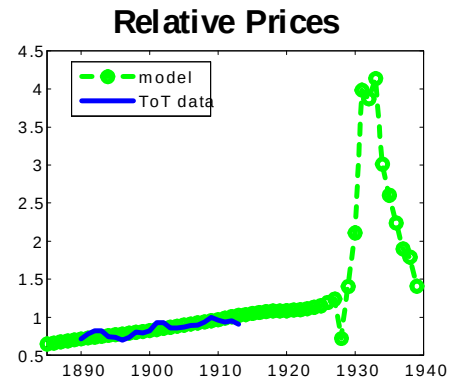
... add collapse in trade...

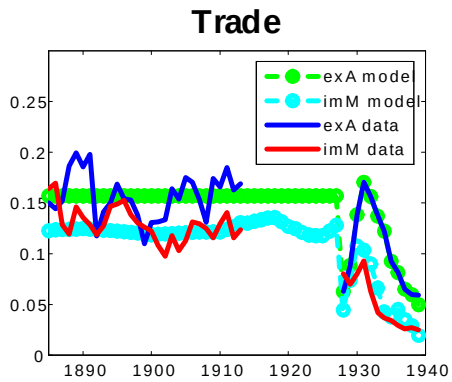




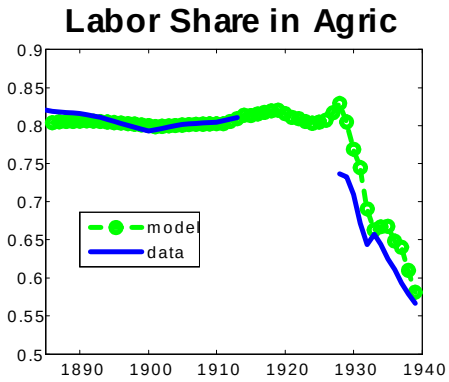


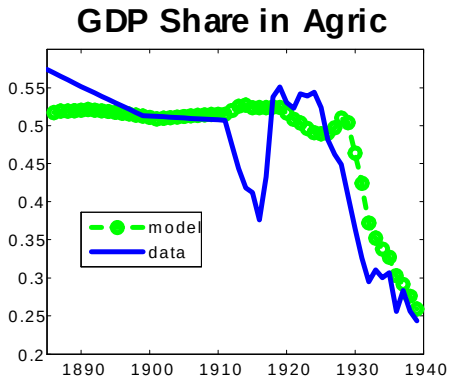


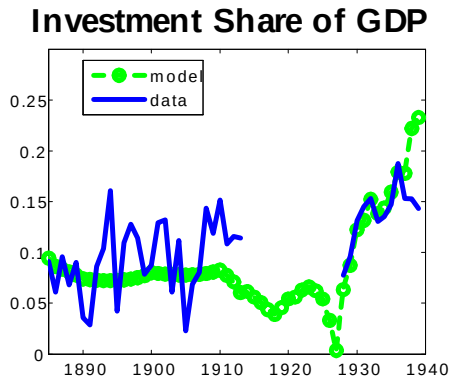


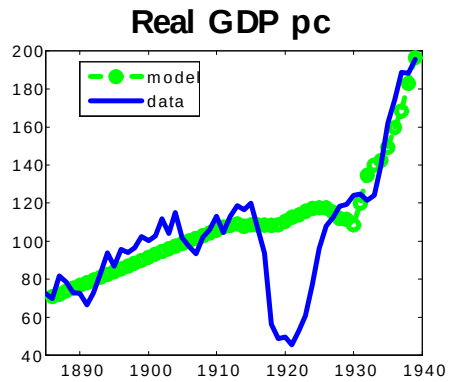


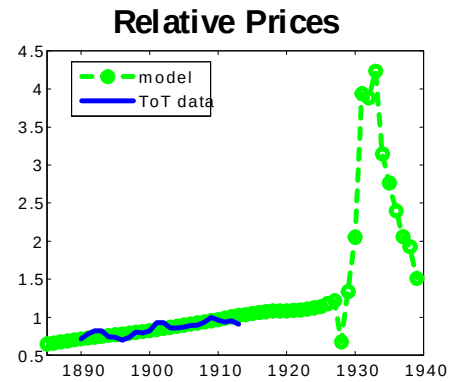
... add intertemporal investment wedge...

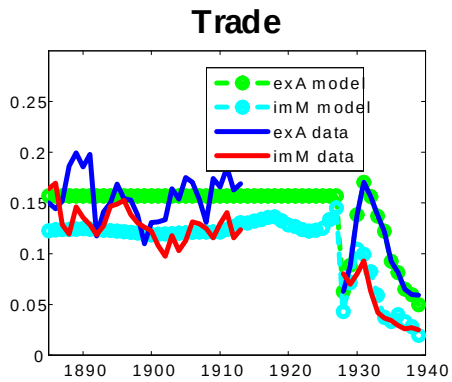




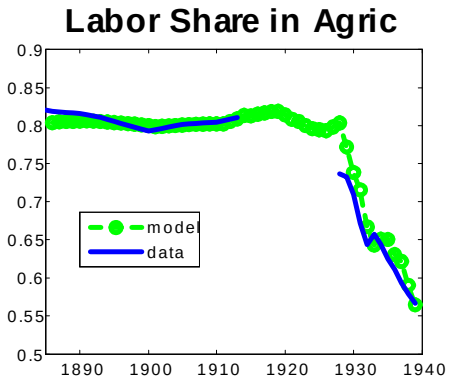


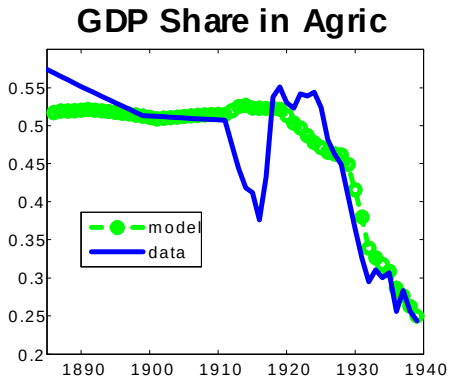


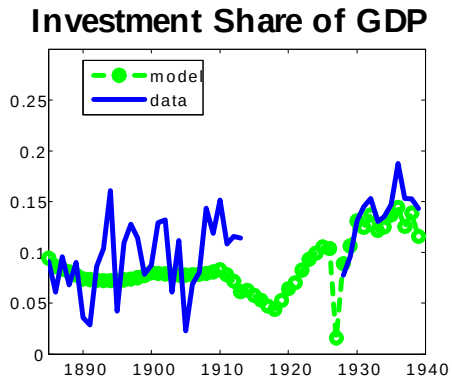


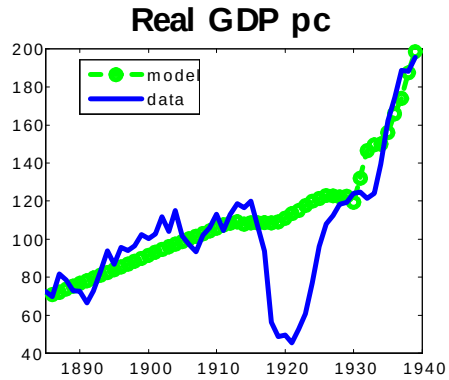


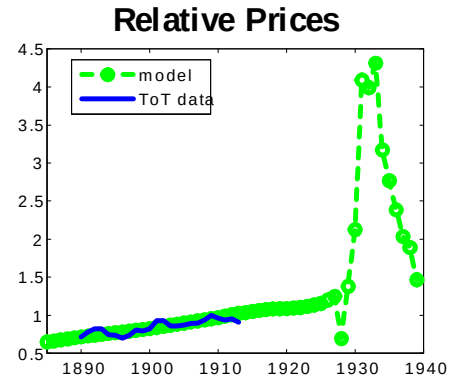
... add government spending = fits the data

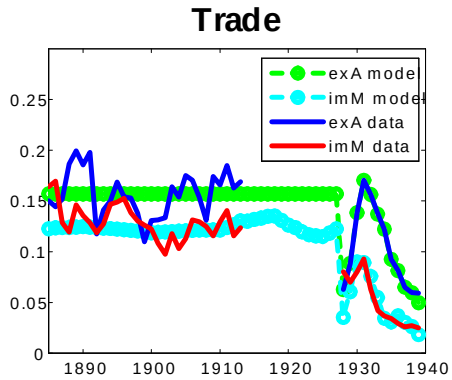












Why did structural change happen?

	Demogr.	Prod-ty	Wage Dist.	Trade	Inv-t	Military
Labor in Agric	14%	-19%	54%	32%	10%	9%
Output in Agric	17%	-40%	65%	33%	18%	7%
GDP pc	27%	-50%	55%	25%	33%	9%

Contributions net of effect of demographics and of productivity

	Wage Distortion	Trade	Investment	Military
Labor in Agric	52%	31%	9%	8%
Output in Agric	53%	27%	14%	6%
GDP pc	45%	20%	27%	7%

Conclusions

- Pre 1917 Russian economy: growth without structural change
  - rapid TFP growth in manufacturing, very slow growth in agriculture
  - structural change was slow:
    - frictions in labor and capital markets
    - high grain prices
- Soviet Russia in 1928-1940:
  - productivity below pre-Soviet trend
  - structural change (industrialization) still happened
    - collectivization moved labor to cities
    - mobilization of labor force also contributed
    - collapse in trade made a major contribution to structural change
  - mobilization of investment had an impact on GDP but not on structural change
  - increase in government spending also had only a minor role