Growth and Institutional Interdependences during the Middle Ages

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Motivation of the Paper

Several historical stylized facts during Middle Ages:

1. Foundation of new cities (High/Late Middle Ages) and economic development (*Bairoch*)
2. Separation of growth patterns: Occident vs. Orient

General question: *What drives growth?*

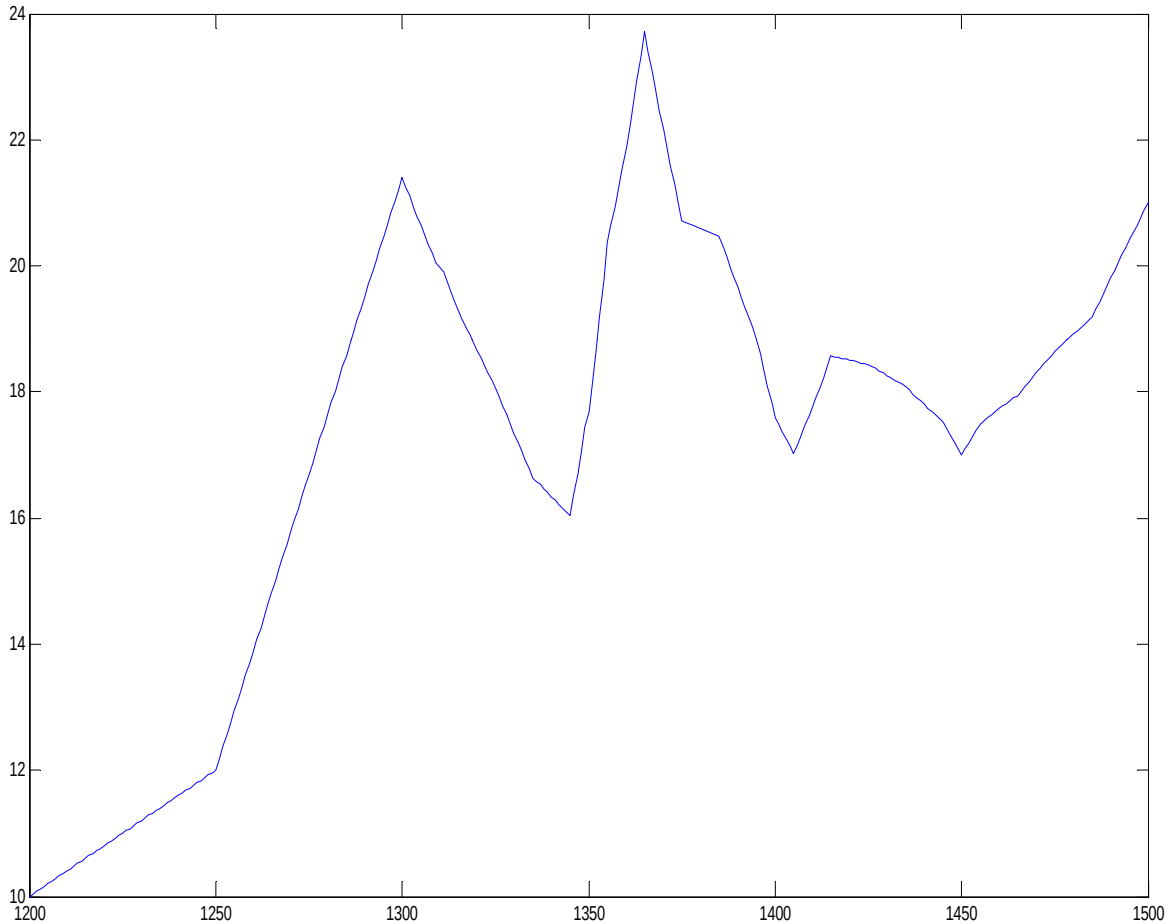
Motivation of the Paper

Several possible explanations:

1. Trade (*Smith, Cipolla, Mokyr*) and Commercial Revolution (*Lopez*)
2. Institutions (*Greif*)
   - private order (partnerships, firms) vs public order (community responsibility system)
   - formal vs informal institutions
   - different forms in the Occident and Orient
3. Human capital (*Kremer*)
   - urbanization and knowledge spillovers (*Glaeser*)
   - Labor specialization
4. Productivity
   - Physical capital accumulation
   - Exogenous shocks (e.g., war, morbidity)

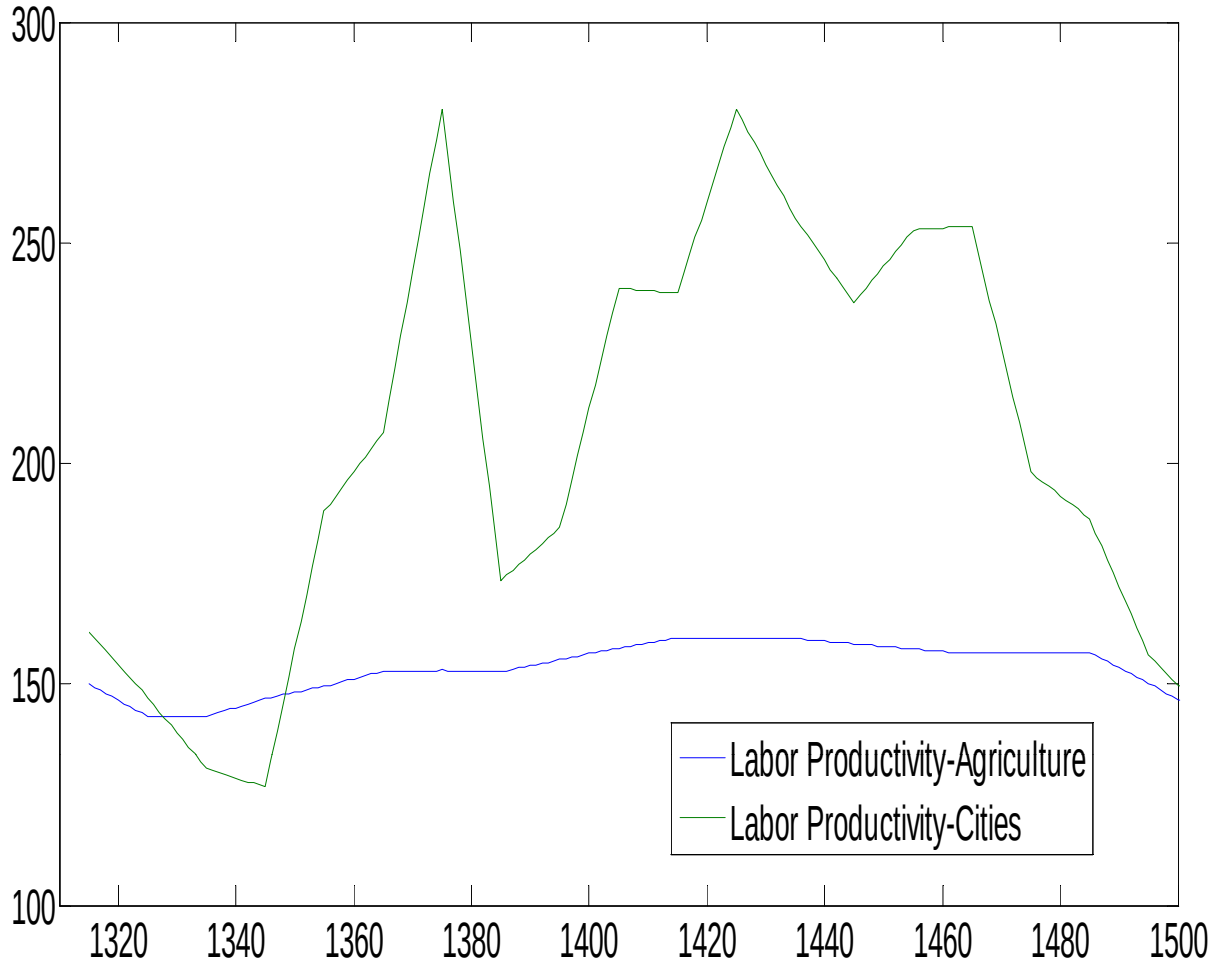
Urbanization in Italy during the Middle Ages

Figure: Source: Authors' calculation using Malanima dataset. Data in %.



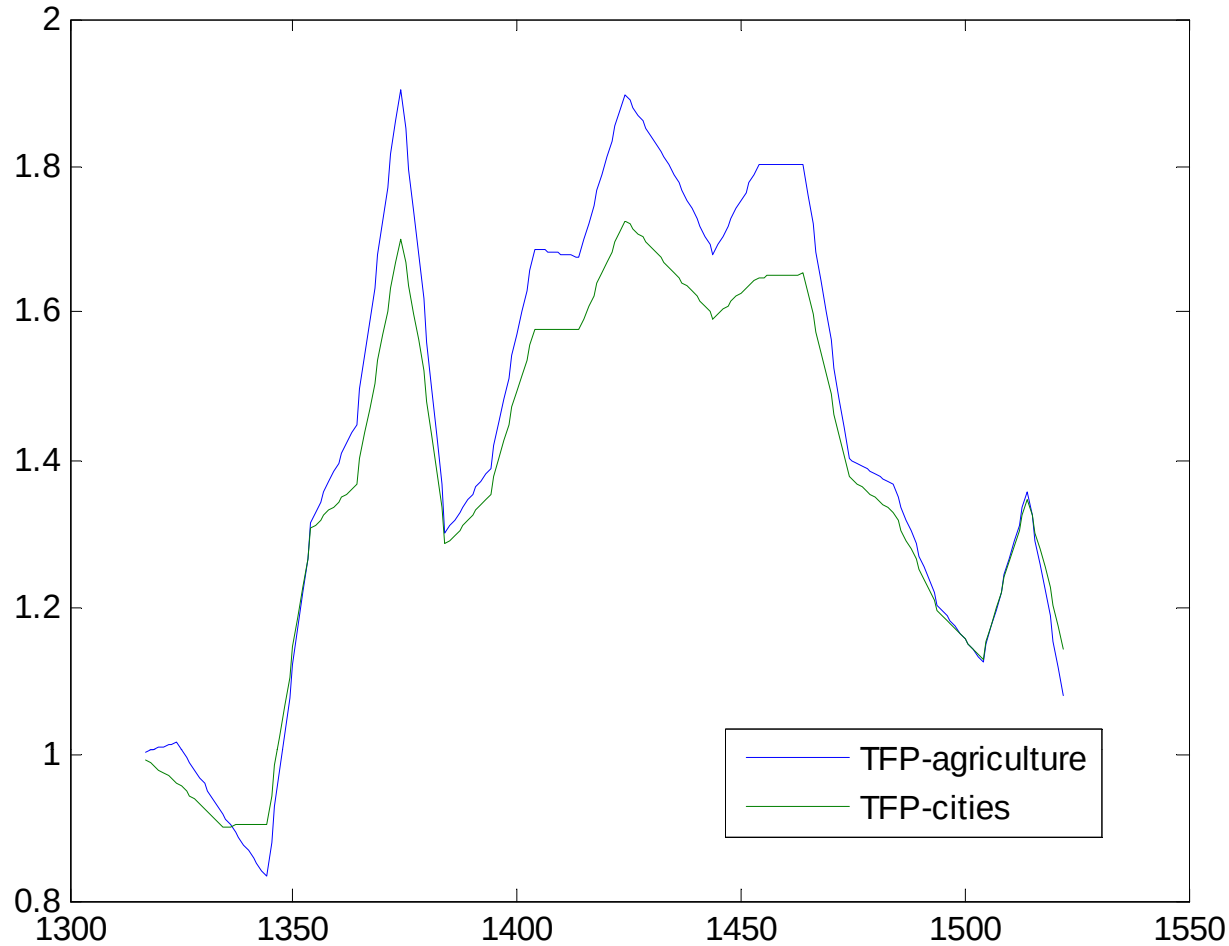
Labor Productivity in Italy during Middle Ages

Figure: Source: Authors' calculation using Malanima dataset.



Total Factor Productivity in Italy during Middle Ages

Figure: Source: Authors' calculation using Malanima dataset.



Preview of the Results

Interplay of these three forces:

1. particular specific productivity shocks and physical capital accumulation
2. institutions and specific human urban capital accumulation
3. trade and biased growth

We are able to disentangle and quantify these historical forces based on a general dynamic equilibrium model.

What is New in this Paper

- Historical interpretation of forces at work
- new modelling which covers these mechanisms
- original application of a Heckscher-Ohlin model in a macro DSGE framework with Arrow security

The Environment of our Model

We want to model the environment of Medieval Italy (Why Italy? Outstanding in the economic development, all three forces can be identified and some quantitative data available)

- Two areas j: urban (u) and country side (c)
- representative household
- two different production functions using traded intermediate goods as inputs
- one production function for the final good
- two worlds: with and without Arrow securities ($\equiv$ institutions) in the urban area
- less institutional structure in the country side (historical evidence)
- two worlds: with and without trade
- exogenous productivity shocks

Households: Utility Function

The preferences over consumption C and leisure N are summarized by the following intertemporal utility function:

$$U_{jt} = E_t \left[\sum_{s=t}^{\infty} \beta^{s-t} \frac{C_{js}^{1-\theta} \left(1 - N_{js}\right)^{\gamma(1-\theta)}}{1-\theta} \right] \tag{1}$$

- Stone-Geary preferences:

$$C_t = \left(c_t^A - \gamma^A \right)^{n^A} \sum_{s=jt} \left(c_t^S \pi_{it} \left(S^{it} \right) + \gamma^S \right)^{n^S} \tag{2}$$

Households: Factor of Production

Moreover, households:

- own both factor of production k_j and n_j, which are traded between the two areas
- can consume of invest the final good (not traded between the city and the country side, i.e. corner solutions are ruled out)
- deal with a set of Arrow-Debreu securities

Historical counterpart:

- in the urban area (manufacturing): skilled workers, human capital, physical capital and institutions
- in the country side (agriculture): unskilled workers and physical capital
- some variety of good $\Rightarrow$ trade

Households: Arrow Security (1)

The complete set of Arrow Security allows to find the Walrasian equilibrium maximizing the social welfare function:

$$U_t \equiv \sum_{j=u,c} \xi_j U_{jt} \tag{3}$$

with $\xi_j > 0$ under the following budget constraints

$$\sum_{j=u,c} p_{jt} \left(c_{jt} + i_{jt} \right) = \sum_{j=u,c} \left(w_{jt} n_{jt} + r_{jt} k_{jt} \right) \tag{4}$$

$$k_{u,t+1} = \left(1 - \delta^u \right) k_{u,t} + i_{u,t} \tag{5}$$

$$k_{c,t+1} = \left(1 - \delta^c \right) k_{c,t} + i_{c,t} \tag{6}$$

$\Rightarrow$

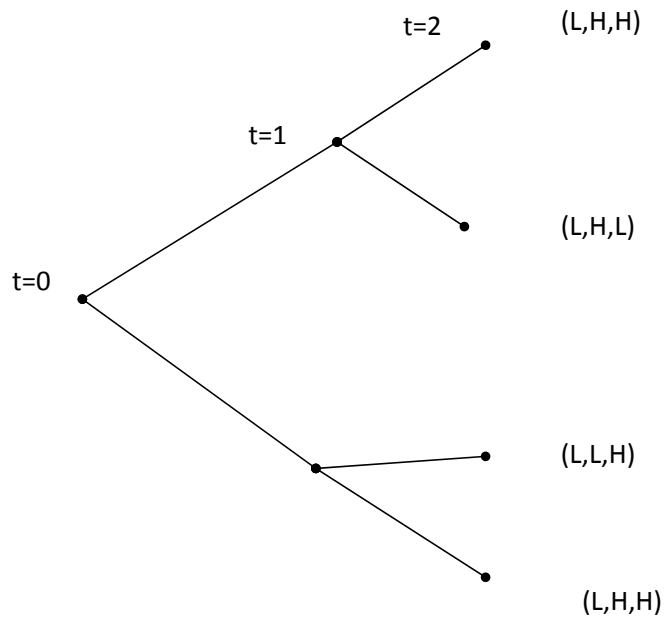
$$p_{c,t} \left(c_{c,t} + i_{c,t} + p_{u,t} \right) = y_{c,t} \equiv w_{c,t} n_{c,t} + r_{c,t} k_{c,t} \tag{7}$$

$$p_{u,t} \left(c_{u,t} + i_{u,t} - \frac{p_{i,t}}{p_{u,t}} \pi_t \right) = y_{u,t} \equiv w_{u,t} n_{u,t} + r_{u,t} k_{u,t} \tag{8}$$

Households: Arrow Security (2)

Assumptions:

- two-stage Arrow security is considered only in the urban area
- Arrow security $\Longrightarrow$ Institutions?
- the institutions determines the probability sequence of the Markov chain



Households: Arrow Security (3)

Why Arrow Securities should be chosen?

- household decides the implementation of an institution (e.g., firm contract)
- the institution can reduce negative externalities and does risk insurance
- can magnify the effect of positive spillovers (knowledge accumulation via merchant books)
- Arrow securities/contracts determine output based on probability and the duration

Households: Arrow Security (4)

The design of Arrow security implemented:

- we implement trade contract in form of partnership/firm
- critical lengths of contract: 8 years (empirical evidence: 6-10 years)
- higher return based on positive/negative externalities
- evidence of micro level on critical higher returns

Production Units. Final Good

The final good is produced in each area by a continuum of competitive production units which use two intermediate goods with the following Cobb-Douglas production function

$$Y_{jt} = y_{c,t}^{\phi} y_{u,t}^{1-\phi} \tag{9}$$

where $\phi \in (0, 1)$.
Y_{jt} is the per-capita output level of the final good and y_{ijt} is the specific good produced in area j.

Production Units. Intermediate Good

Intermediate goods are freely traded. However, even if the markets are competitive, production units in both areas have access to the same technologies to produces them, but in the urban area institutions can also play a role:

$$y_{ict} = a_{ict} k_{ict}^{\alpha i} n_{ict}^{1-\alpha i} \tag{10}$$

$$y_{iut} = a_{iut} i_{ut} k_{uct}^{\alpha i} n_{uct}^{1-\alpha i} \tag{11}$$

with $\alpha_i \in (0, 1)$. y_{ijt} is the amounts of intermediate good i produced in country$j$ at date t, while k_{jit} and k_{jit} n_{ijt} are respectively are respectively the amounts of capital and labor employed in the production of good i; a_{ijt} denotes the total factor productivity (TFP)

Equilibrium. Trade

If there is free trade between the countryside and the urban areas:.

$$w_t = \Gamma \left(\frac{s_N}{s_K}\right)^{s_K} \left(\frac{K_t}{N_t}\right)^{s_K} \tag{12}$$

$$r_t = \Gamma \left(\frac{s_K}{s_N}\right)^{s_N} \left(\frac{K_t}{N_t}\right)^{s_N} \tag{13}$$

with Γ function of the shares.

Dynamic Equilibrium.

$$\frac{c_{ct}}{c_{ut}} = \left(\frac{\xi_c}{\xi_u}\right)^{\frac{1}{(\theta+\gamma(\theta-1))}} \left(\frac{a_{ct}}{a_{ut} i_{ut}}\right)^{\frac{\gamma(\theta-1)}{(\theta+\gamma(\theta-1))}} \tag{14}$$

$$\frac{1-n_{ct}}{1-n_{ut}} = \left(\frac{\xi_c}{\xi_u}\right)^{\frac{1}{(\theta+\gamma(\theta-1))}} \left(\frac{a_{ct}}{a_{ut} i_{ut}}\right)^{\frac{\gamma}{(\theta+\gamma(1-\theta)-\theta)}} \tag{15}$$

Steady State.

- Capital level accumulations

$$\frac{\bar{I}_j}{\bar{K}_j} = \delta^j \tag{16}$$

- the two budget constraints

$$\bar{p}_j \left(\bar{c}_j + \bar{i}_j + \bar{p}_u\right) = \bar{y}_j = \bar{w}_j \bar{n}_j + \bar{r}_j k_j \tag{17}$$

- the wage rate and the rate of return of capital

$$\bar{w} = \Gamma \left(\frac{s_N}{s_K}\right)^{s_K} \left(\frac{\bar{K}}{\bar{N}}\right)^{s_K} \tag{18}$$

$$r_t = \Gamma \left(\frac{s_K}{s_N}\right)^{s_N} \left(\frac{\bar{K}}{\bar{N}}\right)^{s_N} \tag{19}$$

- the dynamic recursive equilibria

$$\bar{I} = \frac{\zeta_u \sum_{jt} \bar{c}_u^{1-\theta} \prod \left(s^i\right) \left(1 - \bar{n}^u\right)^{\gamma(1-\theta)-1}}{\zeta_c \bar{c}^{1-\theta} \left(1 - \bar{n}\right)^{\gamma(1-\theta)-1}} \tag{20}$$

Calibration.

Parameter	Definition	Value	Source
α_1	Int. capital share 1	0.11	Malanima
α_2	Int. capital share 2	0.214	Malanima
ϕ	Final capital share	0.168204	Theory
θ	Rate of intertemporal subsitution	0.3	Voth
β	Intertemporal discount factor	0.99	Theory
γ^A	Stone-Geary parameter 1	0.5	Voth
γ^N	Stone-Geary parameter 2	0.5	Voth
$\bar{r}^u$	Urban capital rent	0.095	Clark
$\bar{r}^c$	Countryside capital rent	0.086	Clark
δ^u	Urban depreciation rate	0.105	Theory
δ^c	Countryside depreciation rate	0.105	Theory
ω	Value of capital share	0.8	Theory
ζ	Welfare weight	0.7	Theory

The Rybczynski Theorem.

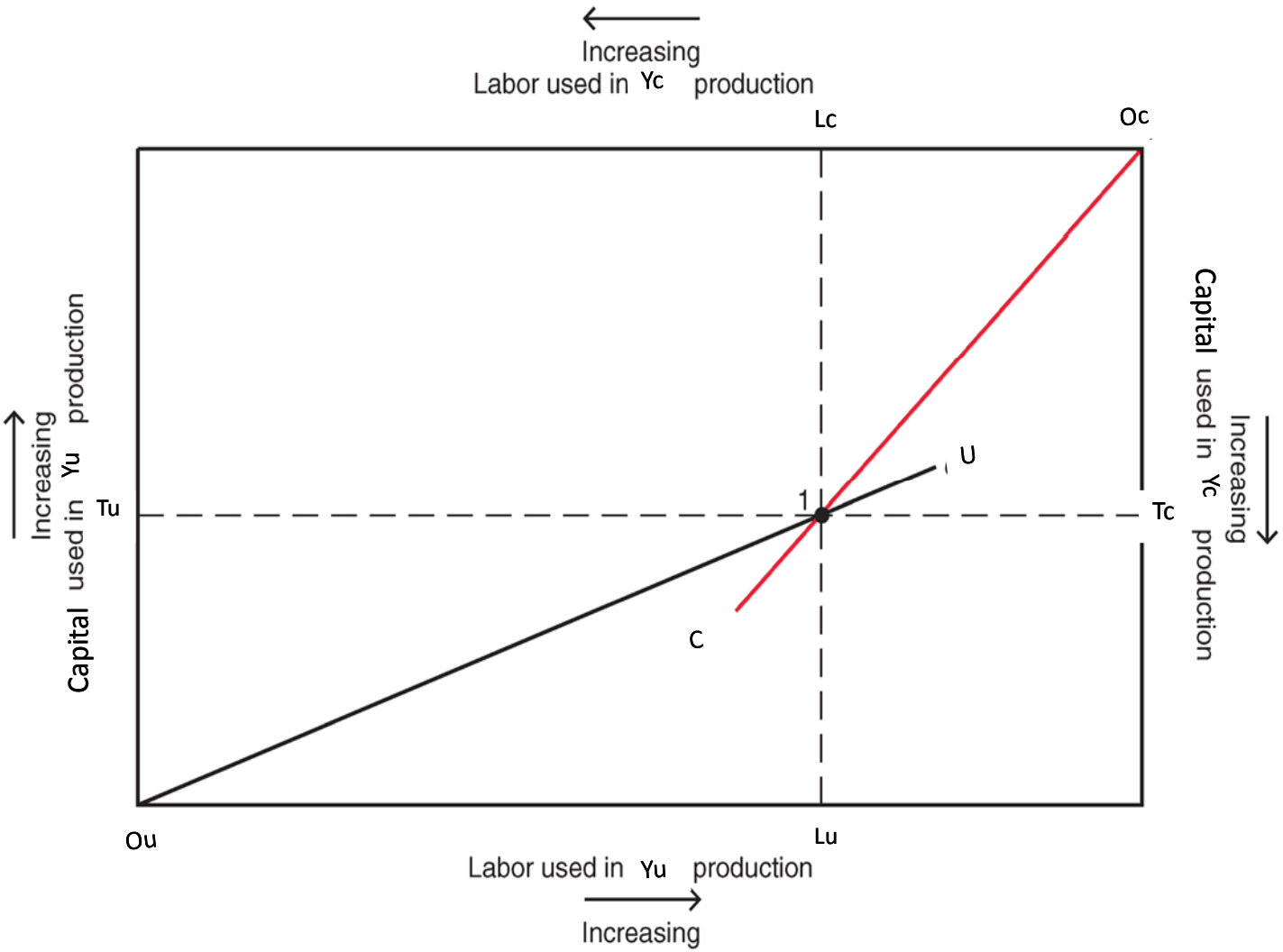
Increase in the endowment of one factor causes a more than proportional increase in the output of the good that uses the factor intensively and an absolute decline in the output of the other good. (Krugman and Obstfeld, 2009)

$$\Rightarrow$$

if, at time t, there are factor proportion differences between the two areas, technological change is balanced, and there is capital deepening, then growth is not balanced, i.e.
$\ln\left(\frac{Y_{ut}}{Y_{ut-1}}\right) \neq \ln\left(\frac{Y_{ct}}{Y_{ct-1}}\right)$ (Acemoglu, 2009)

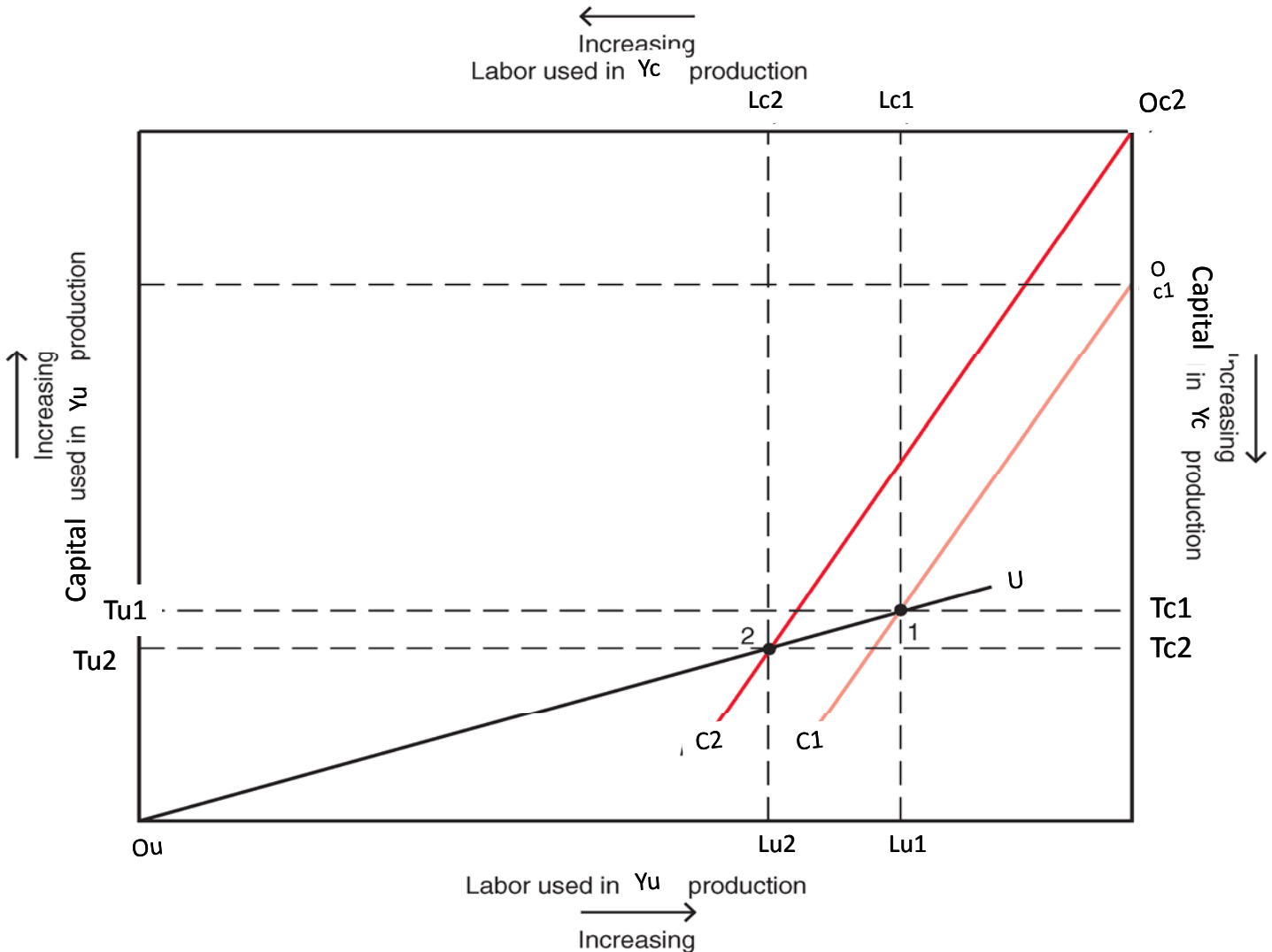
The Rybczynski Theorem.

Figure: The Allocation of Resources



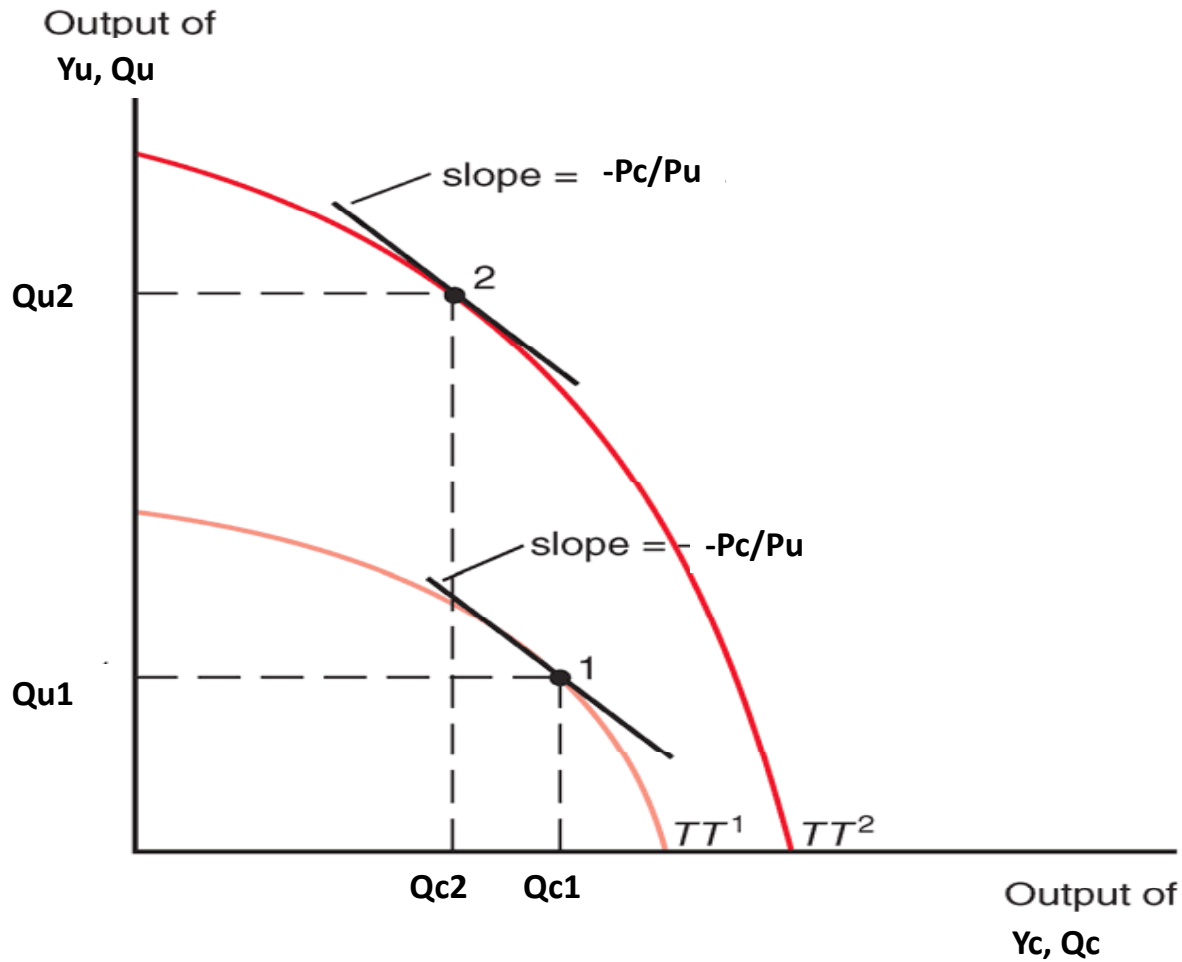
The Rybczynski Theorem.

Figure: An Increase in the Supply of Capital

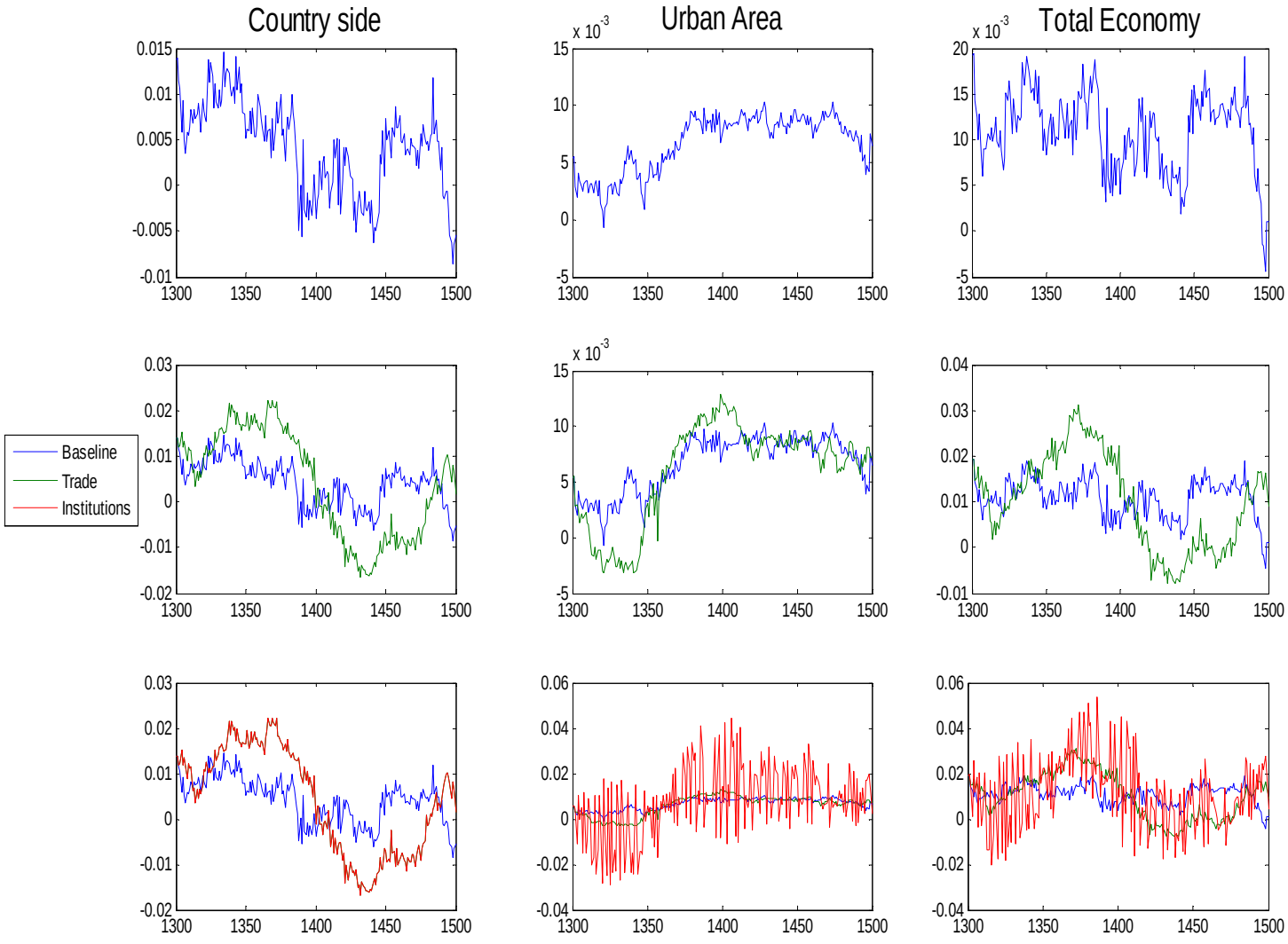


The Rybczynski Theorem.

Figure: Resources and Production Possibilities



Numerical Simulation: A Comparison. Output



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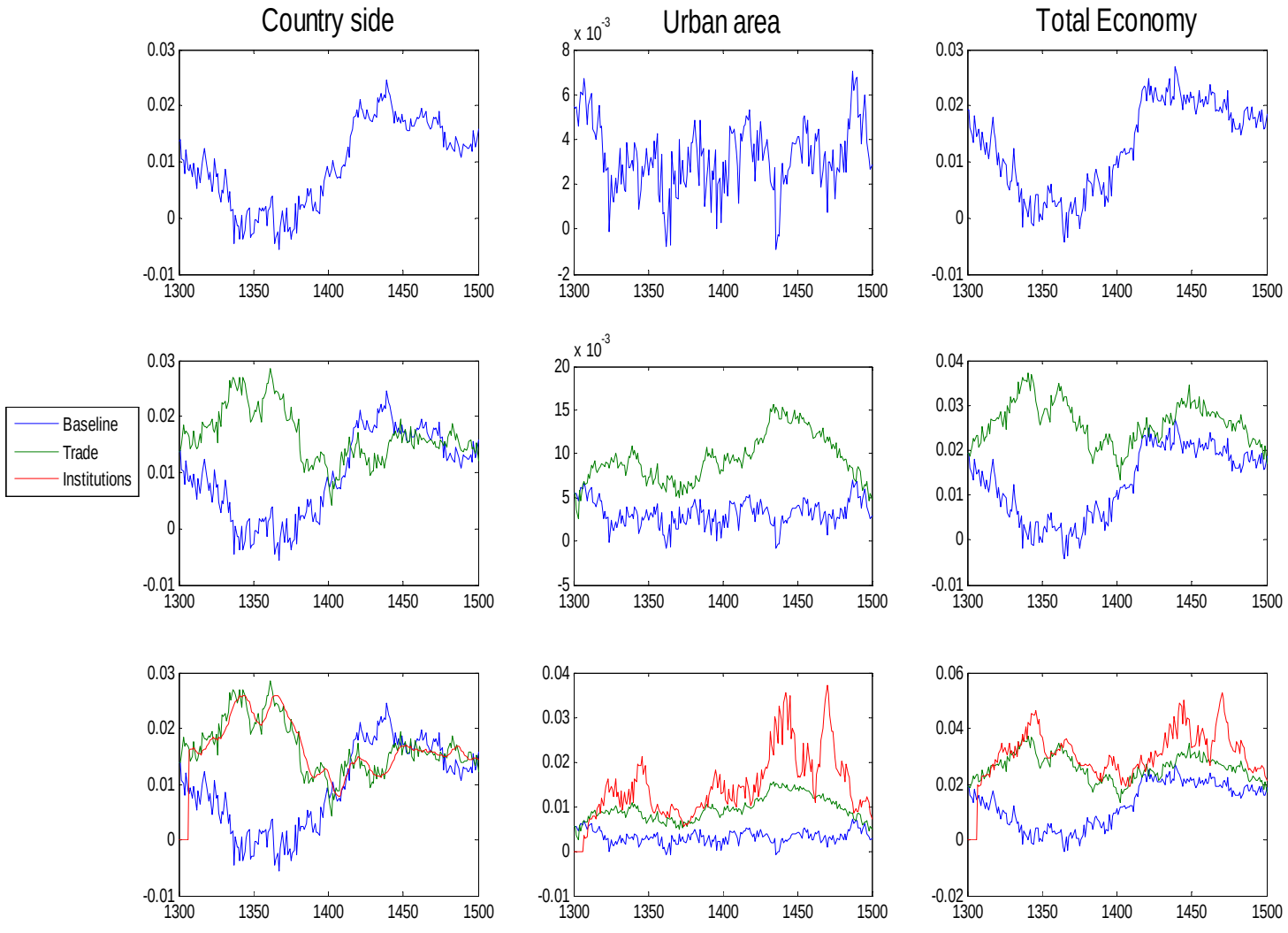

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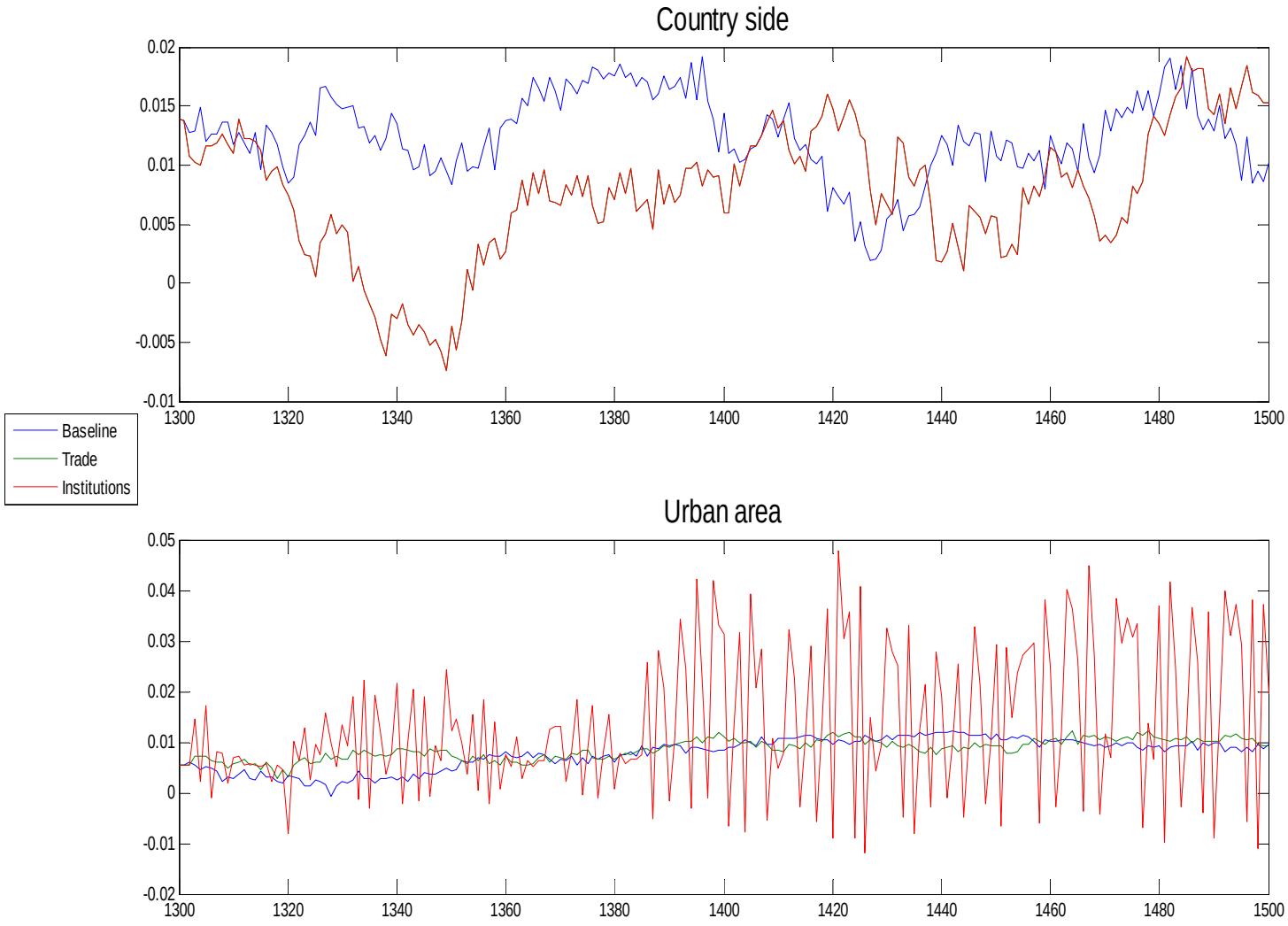

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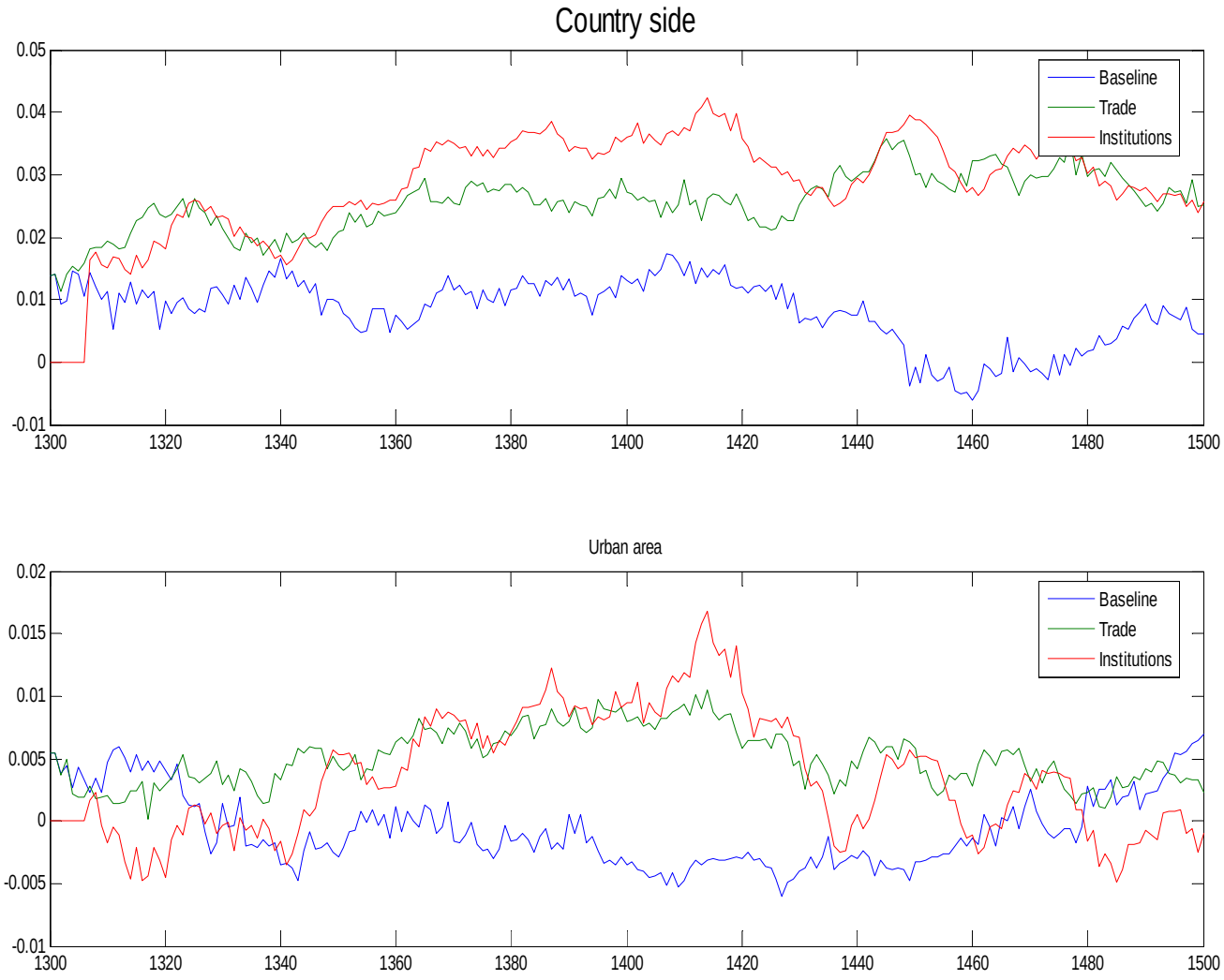
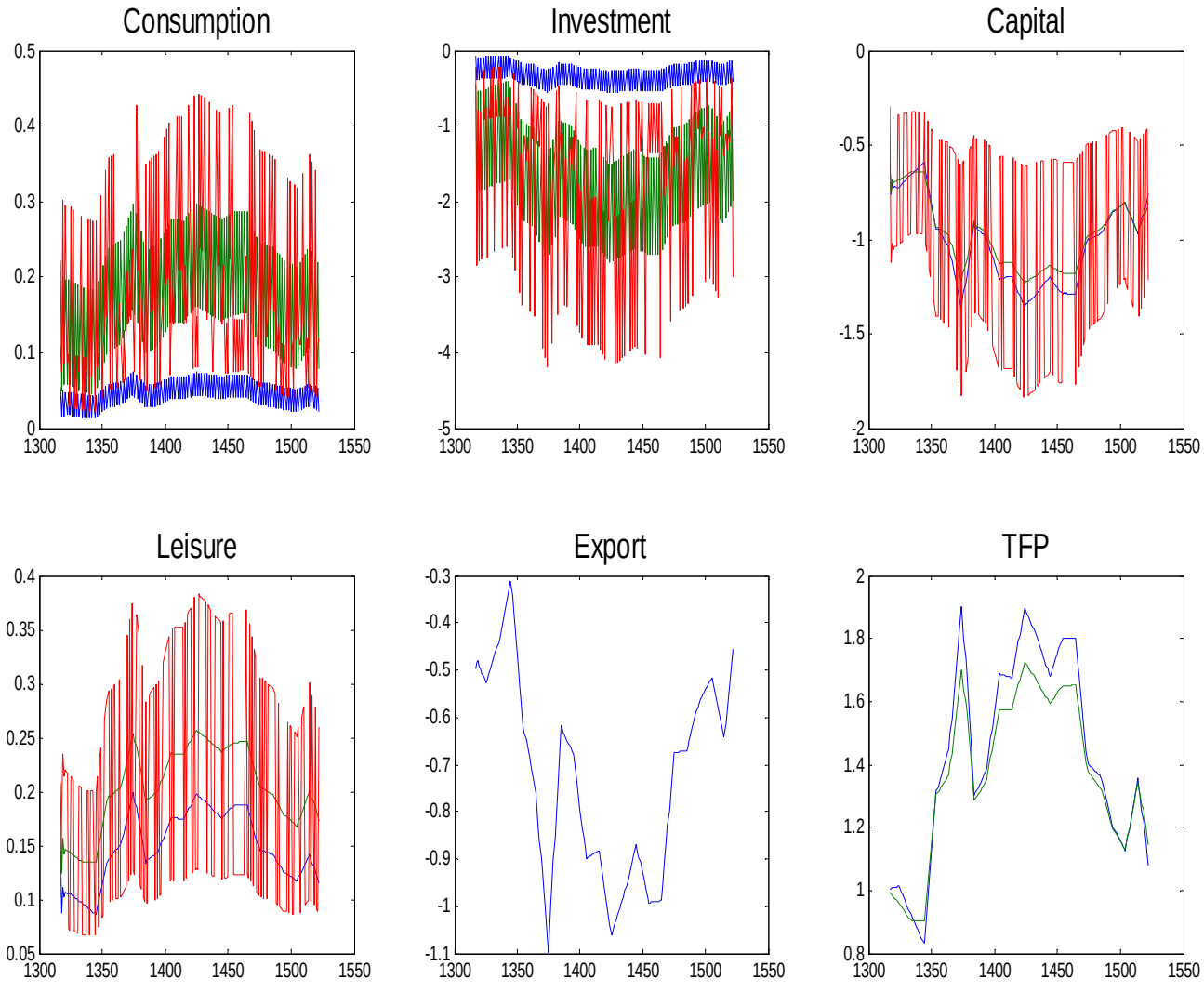
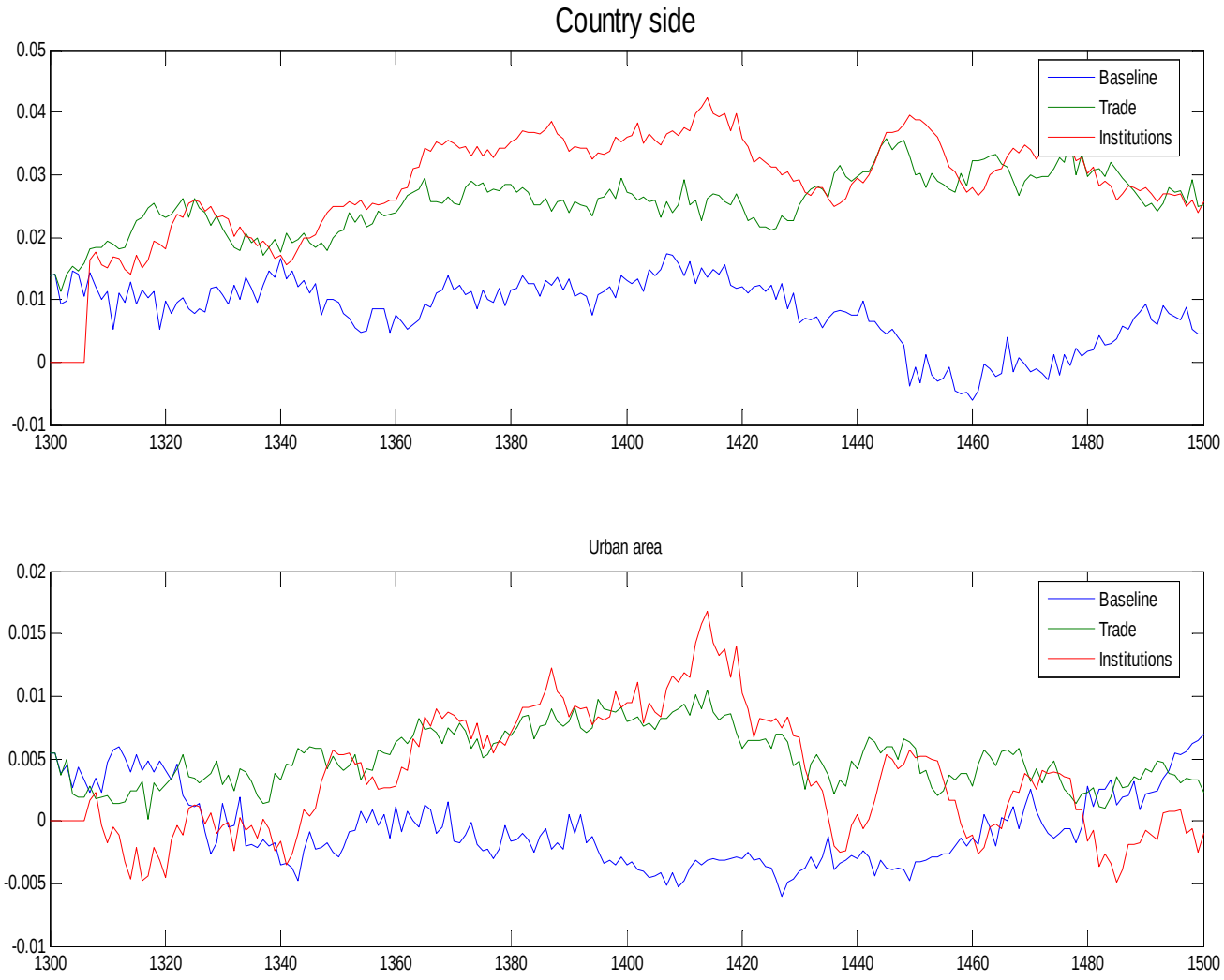


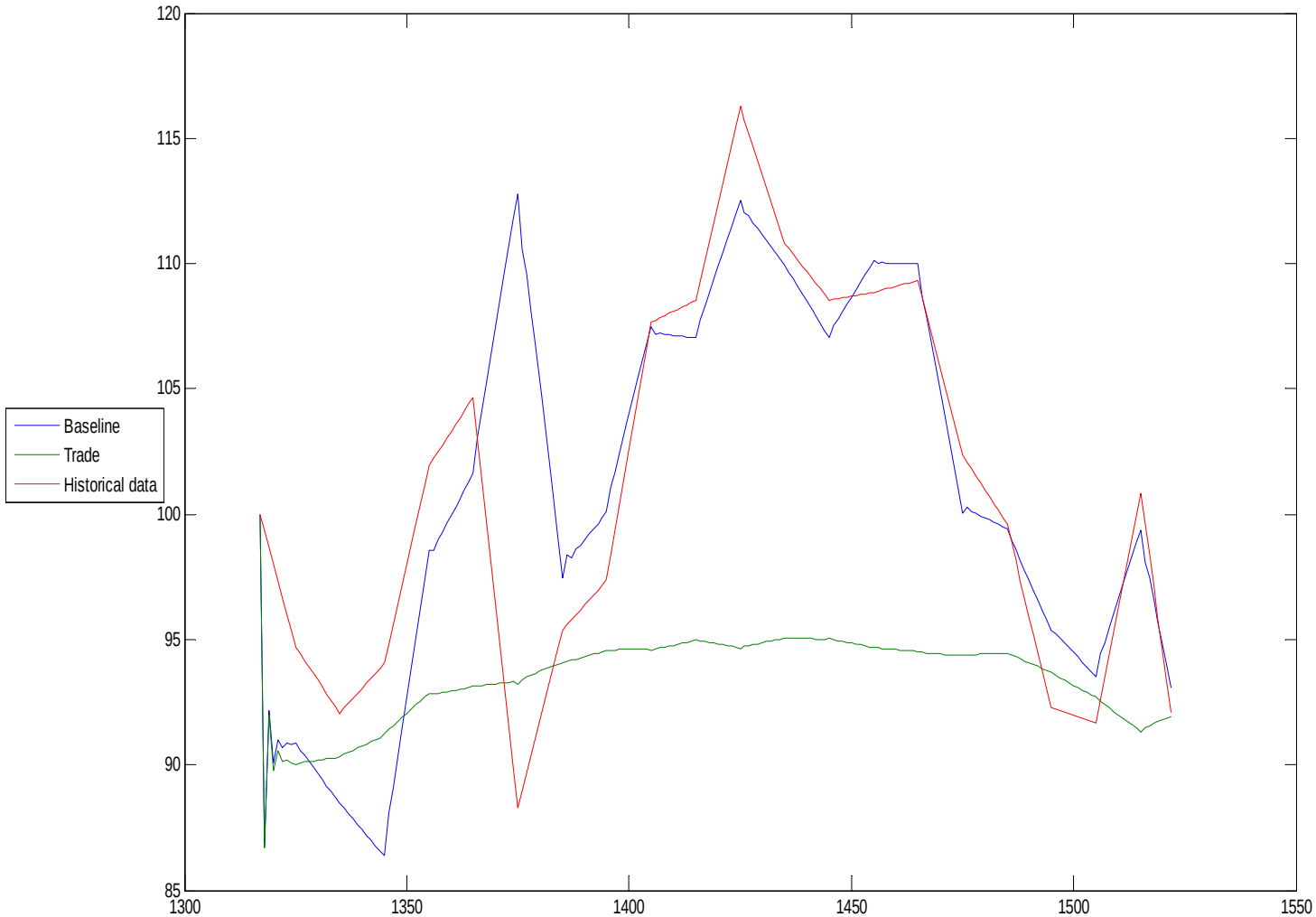
Feeding the Model with Historical Data



Feeding the Model with Historical Data: A Comparison.



Output in the Coutry Side: A Comparison.



Output in the Cities: A Comparison.