Former Communist Countries and their transition to Capitalism

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Abstract

This paper uses the technology adoption general equilibrium model developed by Moscoso Boedo (2006) to analyze the transition for the countries of the former USSR and Eastern Europe. There the real output displayed a U-shapped pattern together with increases in inequality, which are features matched by the model

1. Introduction

The collapse of communism in the early 1990s initiated a set of transformations that continue to take place today in Eastern Europe and Asia. After the communist regimes fell, a transition to a market economy took place, with patterns that repeated themselves in almost all of the former centrally planned economies. Among the most notable effects of this transition we can point out a U-shape behavior of GDP per capita, and a sharp increase in income inequality.

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Can these changes be explained by a model of technology adoption? In other words, can the events in Eastern Europe and the former USSR be rationalized as the introduction of technology adoption mechanisms that generated these distinct patterns?

The focus of this paper is to try to understand the sudden transition from communism to capitalism as a technology adoption phenomenon. The model developed in Moscoso Boedo (2006) provides a good framework to analyze the behavior of these economies.

The work by Milanovic (1998), which studies the evolution of various indicators in the post communist transition, focused on income, poverty and inequality, when referring to the evolution of output argues that *"After the Great Depression of 1929-33, this decline represents the largest peacetime contraction of world output".*

In terms of income distribution Milanovic (1998) documents increases in the Gini coefficient in every country involved, with an average of 9 points, from 24 to 33 in a very short period of time.

The increases in income inequality seem to be a feature common in many transition processes. Latin America in the 1990s experienced rising levels of inequality together with policies that opened its markets to foreign competition and investment. China is also an example where the levels of inequality are rising dramatically.

The difference between cases like Latin America or China and Eastern Europe or the republics of the former Soviet Union is that GDP per capita suffered an abrupt decrease in Eastern Europe an the former USSR, whereas the 1990s were years of positive growth in both Latin America and China.

The dissimilar reactions experienced in China vs.. the centrally planned economies of Eastern Europe or the republics of the former Soviet Union may be explained by the way the collapse of the soviet regime took place. In the Soviet Union and satellite states in Eastern Europe, the communist regime fell in a matter of months, whereas in China, the transition to capitalism has been much smoother, and may explain the different behavior in the macro variables. The sudden collapses of the regimes in Eastern Europe and the Soviet Union present a better scenario to analyze the effect of an unforeseen and abrupt regime change compared to China due to the speed in which the changes took place.

The paper is organized as follows: Section 2 presents the model economy based in Moscoso Boedo (2006), where the choice of production technology is at the center of the economic problem. Section 3 calibrates the model to the former soviet states. Section 4 analyzes the dynamics of income distribution and output per worker in the event of a sudden regime change predicted by the model and finally section 5 concludes.

2. The Model Economy

The model used to analyze the effects of the fall of communist regimes in the former USSR and Eastern Europe is the same as the one developed in Moscoso Boedo (2006).

The utility function of the infinitely lived representative consumer is given by

$$\sum_{t=0}^{\infty} \beta^t u\left(C_t\right) \tag{2.1}$$

The planner in this economy maximizes (2.1), subject to the following budget constraint

$$C_t + I_t \leq F\left(b_t, K_{p_t}, S_{p_t}, U_{p_t}\right) \tag{2.2}$$

where C_t denotes consumption in period t, I_t denotes investment in physical capital in period t, and $F()$ denotes the production function of final goods. $F()$ is a function of the following: b_t indexes the technology adopted in period t, that is, there will be a continuum of functions $F(b_t,\cdot)$ indexed by b_t which is a continuum variable from 0 to 1, and in period t the actual production function adopted will be that indexed by b_t. Once the production function is determined by b_t the amount produced is a function of the physical capital, the skilled labor and the unskilled labor devoted to the production of final goods, K_{p_t}, S_{p_t}, and U_{p_t} respectively.

Technological change is costly. The function $G(b_t, b_{t+1})$ maps changes in the production function into costs of adjustment, with the following properties: $G(b_t, b_t) = 0$, $G(b_t, b_{t+1}) > 0$ for $b_t \neq b_{t+1}$ and $G(b_t, b_{t+1}) = G(b_{t+1}, b_t)$. These costs of adjustment can be understood as accelerated depreciation of the stocks of physical capital and skilled labor or obsolescence due to technological change of those stocks. This idea of a cost of adoption can be linked to the existing literature, where skills are technology specific, as in Chari and Hopenhayn (1991), or that technology is embedded in physical capital as in Jovanovic (1998). Those cases are extreme cases of a cost function, where if technology changes skills or physical capital are completely useless under the new technology, and therefore, in their cases, they have simultaneous presence of new and old technologies, since the cost of changing skills or physical capital is extremely high. This cost function can be understood as capturing the fact that some skills and physical capital may not be appropriate under every technology. For example, the transition from steam to diesel locomotives, meant that some skills were not used anymore, whereas others remain perfectly suitable under the new technology. So this technology transfer cost function can be thought of as capturing an average cost of transition from one technology to other.

The stocks of skilled labor, unskilled labor and physical capital, are divided as follows:

$$U_{p_t} + U_{e_t} + S_{p_t} + S_{e_t} \leq 1 \tag{2.3}$$

$$K_{p_t} + K_{e_t} \leq K_t \tag{2.4}$$

$$U_{p_t} \geq 0,\ U_{e_t} \geq 0,\ S_{p_t} \geq 0,\ S_{e_t} \geq 0 \tag{2.5}$$

Where a variable with a subscript p denotes that that variable is being used in the production of final goods, and a variable with an e subscript denotes a variable that is being used in the production of skilled workers (interpreted as the educational sector). Variables without p or e subscript denote aggregates of physical capital or skilled labor.

The production of skilled labor is given by a function $H\left(K_{e_t}, S_{e_t}, U_{e_t}\right)$. Where I interpret the function $H\left(K_{e_t}, S_{e_t}, U_{e_t}\right)$ as the output of the educational sector. Therefore S_{e_t}denotes the skilled workers in the educational sector, or teachers, U_{e_t} denotes the students and K_{e_t} the physical capital in the educational sector.

The law of motion for the stocks of physical capital and skilled workers are as follows:

$$S_{t+1} \leq S_t \left[1 - \delta_s - G\left(b_t, b_{t+1}\right)\right] + H\left(K_{e_t}, S_{e_t}, U_{e_t}\right) \tag{2.6}$$

$$K_{t+1} \leq K_t \left[1 - \delta_k - G\left(b_t, b_{t+1}\right)\right] + I_t \tag{2.7}$$

Combining (2.2) and (2.7) we get

$$C_t + K_{t+1} \leq F\left(b_t, K_{p_t}, S_{p_t}, U_{p_t}\right) + K_t \left[1 - \delta_k - G\left(b_t, b_{t+1}\right)\right] \tag{2.8}$$

So, the problem can be written as, maximize (2.1), subject to (2.3), (2.4), (2.5), (2.6), and (2.8)

Functional forms

Following Moscoso Boedo (2006) I keep with my choices of functional forms for the utility function, production function, the educational function and the technology change cost function. The model stated above requires the choice of functional forms for the functions $u()$, $F()$, $G()$, and $H()$.

For the instantaneous utility function, I assume that it is of the form

$$u\left(C_t\right) = \frac{C_t^{(1-\varphi)}}{1-\varphi}$$

The technology adjustment cost function $G()$ is given by

$$G\left(b_t, b_{t+1}\right) = e^{\zeta\left(\frac{b_{t+1}}{b_t}-1\right)^2} - 1 \tag{2.9}$$

This function satisfies the requirements stated above, $G(b_t, b_t) = 0$ and $G(b_t, b_{t+1}) > 0$ for $b_t \neq b_{t+1}$.

Note that the function $G\left(b_t, b_{t+1}\right)$ is convex, which is in line with a whole literature of convex adjustment cost, which induce the planner or the market to take small steps in adjusting the technology instead of taking big jumps. Also note that the function $G\left(b_t, b_{t+1}\right)$ has the property that its derivatives in steady state are equal to zero. The function $G\left(b_t, b_{t+1}\right)$ is affected by only one parameter, ζ. As ζ increases the costs associated with technological change (in terms of skilled workers and physical capital), increase, affecting the dynamic transition off the model (while not in steady state).

The choice of the production function of final goods, $F()$, is not straightforward. Since one of the features I want the model to capture is the evolution of the skill premium, it should be the case that skilled and unskilled labor are imperfect substitutes. Therefore I restrict the attention to the family of nested CES functions, with inputs K_p, S_p and U_p. Let $\Omega(A_t, B_t; a, \varrho)$ be a CES function between inputs A_t and B_t with weights parameter a and elasticity parameter ϱ. The technological choice of interest is constrained to the skill biased parameter, which I will call b for "bias". Therefore I restrict the attention to the CES weights between terms containing skilled workers and unskilled workers[1]. Then the possible nested CES forms are:

- $F^1 = \Omega(\Omega(U_t, S_t; \mathbf{b}, \rho_1), K_t; a, \rho_2)$
- $F^2 = \Omega(\Omega(S_t, K_t; a, \rho_1), U_t; \mathbf{b}, \rho_2)$
- $F^3 = \Omega(\Omega(U_t, K_t; a, \rho_1), S_t; \mathbf{b}, \rho_2)$

F^1 is the production function of choice in both Heckman, Lochner and Taber (1998) and Caselli and Coleman (2005). The problem with this functional form is given by the fact that in steady state $F_b(b, K_p, S_p, U_p) = 0$ which requires that $U = \iota S$, where ι denotes some constant, independent of the level of T.F.P. The condition of $U = \iota S$ is a direct consequence of the linearity of the CES function with respect to b.

F^2 is the production function used by Krusell et. al. (2000). They argue in favor of F^2 instead of F^3 because data collected by Hamermesh (1993) suggest that the elasticity of substitution between S and U is higher than that between S and K, and

[1] Even though it is conceivable that one could make the choice of technologies be that of choosing all the parameters in the production function (ρ_1, ρ_2, a, b), I restrict the attention to only b.

function F^3 restrict them to be equal. This feature in the data comes from estimates of the partial elasticity of substitution, which depends on the levels of S, U and K, and not only on the substitution parameter. As I show later, the partial elasticity of substitution in specification F^3 between S and U is higher than that between S and K. The problem with specification F^2 is that under the parameters suggested by Krusell et. al. (2000), the endogenous technological change goes towards higher intensities in the use of unskilled labor. One alternative would be to use F^2 under a different set of parameters, but that would violate the moments estimated by Krusell et. al. (2000), in particular the elasticities of substitution between capital, skilled workers and unskilled workers. That is why I choose form F^3 as the production function in the paper[2].

To summarize the production function used in the quantitative exercise is given by

$$F\left(b_t, K_{pt}, S_{pt}, U_{pt}\right) = z_t \left\{ b_t \left[aU_{pt}^{\rho_1} + (1-a) K_{pt}^{\rho_1} \right]^{\frac{\rho_2}{\rho_1}} + (1-b_t) S_{pt}^{\rho_2} \right\}^{\frac{1}{\rho_2}} \tag{2.10}$$

Finally the function $H()$ is assumed to be Cobb-Douglas:

$$H\left(U_{e_t}, S_{e_t}, K_{e_t}\right) = \psi U_{e_t}^{\mu} S_{e_t}^{\xi} K_{e_t}^{1-\mu-\xi} \tag{2.11}$$

The specification of the law of motion for the stock of skilled workers in equation (2.6) does not restrict S_t to be less than 1, in the case of high enough K_e. Even though this is possible, the planner never chooses an $S_t > 1$ because the productivity of the

[2] F^3 is also the production function of choice in Funk and Vogel (2004).
Under the set of parameters chosen in table 1, the form F^3 does match the elasticities of substitution estimated by Hamermesh (1993), which were close to the ones estimated by Krusell et. al. (2000)

unskilled workers approaches infinity as U_t approaches zero.

3. Calibration

In order to proceed with the calibration and to make things simple, I will use the same calibration as Moscoso Boedo (2006), where parameters where calibrated to the US economy circa 1990. The only parameter that will be calibrated to the former communist economies will be the total factor productivity parameter z which will be set to match the Russian GDP according to Heston, Summers and Aten (2002) relative to the US, which was around 30%. The parameter values presented in table 1, are set so as to match as close as possible the moments presented in table 2.

Therefore, the parameter values are:

Table 1: Parameter values in the model

Parameter	z	ψ	μ	a	ρ_1	ρ_2	ξ	δ_s	δ_k	β	φ	ζ
Value	.52	.2	.75	.5	.75	$-.2$	.1759	.02	.08	.96	2	23

Which match the following moments for the US economy around 1990.

Table 2: Identifying moments.

Comparison between the model and the data in 1990

Moment	Model	Data US, 1990
Skill Premium	1.88	1.87[3]
Skilled workers	.87	.94[4]
Consumption Output Ratio	.83	.79[5]
Primary students over Labor Force	.177	.164[6]
Expenditure per pupil over GDP per worker	.1258	.1132[7]
Capital Share of GDP	.2915	.3
Wage expenditure in education	.7036	.7036[8]
$\frac{\sigma_{S,U}}{\sigma_{S,K}}$	2.62	2.49[9]

4. Dynamics

In order to analyze the collapse of the communist regime, one must define what the regime meant in terms of the model. One alternative would be to follow Moscoso Boedo (2006b), and incorporate a government into the model, where this government taxed close to 100% of income and transferred equally across workers. If we do that,

[3] Return to 8 years of schooling calculated as $\exp(\omega_t 8)$, where ω_t equals the return to one year of high school for "All men" reported by Goldin and Katz (1999).

[4] From DeLong, Goldin and Katz (2003) average between 1980 and 2000 for workers with less than 8 years of schooling.

[5] This is the ratio of Personal Consumption Expenditures to Personal income reported by the Bureau of Economic Analysis, in its table 2.1 for the year 1990

[6] Calculated as the ratio of students enrolled in primary school times the participation rate over the total labor force. Source: Statistical Abstract of The US for 1994 (data taken for 1990).

[7] Obtained from the Statistical Abstract of the US 1990

[8] Obtained from the Statistical Abstract of the US for 1990

[9] $\sigma_{S,U}$ equals the partial elasticity of substitution between S and U. Therefore, $\frac{\sigma_{S,U}}{\sigma_{S,K}}$ is the ratio of partial elasticities of substitution between S and U and S and K. According to Krusell et al (2000) it is 2.49, which is based in turn in calculations reported by Hamermesh (1993)

the technology parameter at taxation level close to 100% is around .6. A simpler way to proceed is to set that technology parameter equal to .6 and derive a steady state where that parameter is not a choice anymore. Then, the transition from a centrally planned to a market economy is modeled as an expansion of the set of available technologies. So, in 1990, this economies changed regimes, from one with a b-parameter fixed in .6 to one where it is a choice variable. Alternatively, the regime change can be interpreted as a change in the technology change parameter ζ from ∞ to some finite value.

Given the calibration the initial level of b is about 20% above the level that a planner with the choice of technology would have picked. So, the experiment consists on starting on a steady state level with the technology parameter fixed at 20% above its steady state when b is a choice variable, and allow the economy to transit to its new equilibrium. We assume that TFP remains constant. Thus, it is possible to view this experiment as tracking the dynamics of the economy to a one time change in the cost of adjusting technologies, ζ, which we assume took place around 1990.

Alternatively, we can view the regime change as lifting constraints on the government. Starting with a constraint towards maximum redistribution, the government under the old regime was forced to tax almost all the income from both workers and capital, and suddenly that redistribution constraint was lifted, allowing the markets to operate without extremely high tax rates. So, under almost 100% tax rate the incentives were not there for the creation of skilled workers, and therefore it was optimal to adopt technologies that were relatively intensive in the use of the unskilled workers. Once tax rates are lowered, the creation of skilled workers increases and also the economy experiences a transition towards skill intensive technologies.

Inequality measure

In terms of inequality, the data available is in terms of Gini coefficients. Milanovic

(1998) reports the evolution on Gini coefficients on income per capita for 18 former communist countries for the years 1987/88 and 1993/95. He finds that in all of the countries but The Slovak Republic, the Gini coefficient suffered a sharp increase in that period. The average Gini coefficient jumped from 24 to 33, with extreme cases such as the Kyrgyz Republic, where the Gini coefficient was 26 points in 1987/88 and 55 points in 1993/95.

In the model the Gini coefficient is computed using labor income. Skilled workers S receive wages w_s, and unskilled workers U_p receive wages w_u. In addition to those elements, I will also consider the fraction of workers that go back to the educational system because they have to build skills that are needed in the new economy. These workers will be paid some fraction of the unskilled wage. So, there is some fraction of workers U_e that represents the unskilled workers in the educational system. This fraction U_e will be divided into two, first $\widehat{U_e}$ which is determined by the steady state level of U_e and represents students in the educational level. The rest, namely $U_e - \widehat{U_e}$ represents unskilled workers that are not in the production process because they are building skills demanded in the "new" economy.

So, in every period, I will have 3 elements in order to compute the model's version of the Gini coefficient: $max(U_e - \widehat{U_e}, 0)$ workers earning ωw_u where ω represents the fraction of the unskilled worker that the workers that are building skills for the new economy get[10], S workers earning w_s and U_p earning w_u. Since the results depend on the chosen value of ω Figure 4.1 plots the evolution of the Gini coefficient for different levels of ω.

[10] ω is introduced to make the model comparable to the data. According to Milanovic (1998), the subsidies in the former communist countries of Eastern Europe and the former Soviet Union was around 30%-50% of the average wage

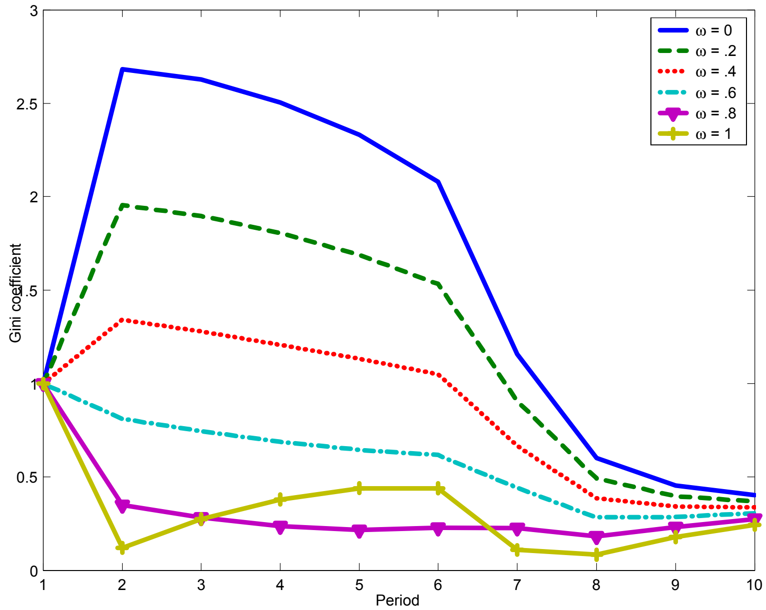

Figure 4.1: Evolution of the gini coefficient as a fuction of ω

Dynamic analysis

As it can be seen in Figures 4.1 and 4.2 the behavior of the Gini coefficient and income depend on the payments to newly created unskilled workers that are generating the skills required in the new regime. Note that increases of more than 50% in terms of Gini coefficients correspond to the cases of low payments to unskilled workers. This workers can be interpreted as re investing in skills under the capitalist regime. Also the case with low subsidies to skill creation generates the observed pattern in terms of the evolution of the total output. The case of subsidies lower than 30% of the wage earned by an unskilled worker corresponds to decreases of up to 30% in total output as discussed by Milanovic (1998). Milanovic (1998) also reports the average social subsidy as a fraction of the average wage rate for some former communist countries. In all the

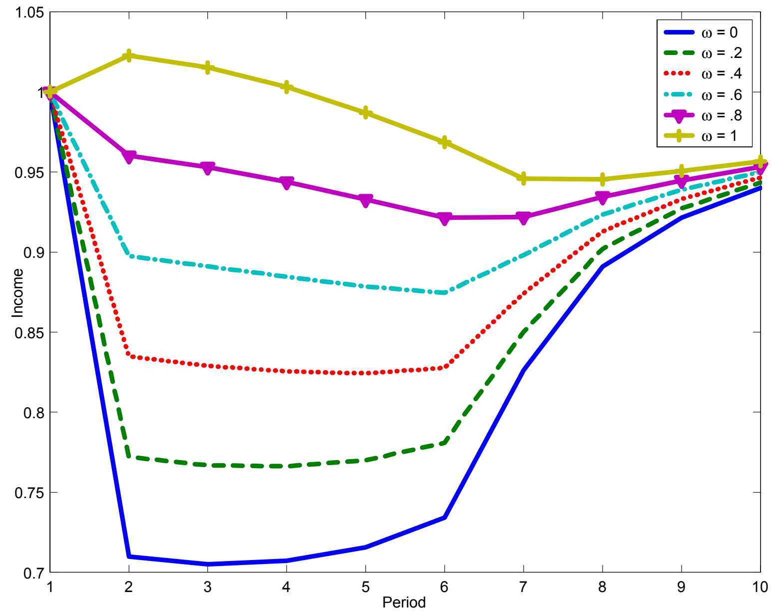

Figure 4.2: Evolution of the GDP per capita as a function of ω

cases the subsidy was around 30%-50%, which gives additional support to the ω being in that range. Note that during the transition $U_e - \widehat{U_e}$ is positive, meaning that under the new regime workers are reallocated to build skills initially and the fraction of those being subsidized is greater initially, generating increases in income inequality. That effect is present even though the relative wages go initially in favor of the unskilled wage.

It is important to keep in mind that throughout the experiment Total Factor Productivity remains unchanged, so, if it were to increase, which is something that we could expect that would make the recovery much faster.

When compared to the data, the model does a very good job in predicting the evolution of the GDP per capita[11] as shown in Figure 4.3

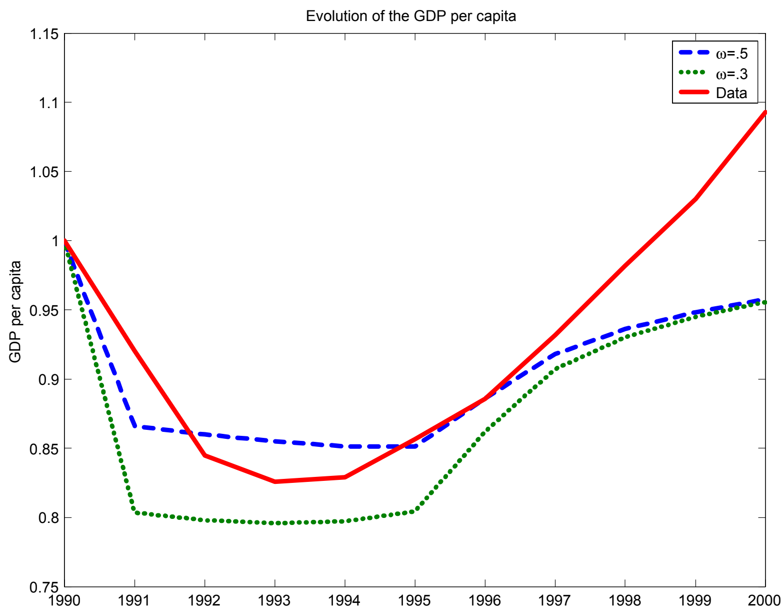

Figure 4.3: Comparison of the evolution of the average GDP per worker in the communist countries vs that predicted by the model

The evolution of the average gDP per worker is matched almost completely up until 1997. This suggest that the initial phase of the transition may be explained by a model of technical adoption. After 1997, the model loses predictive power, possibly due to increases in TFP.

In terms of the Gini coefficient, at ω between 30% and 50% the comparison between the data and the model is given by Figure 4.4. There, it can be seen that the model is close to the data at ω around 30% up to 1994, but that the model predicts decreases in the level of inequality after the initial reaction. This is caused by the fact that

[11] Constructed as the unweighted average of the GDP per capita of the former communist countries in Easter Europe and the Soviet Union with data starting in 1990 in the Penn World Tables.

the model is only capturing a transition effect generated by the reallocation of workers between the educational and productive sectors. After 1994, the model is incapable to match the relative stable evolution of Gini Coefficient.

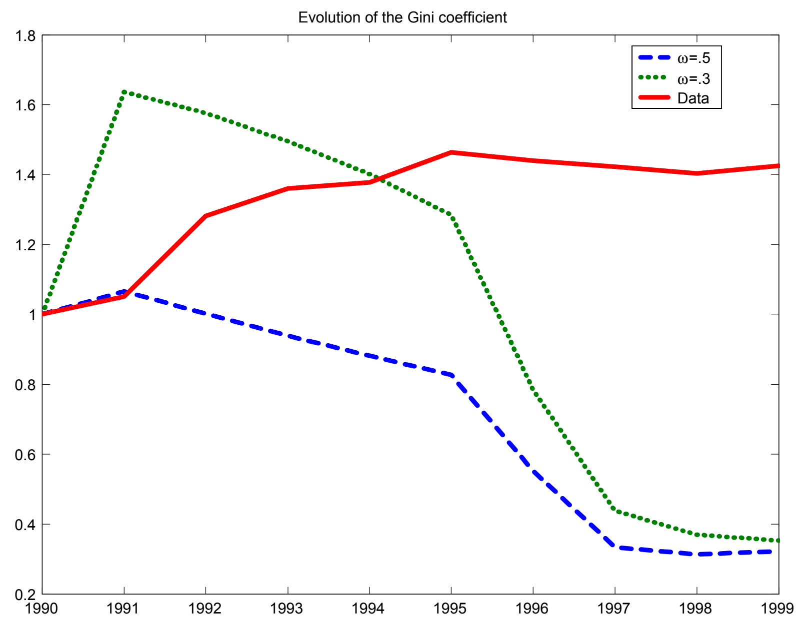

Figure 4.4: Comparison of the evolution of the gini coefficient in the data and in the model at ω 30% and 50%. Data from TransMONEE (2005) for the gini on earnings

Figure 4.5 shows the evolution of the underlying variables which helps in the understanding of the whole system.

Part A shows that the transition towards a technology with a higher skill bias parameter $(1-b)$ starts immediately but is smooth given the presence of the cost of technical change. Given that the economy is transiting towards more and more skill intensive technologies, the demand of skilled workers increases, but initially the stocks are not sufficient, and therefore an important fraction of the unskilled workers are being

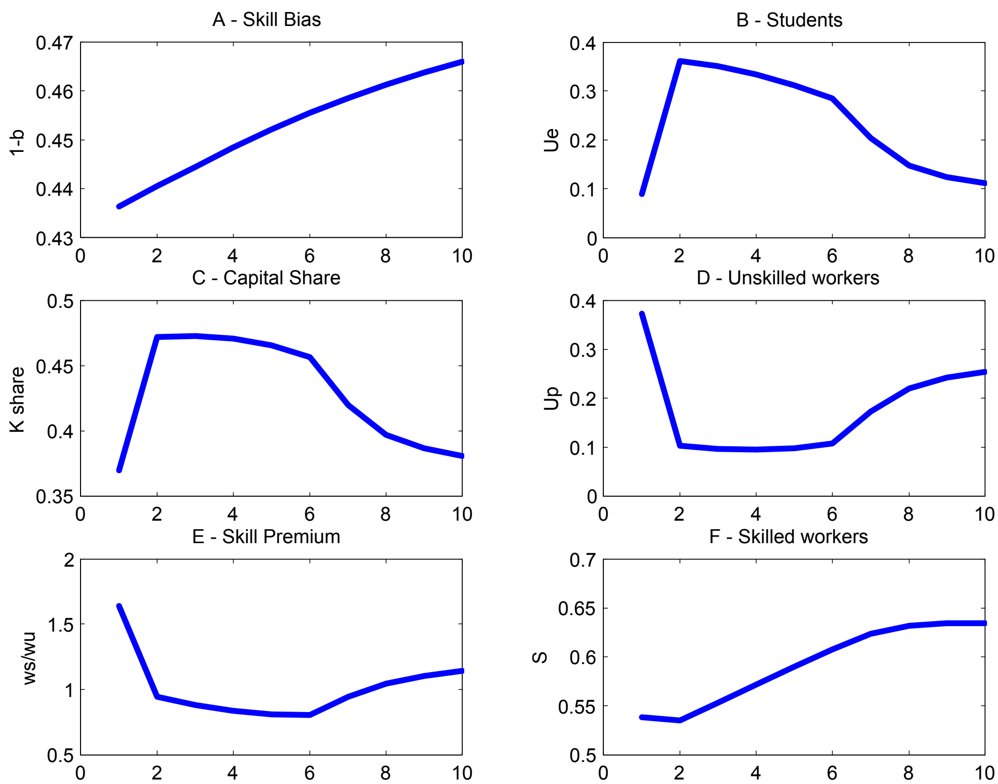

Figure 4.5: Variables determined in the model

retrained (parts B and D). Part B shows that the "students" increased from around 10% of the population to almost 35% in only one year. In the model they are reallocated to the educational sector, but in reality we can interpret them as acquiring the skills needed to participate in the production process under the new regime. That can be going back to school or being trained in the production sector for some time. Those workers that were skilled before the change and became unskilled due to the sudden technological change cannot be captured by looking at the years of school the worker has and therefore the one to one comparison with the data in this dimension becomes impossible.

Note in part C that the capital share of GDP can be thought of as the mirror image of the behavior of unskilled workers. That is because physical capital and unskilled workers are substitutes, and in order for the planner to reallocate unskilled workers to the educational sector, he invests in physical capital, and that is the reason that the capital share increases during the transition. In other words, the economy temporarily replaces part of the unskilled labor force with physical capital so as not to lose so much output while labor resources are being shifted to the educational sector in order to generate a larger stock of skilled workers to be able to maximize the production possibilities under the new more skill intensive technology. Part F, shows the evolution of the fraction of the population that is skilled. As an initial reaction it decreases a little, given the technical change and the accelerated obsolescence induced by that change, but then the big inflow of resources to the educational sector begins to pay off and there is a considerable increment in the stocks of skilled workers.

Finally, part E shows the evolution of the ratio of wages of skilled to unskilled workers. It shows that initially the skill premium decreases, and that is due to the fact that the stocks of unskilled workers suddenly decreased due to the reallocation to the educational sector. It also shows that the wage ratio is not responsible for the considerable increases in the Gini coefficient but the number of "new" or transition students that earn a fraction ω of the unskilled wage.

5. Conclusion

As it can be seen from the evolution of both the Gini coefficient and total output generated by the model, the model has enough power to generate dynamics similar to those seen in the former communists countries in the early years of their transition towards capitalism.

The model captures the time series of the GDP per capita as a result of a technological shift towards technologies ever more skill intensive. The reallocation of workers between the educational sector and the productive one is responsible for the dynamic behavior of the income inequality (sudden and large increases), together with a loss of income of around 15%.

Unfortunately more accurate data is not available in order to judge the performance of the model, but it seems that it performs well in cases of regime changes where these induce technological change. Other application possible for this model could be the transition during the 90s of the Latin American economies after they were opened to the international markets. One addition that should be made to the model is the evolution of total factor productivity, which will help understand longer transition and not just the initial response to a regime change.

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