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MODELING INSTITUTIONAL EVOLUTION

Bilin Neyaptı

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Rumeli Feneri Yolu 34450 Sarıyer/Istanbul

Modeling Institutional Evolution

BILIN NEYAPTI[1]

Abstract

This paper proposes an original formal framework to analyze institutional evolution. Institutions have formal (*F*) and informal (*N*) aspects that may evolve at different paces, although eventually converging towards each other through an dynamic interactive process. *N* evolves with capital accumulation, as in learning by doing, and *F* is optimally chosen by the government who maximizes output given the social and political costs of changing *F*. As transaction-cost-reducing mechanisms, *F* and *N* together define the production technology and affect the income level. As consistent with the evidence, calibrations of the model reveal that optimum *F* exhibits a *punctuated equilibra*.

Key terms: *Institutional evolution, punctuated equilibria, growth*
JEL Codes: E02, O17, O43

[1] Bilkent University, Dept. of Economics, 06800 Bilkent, Ankara, Turkey. Tel: (90 312) 290 2030. Fax: (90 312) 266 5140. E-mail: neyapti@bilkent.edu.tr. I am very grateful for the comments of Cagri Saglam and Esra Durceylan on the technical aspects of the model. Also, I thank M. Kerem Yuksel for his excellent research assistance.

1. Introduction

Institutions are commonly accepted rules of the game and enforcement mechanisms that arise from repeated human interactions. This study offers a formal model of institutional evolution that accommodates two prominent approaches of institutional economics: *transaction cost* and *collective action* theories. The former of these approaches has been pioneered by Coase (1960) and been developed as *New Institutional Economics* (NIE) by Williamson (1985) and North (1990), whereas the latter is due to Olson (1965 and 1982). The two approaches can be viewed as strongly complementary to each other in understanding the nature of institutional frameworks and factors that lead to their change.

The transaction cost approach to institutional change posits that changes in the proportionality of productive factors affect relative prices, preferences and incentives, and hence greatly influence the nature of preferred institutional arrangements; in other words, institutions emerge and change as a result of a process of adapting to each other and to changing economic structure. Collective action theory focuses on the circumstances that lead powerful interest groups to form and become effective[1] in facilitating institutional change through affecting government's decisions. While transaction cost theory provides a rather static view of institutional choice, collective action theory emphasizes the dynamics of institutional change.[2]

Combining the two approaches provides an appropriate framework for understanding the process of institutional evolution. The adaptive institutional change approach of NIE, and the dynamic interaction between political power structure and the level of economic development explained by collective action theory both point at the

interdependence between economic development and institutional change. Efficient institutional change may occur when social cost of maintaining status-quo exceeds the cost of changing existing production relations, or when social benefits of change exceed its social costs. Institutional change is usually slow and inefficient, however, as explained by collective action theory via the development of narrow interest groups into the beneficiaries of the status-quo. While continual technological accumulation and demographic changes lead to small but continuous changes in social norms, their combined effect may start to exert pressure for a change in the legal framework that defines production relations. This occurs as the amount of change in norms reach a threshold where the existing formal institution(s) become severely obstructive for production. In this regard, Pejovich (1998) summarizes the model of institutional evolution as follows:

> *.. When new formal rules conflict with the prevailing informal rules, the incentive they create will raise transaction costs and reduce the production of wealth in the community (p.2).*

The decision to change formal institutions hence crucially depends on the political-power structure, which is, in turn, closely connected with economic structure. Political and economic crises that destroy the existing power-balances therefore often generate a great impetus for major institutional reforms.[3]

In view of the foregoing, modeling institutional evolution should distinguish between two key attributes of production technology: i) a set of informal rules (*N*) that changes slowly and is embedded in, or formed by, cultural or structural characteristics of a society; and ii) a set of formal rules (*F*) that define the organizational or contractual characteristics of production. As production relations (*N*) evolve with the accumulation of factors of production, laws and regulations that organize those production relations (*F*) may usually lag behind. Olson argues that such *institutional sclerosis* can explain the low growth rates observed in some stable democracies. By receiving demands for,

or against, institutional change, the government, or the social planner, becomes the agent that is instrumental in materializing them.

Due to lack of expertise, or based on the advice from international organizations that are not familiar with particular a country's socio-economic characteristics, many developing countries may adopt legislation (*F*) based on the experiences of developed countries, called *best-practice institutions*. These countries may, however, continue to follow their own traditional ways of doing business when they are inconsistent with those legislations. For example, many transition economies adopted laws that are copied from developed countries before achieving sufficiently developed domestic market mechanisms or expertise that would make them effective. Conflicts of *F* with the existing informal rules/norms and enforcement mechanisms (*N*) therefore often led such reforms to be dysfunctional.

Casson et al. (2010) point out the importance of explicitly incorporating the interaction between *N* and *F* into the studies of development. Though there have been recent attempts to model institutional change, the complexity of the dynamics involving its political and economic aspects leads these models to focus on specific aspects of institutional evolution. Acemoglu (2006) elaborates a model of political economy for a society defined by ex-ante characterizations of middle class, workers and the elite, who initially hold all the political power. He argues that policy inefficiency results under both the factor price manipulation and, though to a lesser extent, the revenue extraction incentives of the elite; a potential switch of political power towards the middle class also results in inefficient policy choices. Inefficient institutions result from the elite's desire to maintain these policies. Utilizing the implementation-theory framework to combine social choice with institutional economics, Yao (2004) also studies institutional efficiency. He finds that institutional change is sensitive to income distribution and sticky with respect to the economic environment; under several assumptions regarding a good political process efficient institutions are not implementable.[4]

The model proposed in this paper contributes to the literature by focusing on the dynamics of both formal and informal aspects of institutional change and their explicit and endogenous interaction with economic progress via capital accumulation. Though it is beyond the scope of this paper, the current study can be extended to endogenously account for changes in the power structure, and hence to explicitly incorporate the elements of collective action and hence the political economy perspective.[5]

The following model considers that while informal norms and formal rules, as well as their enforcement characteristics, all change through time, the paces of these changes and the nature of their dynamics are likely to be different from each other. The framework adopted here to address these different dynamics follows an interactive process: as production factors change as a result of continuous technological and other advancements, production relations at the basic level (*N*) usually adjust to these changes. However, higher organization levels that are accommodated by the prevailing legal structures may pose resistance to change, gradually becoming more inconsistent with the changing aspects of the production; *F* represent those aspects of pr*oduction relations that are harder to change.*[6] As a result, societies often end up with reforming their *F*'s only after growing inconsistencies between *F* and *N* eventually lead to welfare costs that exceed the cost of changing *F*. A recent example to such phenomena can be found in the attempts to revise regulatory and supervisory frameworks concerning financial markets in the aftermath of the 2007 global financial crises.

A model that attempts to capture these features can be written in the framework of capital accumulation and technology adoption. Using this framework, the model developed below predicts a *punctuated equilibria* trajectory for *F*. This trajectory is consistent with the evolution of various formal institutions; adoptions of banking or competition laws are, for instance, often observed to lag behind the needs of the market and follow a discontinuous pattern of development.[7] Even in developed

democracies, institutional reforms may not be realized at a socially desirable pace; as politicians may face resistance from special-interest groups, reforms may get delayed until the costs become too widespread and overwhelming.

In what follows, Section 2 outlines a formal model, followed by calibrations that are presented in Section 2.1. The findings of the model are compared to the empirical evidence in Section 2.2. Section 3 concludes

2. The Model

Consider the production function:

$$y = A(F,N).f(k), \quad \text{where } A_{1,2}' > 0 \text{ and } A_{1,2}'' < 0 \text{ and } f' > 0 \text{ and } f'' < 0 \qquad (1)$$

where y stands for per capita output; k is per capita capital; A is a function that stands for technology, or productivity; and F and N stand for the status of *formal* and *informal* (norms) sets of institutions, respectively. The way the technology term $A(F,N)$ enters the production function is in view of the main function of an institution: transaction cost reduction; an increase in institutional quality, indicated by higher values of F and N, implies higher total productivity or lower transaction costs.[8] F and N can be considered as index numbers that both range between 0 and 1 (or some upper and lower values such as $\underline{F} < F < \overline{F}$ and $\underline{N} < N < \overline{N}$), where 1 represents the highest quality of an institutional attribute. Total factor productivity (A) increases in both F and N, but at a decreasing rate.

Informal institutions evolve according to the process:

$$N_{t+1} = N_t + g(k_t), \quad \text{where } g' > 0; \quad g'' < 0, \qquad (2)$$

which indicates that *N* progresses with the level of per capita capital, in lines with the endogenous growth literature. Hence the progression of *N* exhibits *learning by doing*; the higher the level of capital, the higher the quality or level of norms that amass with it, defining a higher level of technology.

Capital per labor evolves according to:

$$k_{t+1} = (1-\delta)\, k_t + I_t \qquad (3)$$

where δ is the rate of depreciation and I_t is the level of investment at time t.[9] Without loss of generality, it can be further assumed that population growth is zero and hence investment is equal to the savings minus depreciation allowance, such that $I_t = sy_t - \delta k_t$, where s is the savings rate.[10]

Amending formal institutions, or changing the production technology involves costs, along with its projected benefits. Hence, the incumbent government chooses *F* to maximize output, net of cost of changing *F*. The costs may be in the form of welfare spending to compensate for the displaced economic agents; for example, the government may increase spending in the form of training or unemployment insurance to compensate for the labor that become idle due to newly adopted technologies or organizational structures. I argue that the extent of these costs can be related with mainly two structural factors; first, the cost is likely to increase with the magnitude of change in *F* and, second, it is expected to decrease with the prevailing distance between *F* and *N*. The first of these arises since each level of *F* is likely to be associated with certain special interest groups whose existence is supported by it and who resist its change. If, on the other hand, one considers that *N* is likely to represent the encompassing interests in a society, assuming that *F* is less than *N*, the closer is *F* to *N*, the less the change would be socially necessary and economically efficient, and

hence the less political support there would be to change *F*; hence the greater is the cost of changing *F* the closer *F* is to *N*.

In view of the above, the government's problem can be written as:

$$Max_F \quad y - C(\Delta F, F/N); \text{ where } C'_1 > 0 \text{ and } C'_2 > 0 \qquad (4)$$

The mechanics of endogenous institutional change can be summarized as follows: output and thus savings determine the level of capital accumulation which in turn leads *N* to evolve due to learning by doing. Each period the government optimally chooses *F*, facing a cost of changing it and the condition that *F* cannot be reduced or exceed *N*. The model implies that while an increase in *k* leads *N* to increase and hence affects the optimal choice of *F*, *F* in turn affects the level of *N* through its affect on *y.* Hence, *F* and *N* interact continuously, as can be observed in real life examples of institutional change. This interaction implicitly reflects that the social cost of changing *F* hinges upon collective action; although higher values of *F* may reduce transaction costs, it may not be optimal for a government to increase *F* when viewed from the point of the dynamics of outlined above.

The above dynamics can be summed up by the following sequential pattern:

i) Given N_t, and F_t, k_t depreciates each period while new capital accumulates due to savings that are fully turned into investments.
ii) N_{t+1} evolves with k_t.
iii) Based on the levels of k_{t+1} and $N_{t+1,}$ as well as the ratio of F_t to N_t in the current period, optimal F_{t+1} is selected to maximize y_{t+1} – if optimal F_{t+1} is higher than F_t and less than N_{t+1}.

2.1. Calibrations

In order to get explicit solutions for the model and to simulate the trajectory of optimal *F*, the following expressions (5) to (8) are considered instead of the equations (1) to (4):

$$N_{t+1} = N_t + N_t^{[1/(\log(k_t/100))]} \qquad (5)$$

$$k_{t+1} = s(F_t.N_t)^{\theta} k_t^{\beta} + (1-\delta)k_t \text{ , where } 0 < s, \theta, \beta, \delta < 1.^{11} \quad (6)$$

Given (5) and (6), the government solves the following problem:

$$\text{Max}_{Ft+1} \quad (F_{t+1}.N_{t+1})^{\theta} k_{t+1}^{\beta} - C(\Delta F_t, N_{t+1}) \quad (7)$$

subject to:

$$C(\Delta F_t, N_{t+1}) = \alpha(F_{t+1} - F_t)(F_t / N_t) \text{ , where } \alpha > 0 \quad (8)$$

It is further assumed that $F_{t+1} > F_t$ and $F_{t+1} \leq N_{t+1}$.

The first order condition of the above problem yields the following optimal path for F_{t+1}:

$$F_{t+1}^{*} = \begin{cases} [\dfrac{\alpha}{\theta}\left(\dfrac{F_t}{N_t}\right)\dfrac{1}{N_{t+1}^{\theta}.k_{t+1}^{\beta}}]^{(1/(\theta-1))} & ;if \quad [\dfrac{\alpha}{\theta}\left(\dfrac{F_t}{N_t}\right)\dfrac{1}{N_{t+1}^{\theta}.k_{t+1}^{\beta}}]^{(1/(\theta-1))} > F_t \\ F_t & ;otherwise \end{cases} \quad (9)$$

The solution of the problem hence satisfies Equations (5), (6) and (9).

Figure 1 shows the calibrations of F^* and k using a reasonable set of values for the parameters δ, β and s.[12] It is assumed that α=50 and θ=0.5, although different values of these parameters lead to similar patterns. In addition, the initial capital intensity is normalized to 1. The figure has three panels corresponding to three different sets of initial F and N values, which are used to proxy different development scenarios; to be able to solely focus on the differences in trajectories arising from different initial values of institutions, the rest of the parameter values and variable calibrations are kept constant across different scenarios.

The first panel represents the case of developing countries that have low levels of institutional development, with less than 0.5 initial values F and N; the second represents developed countries, where institutional indices are relatively high; and the third also represents developed countries where norms are developed but formal

institutions are not, for which Japan may be an example with regards to some of its monetary and financial market institutions. To test the sensitivity of the results to the model parameters, one can also choose higher k and β values for the cases that represent the developed countries. Although these modifications do not change the general nature of the results, the first is observed to postpone the initial reform date and the second seem to lead to faster updates of F^* once reform takes place.

Based on Figure 1, it is easy to note that F^*'s trajectory in all panels reflects a punctuated nature. In addition, comparison of the levels to which F^* and k converge in all three panel indicates that convergence may be realized and poverty-trap may be avoided in the case of continuous institutional reforms, even when institutions are low quality to start with.

Further calibrations are performed to examine the sensitivity of the reported findings to the model parameters.[13] Taking other parameters constant, it is observed that lower values of θ generally lead to more prolonged periods before a change in F^* (except for N>0.5) takes place and lower steady state values. The positive effect of θ on F^* is weaker for the greater values of the income share of capital (β). The relationship between β and F^* is also positive, though also weaker the greater is β. In addition, there is a negative relationship between the cost of changing F (α) and F^*, which increases as β increases. The following partial derivatives summarize these observations.

$$\frac{\partial F^*}{\partial \alpha}<0 \; ; \quad \frac{\partial^2 F^*}{\partial \alpha . \partial \alpha} \approx 0 \; ; \quad \left|\frac{\partial^2 F^*}{\partial \alpha \partial \beta}\right|<0 \quad ; \quad \left|\frac{\partial^2 F^*}{\partial \alpha \partial \theta}\right| = \begin{cases} > 0 ... if \theta < 0.8 \\ < 0 .... otherwise \end{cases}$$

$$\frac{\partial F^*}{\partial \beta}>0 \; ; \; \frac{\partial^2 F^*}{\partial \beta . \partial \beta} < 0 \quad ; \; \frac{\partial^2 F^*}{\partial \beta . \partial \alpha} \approx 0 \; ; \; \frac{\partial^2 F^*}{\partial \beta . \partial \theta} = \begin{cases} > 0 ... if \theta < 0.8 \\ < 0 .... otherwise \end{cases}$$

$$\frac{\partial F^*}{\partial \theta}>0 \; ; \; \frac{\partial^2 F^*}{\partial \theta . \partial \theta} \begin{cases} > 0 ... if \theta < 0.8 \\ < 0 .... otherwise \end{cases} \quad ; \; \frac{\partial^2 F^*}{\partial \theta . \partial \beta} < 0 \; ; \; \frac{\partial^2 F^*}{\partial \theta . \partial \alpha} \approx 0$$

As the above signs indicate, the cost of changing F is not affecting the responsiveness of optimal-F to the income shares of technology and capital. In addition, as expected, the effects of α, β and θ on F^* generally increase in θ and decrease in β.

Appendix 1 shows the trajectories of optimal-F and k in relation to θ and α. The graphs reveal that, though both variables follow an upward trend for a range of θ values, the cost of reform lowers these trajectories severely. Appendix 1b shows that increasing the contribution of F on productivity (especially for θ >0.8*)* substantially increases the long term optimal capital.

2.2. Some Evidence

Various examples can be given to the punctuated nature of formal institutional progress, including the recent emphasis on reforming global financial regulation. The financial crisis of 2007 revealed the necessity for F to catch up with N in the financial sector, where N may represent financial transactions involving the faster-developing financial engineering tools, and F represents the regulatory environment that needs to be reformed to eliminate the transaction costs related with the development in those tools. As Dincer and Neyapti (2007) argue, crises are among the primary causes of institutional change. Crises are often also observed to lead to paradigm changes in economics, examples of which can be found in the form of transitions from inward orientation towards outward orientation, or from a focus on Keynesian policies to monetarism that usually follow major economic events. While preparing complete contracts to account for all the potential risks in the economy, taking into account the fact that institutions are in dynamic interaction with the rest of the economic phenomena is necessary for understanding economic development. The recent proposal for incorporating behavioral aspects to modify the efficient market hypothesis,

called the *adaptive market hypothesis* by Lo (2004), for example, provides an example of the refinements needed for neoclassical theory to conform to the punctuated evolutionary path of economic institutions.

Figures 2a and 2b show sample trajectories of some well-documented institutional reforms, namely central bank independence (CBI) and bank regulation and supervision (RS). The first of these graphs demonstrates the changes in CBI in three formerly centrally planned economies and Chile. Figure 2b also demonstrates much slower changes in Brazil and the UK with regards to RS than in transition countries. This observation possibly arises due to existing interest group resistance to a change in status-quo in the former two countries as opposed to the transition countries that revised their legal frameworks after severe crises whose effects were all-encompassing. In addition, unlike Figure 2a, the different levels or final status of RS in different countries probably indicate that the steady state level of RS is still to be reached in many countries. In other words, comparing the two graphs seem to exemplify the fact that while the central bank reforms have been achieved to a large extent in many countries around the world in response to the high or hyperinflationary episodes that caused great welfare losses during the past century, the financial and banking sector reforms are still in progress in many countries.

3. Concluding Remarks

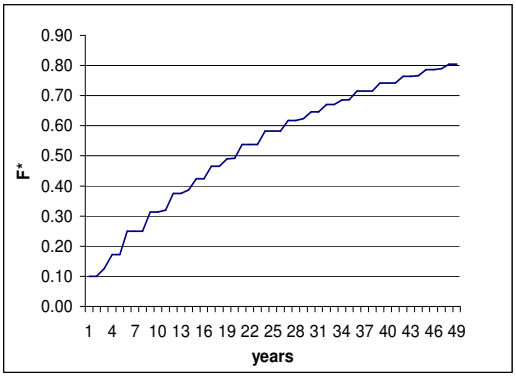
This study proposes an original formal model of endogenous institutional change, where technology is comprised of two attributes that affect productivity and transaction cost reduction: informal ways of conducting business or norms, and formal institutions that help regulate, supervise and enforce those conducts of behavior. While informal

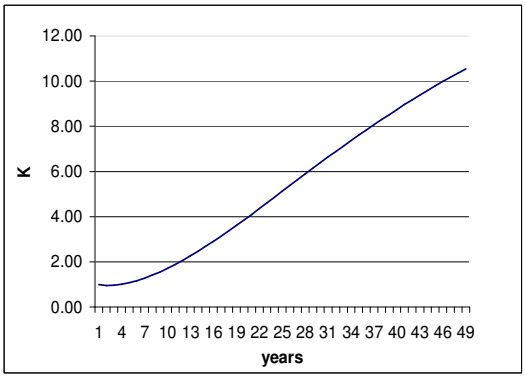
institutions continuously evolve as a result of technological know-how, formal institutions change via an incumbent government's optimizing behavior and follow a pattern of punctuated equilibria. Simulations of the model's solution are consistent with the projected dynamics of the model as well as the evidence.

The model is consistent with the two main strands of institutional approaches: transaction cost and collective action theories. The current framework can be extended to incorporate the political-economy aspect of institutional change explicitly, which is left for a future study.

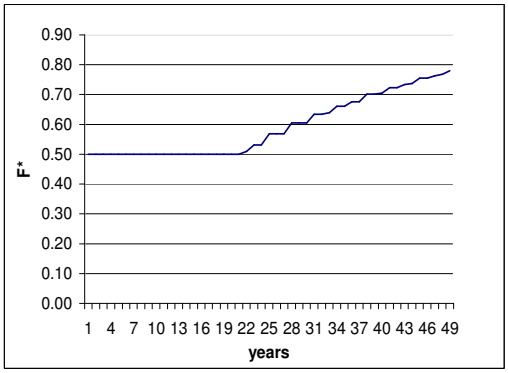
Figure 1: Trajectories (50 years) of F^* and k.
(Assuming α=50; β=0.2; δ=0.08; θ=0.5 and s=0.2)

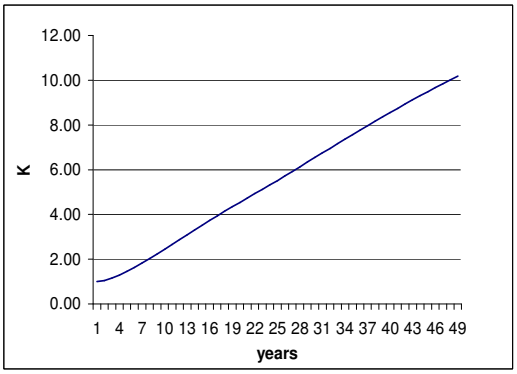
I: Initial N=0.3 and Initial F=0.1



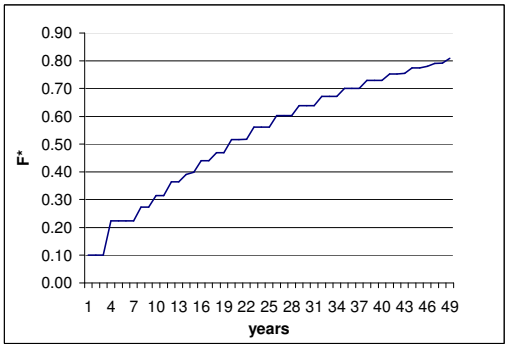


II. Initial N=0.7; Initial F=0.5.





III. Initial N=0.7; Initial F=0.1.



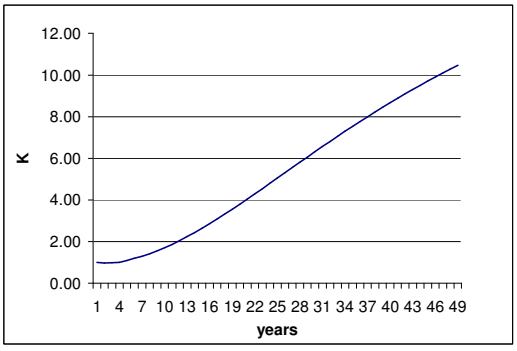
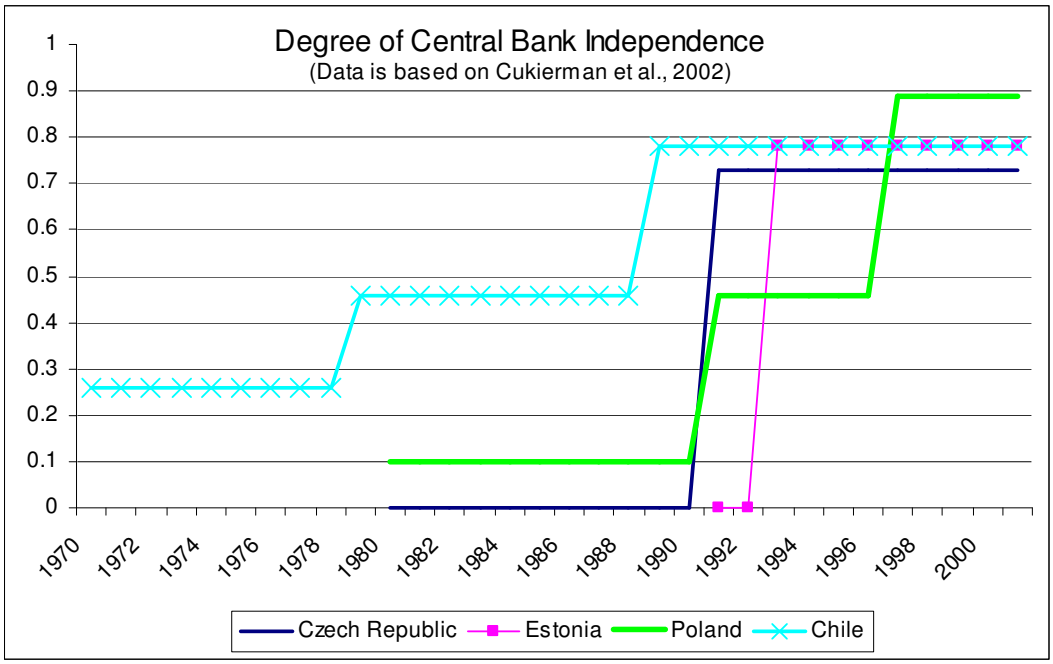
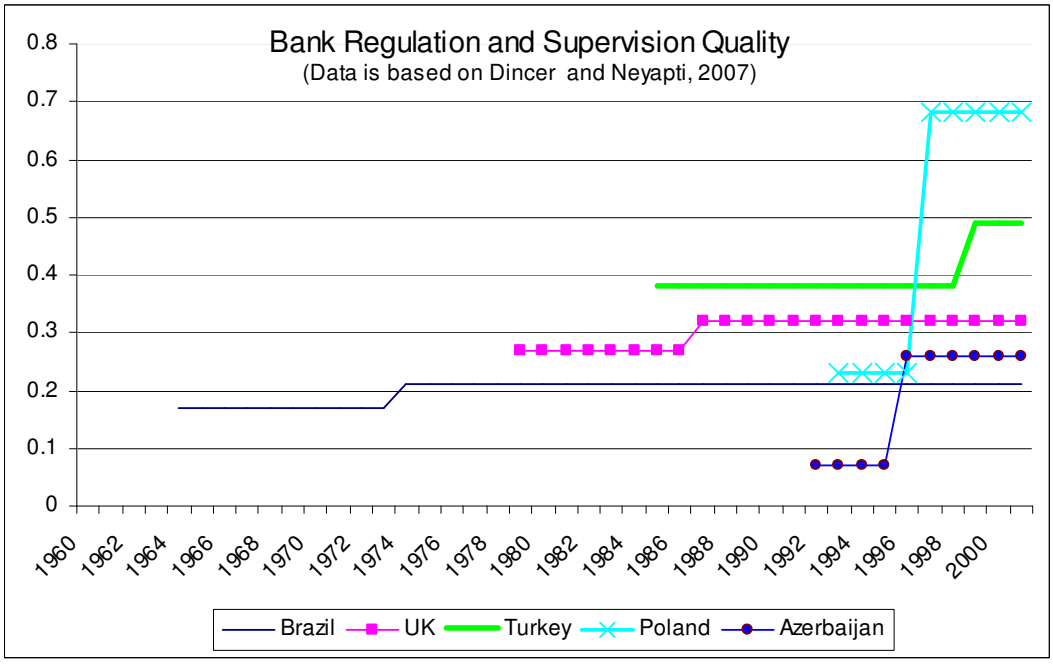


Figure 2: Sample trajectories of institutional reforms: some evidence.





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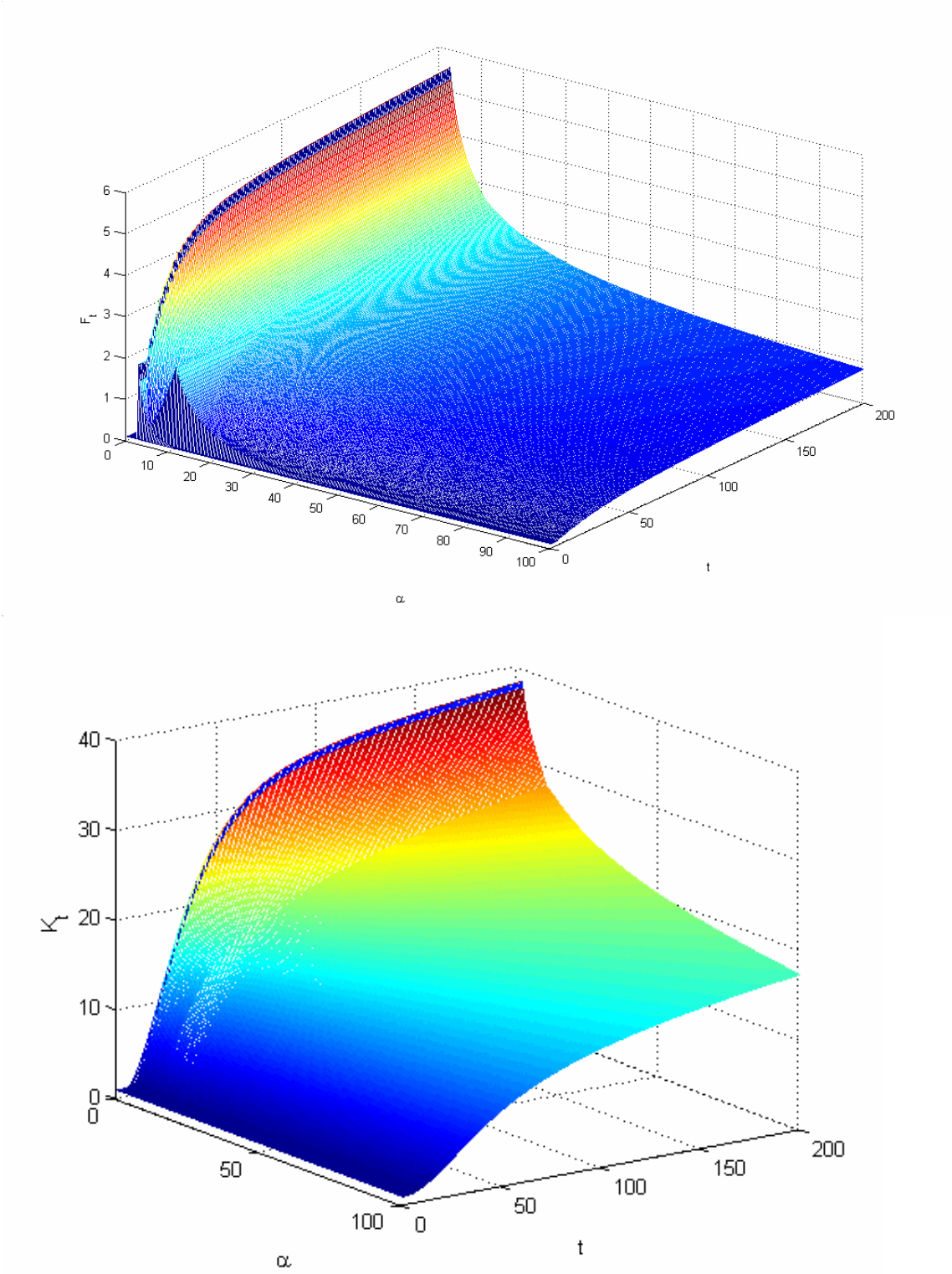
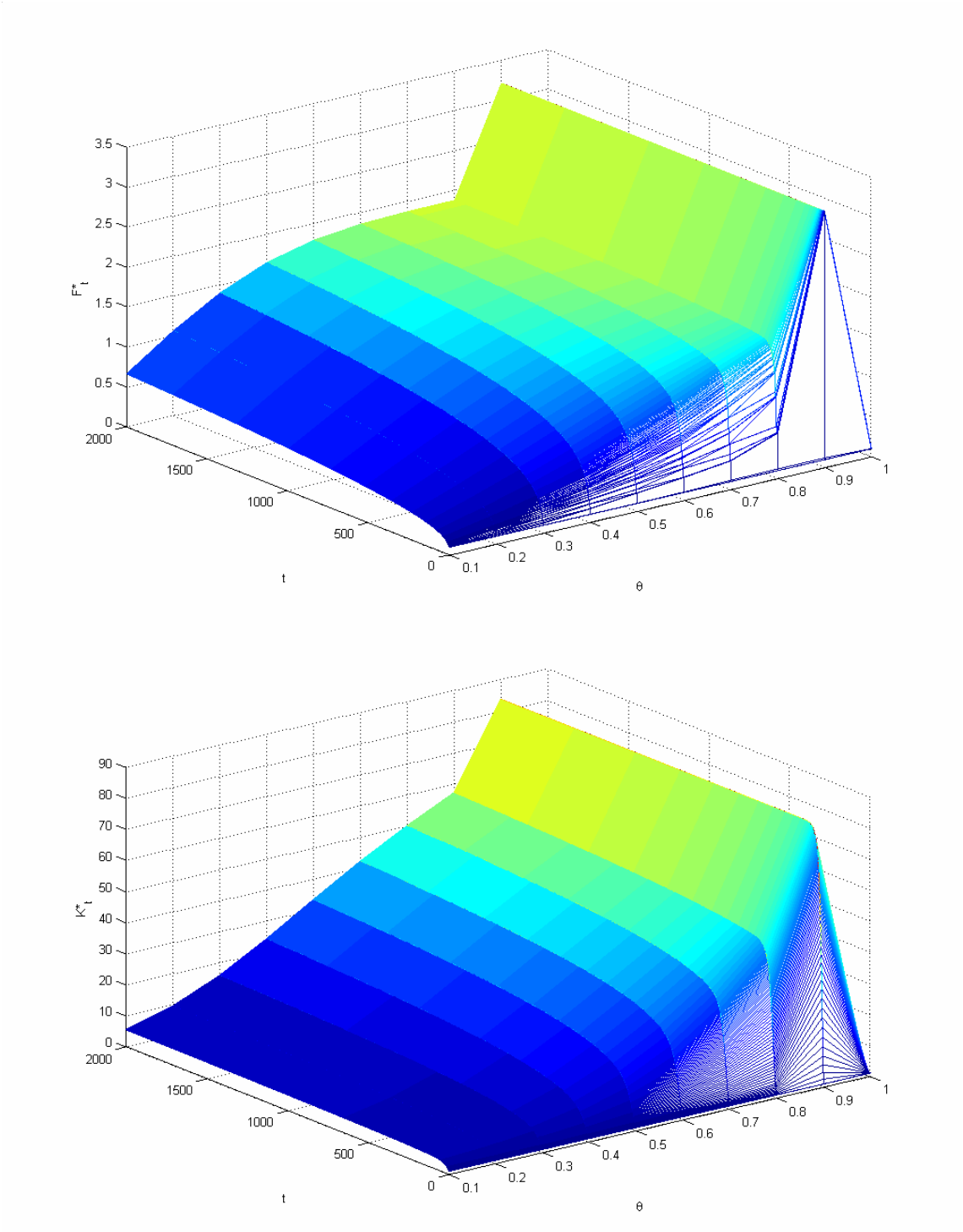
Appendix 1a: Sample trajectories of F^* and k over time and α, for given model parameters and initial F, N and k values (F_0 , N_0 and k_0 , respectively). (F_0=0.1; N_0=0.5 ; k_0=1 ; δ=0.08 ; s= 0.2 ; β = 0.3 ; θ=0.5)



Appendix 1b: Sample trajectories of F^* and k over time and θ, for given model parameters and initial F, N and k values (F_0 , N_0 and k_0 , respectively).
(F_0=0.1; N_0=0.5 ; k_0=1 ; δ=0.08 ; s= 0.2 ; β = 0.3 ; α =50)



[1] Coates and Heckelman (2003) and Coates et al.(2010) provide empirical evidence in support of Olson's theory. Heckelman (2007) provides a review of empirical tests of Olson's theory.
[2] See also Nabli and Nugent (1989).
[3] See, for example, Dincer and Neyapti (2008).
[4] Assumptions that define *good* political process are Maskin monotonicity, the consideration of individual preferences only, no interpersonal utility comparison, and zero monetary transfers, the last of which is crucial for the reported finding.
[5] The mechanism for exogenously imposed institutions, say via a lending country's advice are not considered within the current framework of analysis.
[6] Workers' security and anti-trust legislations can be considered as examples of formal institutions necessitated by improved technology or market structures, but they may be (or have been) resisted by powerful lobbies of firm owners.
[7] Competition law of Turkey, for example, was legislated several years after its proposal, and more than 100 years after it was put into practice in the US.
[8] Granville and Leonard (2010) provide recent empirical evidence, based on the 89 regions of the Russian Federation, that technology is endogenous to informal institutions.
[9] I assume full investment efficiency in the sense that all the investment spending becomes addition to the capital stock.
[10] Capital accumulation may also be considered to involve a shock term such that $k_{t+1} = (1-\delta)\, k_t + I_t + e_t$, where a large e_t stands for a major leap in the capital/labor ratio due to either destruction of some productive forces, in instances such as war or natural disasters or as a result of major technological innovations. Significant changes in the structure of production are also often associated with significant changes in the power structure and hence have important political implications. Transition from feudalism to capitalism and socialism entailed such mass transformations from extensive to intensive labor use and the Industrial Revolution.
[11] Calibrations yield reasonable results for $\theta \leq 0.96$.
[12] Nadiri and Prucha and (1995) show that the depreciation rate for physical capital is 0.06 and for R&D is 0.12 for the US. In addition, Mankiw et al. (1992) show that $\beta = 1/3$ for US. According to World Development Indicators database of the World Bank, the world average of the saving rate (gross savings as percentage of GNI) has been between 0.20 and 0.23 during the past three decades.
[13] The formulas and graphs used in these calibrations are available upon request.