Quality of Civil Administration and Economic Growth: A Threshold Analysis

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Abstract

This paper distinguishes between 'immediate measures of the quality of civil administration' (IM-QCA), such as 'corruption,' 'red-tape,' etc. and the 'final measure of the quality of civil administration' (FM-QCA), which from an economic point of view is the growth performance of an economy. The paper argues that, instead of being monotonic and linear, the relationship between civil service compensation and economic growth is characterized by the presence of 'vicious' and 'virtuous' cycles, which are indicative of multiple equilibrium. The paper uses the threshold regression methodology to test the multiple equilibrium hypothesis and finds considerable support for it. The finding has significant policy implications, because developing countries often resort to across-the-board salary reduction of public servants as part of budget balancing austerity measures. The results of this paper questions the appropriateness of such policies and suggests that civil service compensation can be an important policy tool for promoting economic growth, provided the specific non-linear nature of the compensation-performance relationship is properly understood and taken into account. *(JEL Classification:* O1, O4; *Keywords*: Economic Growth, Civil Administration, and Bureaucracy.)

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1. Introduction

Recent growth literature has identified total factor productivity differences (TFP) as the most important source of per capita income differences across countries and has pointed to institutions as an important determinant of TFP. One of the important components of institutions is civil administration, which plays a crucial role in formulating and implementing economic policies. In investigating the role of civil administration, many researchers have emphasized the issue of corruption. Several studies have shown that corruption affects growth and investment negatively. However some researchers have looked into causes of corruption too and have drawn attention to civil service compensation as a determinant of corruption.

The present paper extends the research on quality of civil administration (QCA) and its role in economic growth in two ways. First, it distinguishes between *immediate* measures of

QCA (abbreviated as IM-QCA) such as indexes of 'corruption,' 'red-tape,' 'bureaucratic delay,' etc. and the *final* measures of QCA (abbreviated as FM-QCA), which from an economic point of view, is given by the growth performance of an economy. This distinction is important for two reasons. First, the relationship between corruption and growth performance may not be monotonic. This implies that the impact of changes in compensation on IM-QCA may not be the same as that on FM-QCA. Second, the generally prevalent measures of IM-QCA are of 'negative' nature and are not geared to capture the pro-active role that civil administration can play in the management of a developing economy. This paper traces the influence of compensation through its impact on both immediate and final measures of QCA and considers the relationship in its totality.

The second way in which this paper extends the research is as follows. Existing studies of the civil service compensation-performance relationship have generally assumed this relationship to be not only monotonic but also uniform in magnitude. Accordingly, these studies have limited themselves to the methodology of *linear* regression. In qualitative description of this relationship however researchers have frequently recognized the presence of *vicious* and *virtuous* cycles. Existence of such cycles is symptomatic of multiple equilibrium and suggests that linear regression may not be the appropriate methodology for studying this relationship. Furthermore, non-linear models of the general variety (such as with quadratic term, etc.) may not serve the purpose either, because these cannot capture the presence of 'vicious' and 'virtuous' cycles.

This paper formulates the compensation-performance relationship in the form of a multiple equilibrium phenomenon, where different equilibria are separated by a threshold level of compensation. Compensations above the threshold level are perceived to be rational and they set off a virtuous cycle, whereby the civil service gets good entrants, who work hard and sincerely. This yields better growth and higher revenue collection, which make it possible to pay the higher, 'rational' level of compensation. The paper refers to this virtuous cycle as the 'Good Equilibrium.' The opposite happens when compensation falls below the threshold level. Such 'irrational' levels of compensation set off a 'vicious cycle,' whereby government service gets bad quality entrants, who do not work hard and instead engage in corruption and other bureaucratic malpractice. This depresses growth, lowers revenue collection, and makes it difficult for the government to pay the 'rational' level of compensation. This vicious cycle is referred to as the 'Bad Equilibrium.'

Finding proper econometrics for testing the proposed multiple equilibrium hypothesis is not easy. One possible approach is to use the methodology of threshold regression. The main econometric difficulty that this methodology strives to overcome is that the value of the threshold level of compensation is unknown. Generically this is the Davies' (1977, 1987) problem, where the parameter value is unknown under the null. In a series of papers, Hansen (1996, 1999) has developed the theory and non-parametric methods to overcome this problem. We use this methodology in this paper.

An important obstacle in implementing the threshold regression methodology lies in the paucity of compensation data. As Heller and Tait (1983) noted earlier, "It is surprising and depressing how little information is readily available on public sector employment and pay." (p. 35) Schiavo-Campo et al. (1997a, 1997b) at the World Bank have recently made a laudable attempt to gather data on bureaucratic compensation and employment across countries. Van Rijckeghem and Weder (2001) (henceforth RW) build on that effort and incorporate myriad of other information available at IMF to put together a data set on civil service compensation as a ratio of manufacturing wages. We use this data set for the analysis in this paper.

The results of the paper provide considerable support for the multiple-equilibrium hypothesis. The compensation-performance relationship proves to be positive and more pronounced at compensation levels that are above the threshold level than when they are below. In terms of Van Rijckeghem and Weder's compensation data, the threshold seems to lie at 1.74. Apart from its own threshold effect, the compensation threshold appears to affect the influence of ethnographic and linguistic composition of the population. On the other hand, the compensation threshold does not seem to affect the influence of the initial income variable, which from the neoclassical growth theory's point of view reflects the force of diminishing returns to accumulation and hence is not expected to be affected by the threshold that much.

The evidence supporting the multiple-equilibrium hypothesis has important policy implications. Multilateral lending organizations often require balanced budget as a condition for loans, and governments of developing countries frequently try to meet this condition by cutting civil service compensation across the board. Such measures can have very unexpected outcomes if the compensation-performance relationship is characterized by multiple equilibrium. On the one hand, minor changes in the compensation level can lead to large consequences if the current

compensation level lies in the vicinity of the threshold level. For example, a small decrease in the compensation level may push an economy down the spiral of the vicious cycle if the current compensation level is barely above the threshold level. On the other hand, even large changes in compensation level may fail to have an appreciable effect if the existing compensation level is far away from the threshold level. It is therefore important to know whether such a threshold exists and if yes then at what vicinity. The results of this paper can therefore help in formulating appropriate civil service compensation policies.

The discussion of the paper is organized as follows. Section-2 provides the background and examines the literature on the issue. Section-3 formulates the multiple-equilibrium hypothesis. Section-4 presents a brief account of the threshold regression methodology. Section-5 discusses baseline specifications, baseline signs of the coefficients, and expected directions of change in sign and magnitude of the coefficients. Section-6 discusses data sources and explains variable construction. Section-7 presents the results. Section-8 offers concluding remarks.

2. Background

Recent research has shown that productivity differences are more important than differences in input intensity in explaining income differences across countries. Proceeding from a production function $Y_i = K_i^\alpha (A_i H_i)^{1-\alpha}$, where Y is output, K is physical capital, H is human capital, and A is labor augmenting productivity, Hall and Jones (1999) find that of the 35-fold difference in per capita income between the US and Nigeria, difference in physical capital intensity accounts for a factor of 1.5, and the difference in educational level accounts for another factor of 3.1, but difference in A accounts for a 7.7 factor. Earlier, using the production function $Y_i = K_i^\alpha (A_i L_i)^{1-\alpha}$, where L is labor, Islam (1995) found that in a sample of 96 countries, the highest estimated value of A was 39 times greater than its lowest estimated value. Islam (2002a) shows significant differences in productivity dynamics too. Prescott (1998) actually goes so far as to declare that in explaining income differences across countries, "Saving rate differences do not matter, all that is important is total factor productivity." He therefore emphasizes the need for a theory of TFP.

The productivity term A of the aggregate production function is however an omnibus term that includes many different items. Mankiw, Romer, and Weil (1992) for example note that "the $A(0)$ term reflects not just technology but resource endowments, climate, institutions, and so on; it may therefore differ across countries." (p. 6) In their quest to find the determinants of productivity, researchers have put forward many different variables. A careful look suggests that these variables may be classified into three groups. The first is the set of 'physical base' variables that include such physical characteristics of a country as its location, (distance from the equator, land-locked, etc.), climate, etc. The second is the set 'social base' variables consisting of such social characteristics as ethno-linguistic fractionalization or religious composition of the population, etc. The third is the set of 'institutional' variables. While physical-base and social-base variables are important, focusing on them is not very useful from a policy point of view. For example, a country cannot change its location without going into a war. Similarly a country cannot change its ethnic composition without engaging in ethnic cleansing. It is therefore more useful to control for the physical-base and social-base variables but to focus on 'institutional' variables, because these variables are often amenable to policy influence.[2]

An important component of 'institutions' is civil bureaucracy, which plays a crucial role in formulating and implementing economic policies. Surveying the evidence, a recent World Bank study concludes that "… a dilapidated civil service has been a key factor in Africa's slow decline. Conversely, a strong civil service is one of several reasons why in much of East Asia, authoritarianism has co-existed with excellent economic performance." (Schiavo-Campo et al. 1997a, p. v)

In discussing the role of bureaucracy, many researchers have focused on 'corruption.'[3] For example, Mauro (1995) presents a careful cross-country analysis showing a significant influence of corruption on growth and investment. Other studies looking at 'consequences' of corruption for growth include Murphy, Shleifer, and Vishny (1993). Some researchers have investigated 'causes' of corruption too. For example, Treisman (2000) presents a comprehensive

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[2] The literature emphasizing the role of institutions in growth is large. Among the recent important papers are Knack and Keefer (1995, 1997), Keefer and Knack (1997), Temple (1999), Temple and Johnson (1998), Easterly and Levine (1997), Engerman and Sokoloff (1997), Hall and Jones (1999), Landes (1998), Rodrik (1999), and Acemoglu et al. (2001). Earlier works emphasizing the role of institutions include North and Thomas (1973), Jones (1981), and North (1981, 1990).

[3] For recent surveys of the corruption literature, see Ades and Di Tella (1997), Andvig (1991), Bardhan (1997), Jain (2001). See also Alam (1995), Gary and Kaufman (1998), Klitgaard (1988, 1998), and Krueger (1974).

cross-country study of possible causes of corruption and considers a wide array of variables, including a country's legal system, ethnic and religious composition, colonial heritage, state and history of democracy, extent of government intervention in the economy, etc. Triesman's analysis includes compensation as a possible determinant of corruption too. However, he does not focus on it.
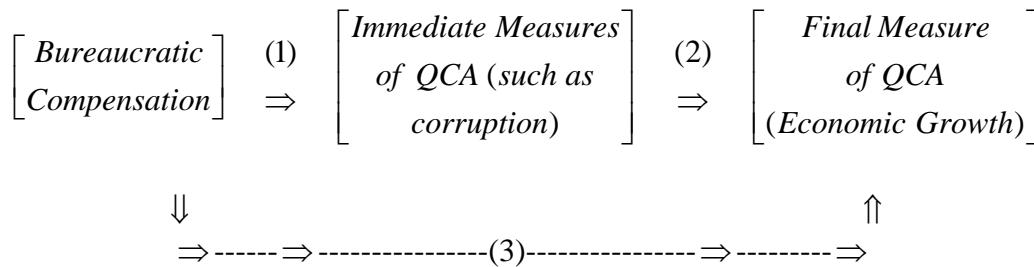
Other researchers have however attached more importance to 'compensation' as a determinant of corruption. For example, the World Bank study cited above mentions that "rehabilitation of government performance will require policies that … restore the linkages between compensation and effort." (p. 38) Van Rijckeghem and Weder (2001) present a cogent analysis of the relationship between corruption and compensation. Proceeding from the compensation data gathered by Chiavo-Campo et al. (1997) and drawing upon myriad of other secondary information available at IMF, these authors have put together a data set on bureaucratic compensation as a ratio of manufacturing wage and found this ratio to be an important determinant of 'corruption.' Rauch and Evans (2000), on the other hand, conduct a survey of experts to gather data on various aspects of bureaucracy, including level and growth in compensation. They use these compensation data to construct a composite 'salary' variable and find it to be not too significant when used along with other right hand side variables. However, Van Rijckeghem and Weder (2001) show that when only the 'level' data are used, instead of the composite 'salary' index, the compensation variable does prove significant.

This paper extends the study of civil service compensation-performance relationship in two ways. First, it distinguishes between *immediate* and *final* measures of the quality of civil administration (QCA). By immediate measures of QCA we refer to such measures as indices of 'corruption', 'red-tape,' 'bureaucratic delay' etc. The final measure of QCA, from an economic point of view, is however given by the growth performance of an economy. The distinction between IM-QCA and FM-QCA is not trivial, at least for the following two reasons. First, despite the evidence put forward by Mauro (1995) and others, many continue to argue that the relationship between corruption and growth performance is not monotonic. Some maintain that a certain degree of corruption may even be helpful for economic growth.[4] Second and more importantly, most of the immediate measures of bureaucratic quality available in the literature

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[4] Mendez and Sepulveda (2000) have recently made a fresh case for this argument. See also Alesina and Weder (1999), Leff (1964), and Rose-Ackerman (1997, 1998, 1999).

are, so to speak, of *negative* nature. They do not refer much to the pro-active role that the bureaucracy can play in managing a developing economy. For example, a civil service may be less corrupt but at the same time very inert. Yet it is the energy and creativity in mobilizing the often-inchoate domestic resources that is very important for the growth performance of a developing economy.[5] These potential gaps imply that the impact of compensation on IM-QCA may not be the same as that on FM-QCA. Schematically, the civil service compensation-performance relationship can therefore be represented as follows:

<p style="text-align:center"><u>Figure-1</u></p>

$$
\begin{bmatrix} Bureaucratic \\ Compensation \end{bmatrix} \begin{matrix} (1) \\ \Rightarrow \end{matrix} \begin{bmatrix} Immediate\ Measures \\ of\ QCA\ (such\ as \\ corruption) \end{bmatrix} \begin{matrix} (2) \\ \Rightarrow \end{matrix} \begin{bmatrix} Final\ Measure \\ of\ QCA \\ (Economic\ Growth) \end{bmatrix}
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\Rightarrow ------ \Rightarrow ----------------(3)---------------- \Rightarrow --------- \Rightarrow
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In terms of Figure-1, studies such as of Treisman (2000), Rauch and Evans (2000), and Van Rijckeghem and Weder (2001), investigate the relationship (1). On the other hand, studies such as of Mauro (1995) and Evans and Rauch (1999) examine relationship (2). Relationship (3) of Figure-1 arises from the above alluded two sources, namely (a) that the influence of compensation on growth via the immediate measures may not be as monotonic as (1)-(2) combination above alone suggests and (b) that the immediate measures of QCA may not be comprehensive enough. Given this complexity, it is necessary to take an extended view and to recognize that impact on conventional IM-QCA may not exhaust the influence of compensation on economic growth. This paper takes under its purview relationship (1) and (2) as well as the possible influence via channel (3).

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[5] There are several reasons for an enhanced role of bureaucracy in the performance of developing economies. First, the developing economies tend to have larger public sectors, whose performance depends directly on the role that the bureaucracy plays. Second, developing countries depend more on lending by foreign companies, banks, and multilateral lending agencies. Bureaucracy plays an important role in negotiations with these foreign partners and thereby in selecting the right projects for which the national government should accept loans. Third, bureaucracy plays an important role in domestic resource mobilization as well. This concerns not only better management of the state owned industrial and commercial enterprises and revenue collection, but also mobilization of the physical and human resources in general. Adequate compensation may be helpful to be not only less corrupt but also to be more enthusiastic and energetic in fulfilling these pro-active roles. For more discussion on this point, see Islam (2001).

The second way in which this paper extends the existing research is to relax the econometric restrictions under which the compensation-performance relationship has been examined so far. Existing studies have generally assumed both relationship (1) and (2) to be monotonic and of uniform magnitude and thereby have used the *linear* regression framework to study them. In rare cases where researchers have considered the possibility of non-linearity, the explorations have generally remained limited to allowing quadratic terms. Yet, many researchers have noted that the compensation-performance relationship is characterized by the presence of vicious and virtuous cycles. For example, Schiavo-Campo et al. (1997a) observe that "…public wage cuts set in motion a *vicious circle* of demotivation, under-performance, and justification for further reductions. (Fortunately, the reverse may also be true: even small wage increase can trigger a positive dynamics.)" (p. 38) Similarly, Treisman (2000) recognizes a feedback effect of economic growth on corruption. Such a feedback effect can lead to a virtuous cycle.[6] The presence of vicious and virtuous cycles suggests the existence of multiple equilibrium.[7]

The possibility of multiple-equilibrium has important policy implications. Multilateral lending organizations, such as the World Bank and IMF, often impose reductions in public spending as a condition for receiving loans, and governments in developing countries frequently try to meet this condition by reducing civil service compensation across the board. The existence of multiple-equilibrium implies that such reductions can have serious unintended effects. If a threshold compensation level separates a 'virtuous cycle' from a 'vicious cycle' then even a small change in compensation can have large effect. In particular if a country's civil service compensation level is just in the vicinity of the threshold level, a small reduction may push the country along the downward spiral and lead it to the Bad Equilibrium. The converse is also true. If the current compensation level is just below the threshold level, a small increase can set off a virtuous cycle leading the country to the Good Equilibrium. On the other hand, if current compensation level is far from the threshold level, then even large changes in compensation level may not have appreciable effect. It is therefore important to know whether the compensation-performance relationship is characterized by multiple-equilibrium and if yes what the threshold

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[6] Treisman (2000) notes, "… even though corruption hinders growth, countries can at times grow their way out of corruption. If other factors lead to vigorous economic development, corruption is likely to decrease." However, Treisman himself does not formulate the feedback effect in the form of a virtuous cycle and does not trace it via the compensation.

[7] Many narrowly focussed models of corruption also suggest multiple equilibrium with regard to the level of corruption.

level of compensation is that separates the Good Equilibrium from the Bad Equilibrium. This provides the motivation for this paper, and we begin the analysis by providing in the next section a more detailed argumentation for the multiple-equilibrium hypothesis.

3. The Possibility of Multiple Equilibrium

In arguing for the possibility of multiple equilibrium in civil service compensation-performance relationship, we may start from the above mentioned notions of 'virtuous' and 'vicious' cycles. Figure-2 provides a schematic presentation of these cycles.

Figure-2 about here

To follow the reasoning behind the scheme, we may first focus on the 'Good Equilibrium' and start from the point of compensation level. As the scheme suggests, a higher compensation level can set off several processes. One of these is less corruption, something that Van Rijckeghem and Weder (2001) and others have emphasized. However, better compensation may also enhance civil servants' pro-active role. There are several ways in which this may come about. One is through increased effort, sincerity, and concern for national interests,[8] etc. These processes are however of short run nature. Better compensation is also likely to lead to some positive long-term processes. One of these is improvement in the quality of recruits.[9] These short and long term processes are expected to cause improvements in IM-QCA. Together with the positive influence on the proactive attributes of the civil service, this should lead to better performance, both at the micro-level of selection and implementation of individual development projects as well as at the macro level of overall economic management. In terms of variables of the growth model, this should imply higher marginal product of capital (both physical and human), lower discount rate (ρ) rate, and higher inter-temporal elasticity of substitution (θ). This should lead to higher saving rates and lower rates of population growth. Both these short and long run processes would lead to higher rates of per capita income growth, which in turn should yield higher government revenue collection. The higher revenue may make it possible for

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[8] Including less dalliance with domestic private and foreign organizations to line up own pockets.

[9] The *New York Times* of January 1, 2002 reports that "Chief Justice William H. Rehnquist warned today that a combination of relatively low salaries and a tortuous confirmation process was making the federal judiciary

the government to provide higher compensation to its civil servants. This virtuous cycle leads to the 'Good Equilibrium.'

The converse may also happen. A low compensation level is likely to lead to low IM-QCA and dampen the pro-active attributes of the civil service.[10] Together this may lead to lower marginal products of physical and human capital, higher discount rate, and lower inter-temporal elasticity of substitution. All these may cause lower savings rate and higher population growth rate and hence lower per capita income growth. The lower income growth may result in a fall of government revenues, making it difficult for the government to pay higher compensation to its civil service personnel. This would reinforce the low QCA, thus yielding the 'Bad Equilibrium.'

The idea of multiple-equilibrium can also be expressed using the familiar diagram of the neoclassical growth model. Since institutions are a part of the shift term A of the aggregate production function, an improvement in IM-QCA can be modeled as increase in the value of A. Suppose the relationship between IM-QCA and compensation is described by the step function represented by Figure-3a. So long as compensation levels are below the threshold level γ, the value of A remains around the low level, A_L. However when compensation level nears and exceeds γ, positive processes ensue pushing A to the higher level A_H. The consequences of these dynamics for growth of the economy can be seen in Figure-3b. The shift from A_L to A_H, causes the steady state capital and income (per effective labor) to increase from ($\hat{k}_L^*$, $\hat{y}_L^*$) to ($\hat{k}_H^*$, $\hat{y}_H^*$). The higher per capita income may make it possible to pay higher compensation to the civil servants, thus completing the virtuous cycle representing the 'Good Equilibrium.' The analogous reasoning for the 'Bad Equilibrium' is clear.

It may be noted that in Figure-3b we have considered only the *direct* effect of an improvement in A. However, as observed earlier, an improvement in A can also have beneficial effects on saving rate and population growth rate. We may call these *indirect effects*. Incorporation of these indirect effects will magnify the impact of improvement in A. There is

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increasingly unappealing as a career move for lawyers in private practice." This shows salaries are important for recruits in a developed country such as the USA and for such high and prestigious positions as federal judgeships.

[10] For example, Schiavo-Campo et al. (1997a) note that "The nexus between compensation and performance is complex, but the consequences of wage-erosion are visible everywhere – increased turnover rates and absenteeism, moonlighting and sunlighting, difficulty in recruitment and retention, rise in petty corruption, etc." (p. 38) See also Mookerjee and Png (1995).

also the wider scope of *feedback effect* on *A* ensuing from the above mentioned direct and indirect effects. The feedback effect on QCA is just one such instance. Another example of feedback effect is the possibility that higher per capita income and higher saving rate will induce political parties of a country to behave more responsibly, because the economic costs of irresponsible behavior will now be higher.

Finally, we may note here that since Figure-3b is based on the Neoclassical Growth Theory (NCGT), higher *A* has *transitional growth effect* (along with the *level effect*) only. If instead we thought in terms of the New Growth Theories (NGT), higher *A* would have *long term growth effect*, implying increase in the equilibrium (steady state) growth rate. The long-term growth effect under NGT would also get accentuated if the above discussed 'direct,' 'indirect,' and the complete range of 'feedback effects' were taken into consideration. Thus the impact of positive changes in *A* resulting from increase in civil service compensation would be more consequential in the context of NGT than in the context of NCGT.[11]

The causal relationships mentioned above to establish 'Good' and 'Bad' equilibrium are hypotheses. In a particular country during a specific period, a particular hypothesized relationship of Figure 2 or 3 may not hold. However, the proposition here is that over time and across countries the hypothesized relationships portrayed in the scheme should hold as broad tendencies. Accordingly, when confronted with data from a sizable number of countries and over a sufficient period of time, these tendencies will be borne out as the average behavior.

It needs to be emphasized here that the multiple-equilibrium phenomenon portrayed in this paper is different from multiple equilibrium of models that focus narrowly on corruption (or other such IM-QCA). Our scenario of multiple equilibrium works via compensation's influence on FM-QCA, i.e., the economy's growth performance. Unlike corruption models, the macro-economic causal chains are of crucial importance for the multiple-equilibrium hypothesis of this paper.

The important question is how the multiple-equilibrium hypothesis can be tested. Finding proper econometrics for this purpose is not easy. Of the possible approaches, the methodology of threshold regression seems to be appealing because of its directness and its close correspondence with the content of the problem at hand. The main econometric difficulty that this methodology

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strives to overcome is that the value of the threshold level of the variable (in our case 'compensation') is unknown. Generically this is the Davies' (1977, 1987) problem, where the parameter value is unknown under the null. In a series of papers, Hansen (1996, 1999) has developed the theory and non-parametric methods to overcome this problem. The next section of the paper provides a brief account of this methodology in the context of the problem investigated in this paper.

4. Threshold Analysis of Multiple-Equilibrium

The threshold model for the civil service compensation-performance relationship may be formulated as follows:

(1)
$$y_i = \mu + \boldsymbol{\beta}_1' \, \mathbf{x}_i \, I(q_i \leq \gamma) + \boldsymbol{\beta}_2' \, \mathbf{x}_i \, I(q_i > \gamma) + e_i,$$

where,

y_i is a measure of the quality of civil administration (QCA) in country i,

$\mathbf{x}$ is a vector of variables that influence QCA,

q is the threshold variable, in our case the civil service compensation level,

γ is the threshold value of the compensation level, and

I is the indicator variable which equals 1 when its argument is true and 0 when the argument is false.

The model may be formulated more compactly by adopting the following notations. Let

(2)
$$\mathbf{x_i}(\gamma) = \begin{pmatrix} \mathbf{x_i} \, I(q_i \leq \gamma) \\ \mathbf{x_i} \, I(q_i > \gamma) \end{pmatrix}$$

and $\boldsymbol{\beta}' = (\boldsymbol{\beta}_1' \, \boldsymbol{\beta}_2')$. Then the model can be written as:

(3)
$$y_i = \mu + \boldsymbol{\beta}' \mathbf{x_i}(\gamma) + e_i.$$

For a given value of γ, the model is similar to regression with dummy variable, and OLS can be applied to estimate

(4)
$$\hat{\boldsymbol{\beta}}(\gamma) = \left(\mathbf{X}(\gamma)' \mathbf{X}(\gamma)\right)^{-1} \mathbf{X}(\gamma)' \mathbf{Y},$$

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[11] The relationships between changes in A on the one hand and growth rate and income level of an economy on the other are discussed in more detail in Islam (2002b).

where $\mathbf{X}$ and $\mathbf{Y}$ are stacked matrices containing $\mathbf{x_i}'$ and y_i as rows. The sum of squared residuals is given by $S_1(\gamma) = \hat{\mathbf{e}}(\gamma)'\hat{\mathbf{e}}(\gamma)$, where $\hat{\mathbf{e}} = \mathbf{Y} - \mathbf{X}(\gamma)\hat{\boldsymbol{\beta}}(\gamma)$ are the OLS residuals. Hansen suggests estimating γ by minimizing $S_1(\gamma)$ over all possible values of γ. So the least squares estimator of γ is given by

(5) $$\hat{\gamma} = \arg\min_{\gamma} S_1(\gamma)$$

The null hypothesis of no threshold effect for this model may be formulated as:

(6) $$H_0 : \boldsymbol{\beta}_1 = \boldsymbol{\beta}_2 .$$

The Davies' problem manifests itself in the fact that the parameter γ is not identified under the null. A consequence of this problem is that the estimator of γ given above does not have a standard distribution. Hansen however shows that the above null can still be tested using the F_1 statistic computed as:

(7) $$F_1 = \frac{\left(S_0 - S_1(\hat{\gamma})\right)}{\hat{\sigma}^2},$$

where S_0 is the sum of squared residuals under the null, and $\hat{\sigma}^2$ is the residual variance defined as $\hat{\sigma}^2 = \dfrac{S_1(\hat{\gamma})}{N-k}$, with N being the number of observations and k being the number of right hand side variables. The statistic F_1 does not have a standard distribution. However, Hansen shows how bootstrap p-values can be used to test the null using F_1.

Further, it is possible to test whether γ equals to any particular value γ_0, i.e., in order to test the null $H_0 : \gamma = \gamma_0$. This can be done using the statistic $LR_1(\gamma)$ defined as

(8) $$LR_1(\gamma) = \frac{S_1(\gamma) - S_1(\hat{\gamma})}{\hat{\sigma}^2},$$

where $\hat{\gamma}$ stand for γ_0, owing to the result (see Chan 1990, 1991 and Hansen 1999) that when there is threshold effect (i.e., $\beta_1 \neq \beta_2$), then $\hat{\gamma}$ is a consistent estimator of γ_0, the true value of γ. Hansen also shows that under reasonable assumptions, $LR_1(\gamma)$ has an asymptotic distribution given by ξ such that

(9)
$$P(\xi \leq x) = \left(1 - e^{-\frac{x}{2}}\right)^2.$$

Inverting this distribution function it is possible to find the critical values for $LR_1(\gamma)$ corresponding to chosen significance levels. This allows testing against all possible alternative values of γ.

The above consistency property of $\hat{\gamma}$ helps in determining the asymptotic distribution of the estimator $\hat{\beta} = \hat{\beta}(\hat{\gamma})$ too, despite its dependence on the threshold estimate $\hat{\gamma}$. Chan (1993) and Hansen (1999) show that the dependence is not of first order asymptotic importance, and hence inference on β can proceed assuming that $\hat{\gamma}$ was the true value γ_0. Hence $\hat{\beta}$ can be taken to be asymptotically normal with the estimated covariance matrix given by

(10)
$$\hat{V} = \left(\sum_{i=1}^{N} \mathbf{x_i}(\hat{\gamma}) \mathbf{x_i'}(\hat{\gamma})\right)^{-1} \hat{\sigma}^2.$$

If heteroskedasticity is suspected, the heteroskedasticity-consistent estimate of the asymptotic covariance matrix can be obtained as

(11)
$$\hat{V}_h = \left(\sum_{i=1}^{N} \mathbf{x_i}(\hat{\gamma}) \mathbf{x_i}(\hat{\gamma})'\right)^{-1} \left(\sum_{i=1}^{N} \mathbf{x_i}(\hat{\gamma}) \mathbf{x_i}(\hat{\gamma})'(\hat{e}_i)^2\right) \left(\sum_{i=1}^{N} \mathbf{x_i}(\hat{\gamma}) \mathbf{x_i}(\hat{\gamma})'\right)^{-1}.$$

The correspondence between the threshold regression model and the multiple-equilibrium hypothesis of this paper is quite apparent. As Figure-2 shows, as long as the compensation level is quite below the threshold level, the economy is likely to remain stuck with the 'Bad equilibrium.' In this range changes in compensation level are not likely to have significant positive impact on civil service performance. However, once the compensation level is close to the threshold level, changes in compensation are likely to have significant positive impact on the performance of the civil service, because such changes can cause the country to switch to the 'Good equilibrium.'

Suppose compensation (abbreviated as *COMP*) is one of the variables included in **x** matrix, and let $\beta_{1,COMP}$ denote the coefficient of this variable when its value is less than the threshold value γ, while $\beta_{2,COMP}$ is the coefficient when compensation is greater than γ. The

proposition of multiple-equilibrium suggests that $\beta_{2,COMP} > \beta_{1,COMP}$. Thus a rejection of the null

hypothesis $H_0 : \beta_{2,COMP} = \beta_{1,COMP}$ in favor of the alternative $H_A : \beta_{2,COMP} > \beta_{1,COMP}$ is a

necessary condition for the empirical validity of the multiple-equilibrium hypothesis.

It is to be noted that the threshold affect of compensation is likely to work through other explanatory variables. From this point of view, $\mathbf{x}$ can be partitioned into two sub-matrices, $\mathbf{x_s}$ and $\mathbf{x_d}$, where $\mathbf{x_s}$ consists of those variables whose coefficients do not change with the threshold (in other words, stays the *same*, and hence the subscript *s*). On the other hand, $\mathbf{x_d}$ consists of those variables whose coefficients do change with the threshold (i.e., *differ*, and hence the subscript *d*). Notice that in our case *COMP* is the prime member of $\mathbf{x_d}$.[12] Suppose $\mathbf{\beta_s}$ and $\mathbf{\beta_d}$ denote the coefficient sub-vectors corresponding to the variables in $\mathbf{x_s}$ and $\mathbf{x_d}$, respectively. Then the multiple-equilibrium hypothesis suggests that $\mathbf{\beta_{1,s}} = \mathbf{\beta_{2,s}}$, but $_{1,d} \neq \ _{2,d}$. In this context a rejection of the $H_0 : \ _{1,d} = \ _{2,d}$ will provide support for the multiple-equilibrium hypothesis.

An interesting question in applying the threshold regression model to test the multiple-equilibrium hypothesis is to decide which variables belong to $\mathbf{x_s}$ and which to $\mathbf{x_d}$. Also, unlike with the compensation variable, the direction in which the sign and magnitude of coefficients of many variables belonging to $\mathbf{x_d}$ change under the alternative, may not be *a-priori* known. This will depend on the nature of influence of these variables and hence will vary, as we shall see.

5. Baseline specification, Signs, and Directions of Change

In applying the threshold regression methodology to test the multiple-equilibrium hypothesis, we first need to determine a baseline specification, in the context of which the threshold effect can be introduced. We shall call the sign of a coefficient in the baseline regression as the *baseline sign*. The empirical literature has come up with a host of explanatory variables for growth regressions.[13] These variables may be classified broadly into two groups,

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[12] However, it is possible for the threshold variable itself not to be part of the **x** matrix and instead exert all its influence through changes in the coefficients of other included explanatory variables of the regression.

namely *economic* and *non-economic*. The economic variables include initial income, investment rate, etc. In an extended sense, economic variables also include measures of human capital, population growth rate, etc.[14] The non-economic variables are included mainly to control for the productivity shift term, and as mentioned earlier, they may be classified into three subgroups, namely the 'physical base,' the 'social base,' and the 'institutional.' The latter include, other than 'quality of civil administration,' such variables as the 'nature of the legal system,' 'nature of the political system,' 'extent of democracy,' 'civil rights,' etc.[15]

From the point of view of threshold analysis, not all these variables have similar roles. Often there is no consensus in the literature about the expected baseline sign of the coefficients. This is particularly a problem for coefficients of the $\mathbf{x_d}$ variables, because ambiguity regarding the baseline sign also implies ambiguity about the expected direction of change in $\boldsymbol{\beta_d}$ resulting from the threshold. The following discussion illustrates the issues in the context of several variables that are important candidates for inclusion in our baseline regression. In particular, we ask the following questions: (a) what the baseline sign of the variable is, (b) whether the variable belongs to $\mathbf{x_s}$ or $\mathbf{x_d}$, and (c) if the variable belongs to $\mathbf{x_d}$, how the sign or magnitude of the variable's coefficient is likely to change. We begin with some economic variables about the role of which theory provides some guidance, and then move on to the 'social base' and 'physical base' variables, about whose sign the guidance is less clear.

Initial income level: The presence of the initial income variable is linked to the neoclassical growth theory (NCGT), which implies that, other things remaining the same, growth rate will decrease as the income level rises.[16] This suggests that the baseline sign of the initial income variable will be negative. To the extent that the force of diminishing returns is not likely to depend on QCA, the compensation threshold may not affect this sign, and hence this variable is likely to belong to $\mathbf{x_s}$ instead of $\mathbf{x_d}$. On the other hand, the initial income variable may also be

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[13] This is a huge literature, which is not possible to survey here. Some pertinent works include Levine and Renelt (1992), Sala-i-Martin (1997), Temple (1999), and Islam (2003).

[14] Initially growth researchers used to limit themselves to economic variables, which are often also called the 'proximate' sources of growth. With time, however, researchers have become interested in finding 'ultimate' or 'fundamental' sources of growth. This quest has led them to non-economic variables.

[15] For recent discussion of the role of non-economic variables in growth, see Alesina and Perotti (1994) and Brunetti (1997).

[16] This is due to the NCGT assumption of diminishing returns to capital accumulation.

thought to proxy for opportunities of technological diffusion.[17] The extent to which these opportunities are realized may then depend on QCA, suggesting that this variable belongs to $\mathbf{x_d}$ instead of $\mathbf{x_s}$. Finally, leaving the cross-country phenomenon of technological diffusion aside, many models of New Growth Theory (NGT) suggest the initial income variable to be insignificant, because these models do not postulate diminishing returns. We thus see that the situation with regard to the baseline sign of even the initial income variable is not unambiguous.

Other economic variables: Many researchers have been wary of including other economic variables such as investment rate, labor-force growth rate, etc., in growth regressions because of their suspected simultaneity. Earlier, Mauro (1995) found that most of the (negative) effect of corruption on growth is channeled through its negative effect on investment. Thus inclusion of investment rate in the regression can frustrate the goal of capturing the influence of civil service compensation on economic growth.[18] One economic variable that deserves special mention is 'human capital.' Researchers have often included in their regressions the initial level (stock) of human capital, the sign of which differs depending on the growth theory believed.[19] Viewed from the perspective of augmented NCGT, such as of Mankiw, Romer, and Weil (1992), returns to human capital would also be subject to diminishing returns, suggesting a negative coefficient on the initial human capital variable.[20] As just mentioned, most NGT models, on the other hand, do not imply diminishing returns. From the NGT perspective therefore the initial human capital variable can appear as either positive or insignificant, depending on the particular variant of the NGT that is used as the reference model. In both cases, however, the compensation threshold level is not likely to affect the sign or magnitude of the initial human capital variable, and hence this variable can also be thought to belong to $\mathbf{x_s}$ instead of $\mathbf{x_d}$. However, the initial human capital stock can also be thought to proxy for a country's capacity to exploit the opportunities of technological diffusion as reflected by the initial level of income. In that case the initial human capital stock variable may have a positive sign, and it may belong to $\mathbf{x_d}$ instead of

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[17] Or of 'advantages of backwardness,' as Alexander Gerschenkron (1953) put it.

[18] As Barro (1991) suggests, these other economic variables themselves can be viewed as dependent variables for separate analysis.

[19] This treatment is similar to that of 'initial income variable,' mentioned above.

[20] However, this negative correlation may not emerge in a regression which already includes initial income variable, because the latter already proxies for the initial level of capital, which from the augmented NCGT perspective already includes human capital.

$\mathbf{x_s}$, because the aforementioned capacity may also depend on IM-QCA.[21] Turning to non-economic variables, the ones that have found importance in the recent literature are the following:

Ethno-linguistic fractionalization: This variable (abbreviated for further reference as *Ethfrac*) refers to the degree of fragmentation or diversity of a country's population in terms of ethnic origin and language spoken. There have been contradictory hypotheses regarding the nature of influence of *Ethfrac* on IM-QCA. Some argue that *Ethfrac* influences IM-QCA negatively (say increases corruption), because government officials try to favor unduly people of their own ethnic group at the expense of others. If this 'nepotism-hypothesis' is correct, the baseline sign of this variable's coefficient, say β_{ETH}, will be negative. One can then argue that β_{ETH} is part of $\mathbf{\beta_d}$, because at higher compensation levels, civil servants do not indulge in ethnic nepotism as much as they do when compensation is low. This may suggest the hypothesis: $H_A : \beta_{2,ETH} > \beta_{1,ETH}$, where $\beta_{1,ETH}$ and $\beta_{2,ETH}$ are coefficients of *Ethfrac* variable depending on whether the corresponding value of compensation is less or greater than its threshold value. On the other hand, it is possible to argue that *Ethfrac* creates an atmosphere of countervailing power, which keeps civil servants of all ethnic groups in check and thus exerts a positive influence on QCA. If this 'countervailing-hypothesis' is true, compensation may fail to have a threshold effect on β_{ETH}, and it may thus be a part of $\mathbf{\beta_s}$ instead of $\mathbf{\beta_d}$.

Religious composition of the population: The religious composition variable can be thought to influence QCA in different ways. The first of these is similar to that of *Ethfrac*, and the general sign of this variable may accordingly be thought to be ambiguous. However religious differences often run along the same lines as ethnic and linguistic differences do. Hence, once ethnic differences have been taken into account, religious differences may not be that significant. However, religious composition may be thought to influence QCA in another way, particularly if it is thought that certain religions are more favorable to QCA than others. Generally speaking, all religions enjoin people to lead a righteous life and not to indulge in corruption. This suggests that differences in religion may be less of a factor for IM-QCA. However some authors argue that

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[21] Note that if the human capital variable enters as a flow variable, i.e., in the form of rate of accumulation, then its expected sign is positive from both NCGT and the new growth theory (NGT) perspectives. But, the simultaneity problem noticed above with respect to physical investment rate applies equally to contemporaneous rates of human capital accumulation.

puritan aspects of many Protestant sects have positive influence on IM-QCA. More importantly, Max Weber (1998) and other sociologists have argued that protestant ethics played an important role in the rise of capitalism. Hence preponderance of Protestants in the population may have a positive influence on economic growth, because this growth is achieved under capitalism. In the light of the above, we may be interested in the religious composition variable more as an indicator of incidence of Protestant religion in the population than as an indicator of religious diversity *per se*. Compensation threshold may not therefore have much impact on the influence of this variable, and it may belong to the sub-matrix $\mathbf{x}_s$.

Origin of the legal system: The influence of the legal system on QCA is not difficult to see. Clearly, the civil service has to operate under the country's prevailing legal system, and its efficacy therefore depends to a large extent on this system. Researchers have distinguished several legal systems, such as the Common Law, the Civil Law, the German Law, the Scandinavian Law, the Soviet Law, etc. The common view in the literature is that the Common Law system is oriented toward protection of citizens' rights, while the Civil Law is oriented toward protection of the monarch's or the government's rights. The remaining legal systems fall somewhere in between. The literature therefore suggests that the Common Law will be associated with less corruption.[22] It is important however to note that this positive influence of Common Law may not hold automatically for all IM-QCA and for FM-QCA. To the extent that it puts civil servants under a more restrictive framework, one may argue that the Common Law hinders civil servants' initiatives and thus affects adversely some of the pro-active attributes of bureaucracy and thus ultimately affects economic growth negatively. Suppose **x** contains a dummy variable, which equals 1 if the legal system follows the Common Law system and zero if it follows other Laws. If it is thought that the Common Law system is generally better for QCA than other Laws, then the baseline sign of this variable, say β_{LS}, should be positive. Suppose now that the impact of the legal system depends largely on how the system is actually implemented by the civil service.[23] If the performance of the civil service depends on compensation in the way described by the above multiple-equilibrium model, β_{LS} will differ

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[22] See Treisman (2000) and La Porta et al. (1998) for discussion of the legal systems and their possible influence on QCA.

[23] This is similar to Treisman's (2000) argument for the 'Legal culture' variable in his paper.

depending on the threshold,[24] and we may expect $\beta_{2,LS} > \beta_{1,LS}$. On the other hand, if the baseline sign of β_{LS} is deemed negative, then it is possible that $\beta_{2,LS} < \beta_{1,LS}$.[25]

Colonial Past: Many recent studies of corruption and growth have included some type of 'colonial past' variable in their regressions.[26] Colonial heritage is indeed an important factor for many developing countries. The administrative and legal systems that many developing countries inherited are generally legacies of the colonial rule. The ethnic and religious composition of many countries was also determined largely by the way their borders were drawn by the colonial rulers at the time of independence. This however raises the question whether the 'colonial past' variable can have any independent effect after such variables as 'ethnic' and 'religious composition,' 'legal system,' etc., have already been included in the regression.

This discussion can be continued further. However, two general points are clear. First, whether a particular variable belongs to $\mathbf{x_s}$ or $\mathbf{x_d}$ is in many cases an empirical issue, because more often than not, theory lacks clear verdict. Second, the direction in which coefficients of $\mathbf{x_d}$ variables should change is also often an empirical issue. It is an advantage of the threshold model that it allows investigation of both these questions, in addition to the general question of whether or not a variable belongs to $\mathbf{x}$ at all.

6. Data and Variables

Before presenting the results, we provide in this section some idea about the data and variable construction.

Data on QCA and Other Control Variables:

So far as data are concerned, the most unambiguously defined variable is FM-QCA, namely the growth rate of the economy. The growth data are obtained mainly from Penn World

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[24] That is, the 'Legal System' dummy would be a part of $\mathbf{x_d}$.

[25] It may be argued that even in this case $\beta_{2,LS} > \beta_{1,LS}$. This further illustrates the potential ambiguity. The threshold model implies that $\beta_{2,LS} \neq \beta_{1,LS}$; it does not specify the direction of inequality.

[26] See for example, Sala-i-Martin (1997). For more extended discussion of colonialism's impact on growth, see Acemoglu et al. (2001) and Grier (1998).

Tables, supplemented where necessary by data from a few other sources such as the World Bank. These sources also provide data on many of the economic control variables mentioned above.

The situation regarding data on IM-QCA is however murky, from both conceptual and measurement points of view. The major sources of data on IM-QCA are *Transparency International* of Gottingen University, *International Country Risk Guide (ICRG)* of the Political Risk Services of IRIS, University of Maryland, *Business International*, etc. Some of these IM-QCA data sets also include many of the 'institutional,' 'social-base,' and 'physical-base' variables mentioned above. Drawing upon these sources, La Porta et al. (1998) and Triesman (2000) provide useful compilations of data on a range of variables. The current paper relies upon data appendices of these two papers for information on many of the non-economic variables.

The Compensation Variable

The most problematic is data on civil service pay. Paucity of pay data has been one of the main reasons why compensation has not received that much attention from scholars in their research on determinants of QCA. As mentioned earlier, the recent World Bank study by Schiavo-Campo et al. (1997a, 1997b) has been an important step forward. It gathers and analyzes data on government employment and compensation for a sizable number of countries. However, this study itself reveals the difficulties in getting satisfactory civil service compensation data.[27] There are several problems in this regard.[28] The first is that the civil service in every country has a large number of ranks, grades, classes, etc.[29] This complexity of structure makes it difficult to arrive at an average wage for the civil service as a whole. Second, the civil service compensation in most countries contains many benefits and in-kind components whose cash value is often difficult to ascertain.

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[27] This is how Schiavo-Campo et al. (1997a) themselves characterize their study: "Although this study attempts to remedy, in part, this state of affairs, the paucity of readily available data is explained by persisting methodological difficulties. *There is no more hazardous cross-country comparison than in the area of 'civil service' employment and wages*." (p. 4, italics added)

[28] This is without going into the deeper issue of valuation of civil service. As Schiavo-Campo et al. (1997a) rightly notes, "The classic problem in civil service compensation is how to value the labor that produces the output of civil servants, given that such output is not generally not marketable." (p. 38) We are avoiding this issue by considering relative pay, and not the pay in relation to the value produced.

[29] This also brings up the issue of what has been called the "intra-civil service" fairness in compensation, i.e., whether the pay differential within the civil service is commensurate to the skill and effort differential. In this study, however, we are not dealing with this issue, although is does not mean that it is unimportant.

It is widely believed that instead of the absolute level, it is the relative level of civil service compensation that is more important in influencing civil service behavior.[30] This makes construction of the compensation variable even more difficult, because one then also needs to be concerned about the denominator of the ratio (assuming civil service salary to be the numerator) measuring the relative level. Suggestions regarding the denominator vary and include manufacturing wages, private sector salary, etc.[31] None of these is free of problems just mentioned. For example, the issues of structural complexity and difficulty of conversion of in-kind components into cash equivalents apply to manufacturing wages too. In addition, the skill and effort content differential between civil service job and manufacturing job may not be of the same degree across countries. Also, a civil service job and a manufacturing job of similar pay may differ in other respects, such as job security, social esteem, etc. These difficult-to-measure aspects may also differ across countries. The task before Schiavo-Campo et al. (1997a, 1997b) was therefore daunting indeed, and this makes the progress they have made all the more commendable. As already mentioned, Van Rijckeghem and Weder (1997, 2001) build on this progress in putting together their data set.

Construction of Variables

Given our discussion above, construction of most of the variables is self-explanatory. As suggested in Section-3, the religious composition variable is constructed as a percentage of the population belonging to the Protestant faith and is abbreviated for further reference as *Rel_prot*. The legal origin variable (abbreviated as *Legor_co*) is a dummy that assumes the value 1 if the country's legal system is based on the Common Law system, and it assumes the value 0 otherwise. Finally, the colonial past variable (abbreviated as *Col_brit*) is also a dummy that takes the value 1 if the country was under British colonial rule, and it assumes the value 0 otherwise.

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[30] Some 'satisficing'-behavior theories may favor the absolute level. However, most observers, including many of those who think 'satisficing-behavior' to be the correct way of modeling bureaucratic behavior agree that it is the relative level of compensation that plays a more important role in determining civil service behavior.

[31] Schiavo-Campo et al. (1997a, 1997b) seems to favor manufacturing wages as the denominator. Treisman (2000), on the other hand, uses "average wages in central government as a percentage of per capita GDP" as the relative pay variable.

7. Empirical Results

Baseline Specification

Table-1 compiles results for the baseline specification. According to Van Rijckeghem and Weder, their compensation data pertain to the 1970s. In order to minimize the reverse causality problem, the GDP growth rate over 1970-90 has therefore been taken as the measure of growth performance, i.e., as the dependent variable.

Several things emerge from these results. First, we see that the compensation variable proves significant in all specifications. The numerical magnitude of the coefficient diminishes somewhat as more variables are included in the regression, however it remains in the vicinity of two. As we may recall, Rijckeghem and Weber found strong positive influence of compensation on IM-QCA (measured by the 'corruption' index). The results of Table-1 show that the positive influence of compensation extends to FM-QCA, i.e., to growth performance. Table-2 aids in gauging the economic significance of the coefficients. The standard deviation of the compensation ratio variable in the data is 0.66. The baseline results therefore indicate that an one standard deviation increase in compensation is associated with an annual growth rate increase by 1.15 to 1.58 percentage points, depending on the specification chosen. This represents a very big positive impact, and the threshold analysis will soon help us better interpret the source of this impact.

Second, among economic variables, the initial per capita income (*Lgdp70*) appears with a negative sign reflecting either diminishing returns of the NCGT and/or diminished opportunities of technological diffusion as (relative) income level rises. The variable is however marginally significant, and in fact loses its significance in some specifications. The initial income variable enters the regression in log form. Table-2 shows that at the mean level of the variable ($1,772), an increase by $1,000 is associated with an annual growth rate decrease by 0.28 to .98 percentage point, depending on the specification chosen. The other economic variable, namely the initial level of human capital, enters the baseline regression with a positive sign, supporting some of the ideas of the New Growth Theories. However, the coefficient proves statistically insignificant. Also, inclusion of this variable leads to a drastic reduction of the sample size. (Only fifteen countries of the sample have requisite data on human capital.) This variable is therefore left out of the baseline regressions.

Third, among non-economic control variables, the ethno-linguistic composition variable, *Ethfrac*, proves to be significant, irrespective of the specification used. The sign proves to be negative, indicating that the 'nepotism-' rather than the 'countervailing power-' hypothesis regarding this variable's influence on QCA finds support in the data. The numerical magnitude of this coefficient remains almost unchanged across specifications. Table-2 shows that one standard deviation (equaling to 28 percent) increase in *Ethfrac* is associated with an annual growth decrease by 0.84 to 1.40 percentage points depending on the specification chosen.

The legal origin variable (*Legor_co*), on the other hand, appears with a positive sign in the regressions, supporting the hypothesis that, other things being equal, the Common Law is conducive to growth. However, the variable is barely significant or not significant. Similarly, the religious composition variable (*Rel_prot*) does not prove significant, though it appears with a negative sign, indicating that Protestantism may not have been more conducive to growth than other religions in the recent decades. Finally, the colonial past variable (*Col_brit*) proves insignificant too.[32] This may not be surprising in view of our earlier observation that the colonial past may not have any independent influence once other variables such as the legal system etc. are included in the regression.

The results of Table-1 therefore point to either models in column (2) or (4) as suitable baseline specifications. For further reference we will call these as Model-2 and Model-4, respectively. Despite their parsimony, these specifications contain the possibility of having both $\mathbf{x_s}$ and $\mathbf{x_d}$ sub-vectors as explanatory variables. As noted earlier, from the NCGT point of view, the initial income variable, *Lgdp70*, is likely to belong to the sub-vector $\mathbf{x_s}$. On the other hand, *Ethfrac*, for example, may belong to $\mathbf{x_d}$. Of course, the compensation variable, *Comp*, is itself a part of $\mathbf{x_d}$, and the coefficient of the compensation variable, β_{COMP}, is the prime element of $\boldsymbol{\beta_d}$. Given these possibilities and the parsimony, it may be reasonable to work with Model-2 and Model-4 as baseline specifications.[33] Having established some baseline specifications, we can now turn to introduction of the threshold effect.

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[32] It has a negative sign, indicating that other things equal, countries that were under British colonial rule do not demonstrate better economic performance.

[33] Parsimony is an important attribute in our case given the data constraints.

Threshold regressions

Consider first introduction of threshold effect to the baseline Model-2. The results are compiled in Table-3. The column-1 of this table reproduces the baseline results from this model. As we saw, according to this specification, β_{COMP} is positive (with a value of 2.26) and significant, with a *t*-value of 4.10. We first introduce threshold effect only to the compensation variable itself. That is, we allow $\beta_{1,COMP}$ differ from $\beta_{2,COMP}$, while keeping coefficients of rest of the variables the same on both sides of the threshold. The results from this regression are shown in column (2) of Table-3. Several things emerge from these results. First, we see a dramatic difference between $\hat{\beta}_{1,COMP}$ and $\hat{\beta}_{2,COMP}$. In fact, they are now of opposite signs. While $\hat{\beta}_{2,COMP}$ is positive (1.92), $\hat{\beta}_{1,COMP}$ turns out to be *negative* (-0.39). As noted earlier, the distribution of these coefficients may be taken to be asymptotically normal, and hence we can draw inferences by comparing the sample *z*-values (reported in parentheses below respective coefficient estimates in Table-3) with the usual critical z-values. We thus note that $\hat{\beta}_{1,COMP}$ is not significant with a sample *z*-value of only -0.44. By contrast, the sample *z*-value for $\hat{\beta}_{2,COMP}$ is 4.25, indicating that it is significant at less than 1 percent significance level. This shows that the strong positive association between compensation and performance that we see in the baseline regression comes mainly from compensation's positive impact when it crosses the threshold level. When compensation levels are below the threshold level, changes in compensation fail to have any appreciable effect on the performance.

We may now subject the above conclusion to formal testing using the F_1 statistic defined by (7). As can be seen in Table-3, the sample value of the F_1 statistic to test the null $H_0 : \beta_{1,COMP} = \beta_{2,COMP}$ against the alternative $H_A : \beta_{1,COMP} \neq \beta_{2,COMP}$ turns out to be 174.92. We compute a bootstrap distribution of this F_1 statistic using the residuals from the unrestricted regression and the predicted values of the restricted regression. The *p*-value of the sample F_1 from this bootstrap distribution (based on 1000 replications) turns out to be 0.0425. This implies that the $H_0 : \beta_{1,COMP} = \beta_{2,COMP}$ can be rejected in favor of $H_A : \beta_{1,COMP} \neq \beta_{2,COMP}$ at a 5 percent significance level.

Second, the estimated value of γ, the threshold level of compensation, turns out to be 1.74. This value of $\hat{\gamma}$, as we shall see, remains quite stable across different baseline specifications used for introduction of the threshold effect. As mentioned in section-4, the threshold regression theory developed by Chan (1993) and Hansen (1999) suggests that when $H_0 : \beta_{1,COMP} = \beta_{2,COMP}$ is rejected in favor of $H_A : \beta_{1,COMP} \neq \beta_{2,COMP}$, the $\hat{\gamma}$ obtained from equation (5) provides a consistent estimate of the true threshold value, say γ_0. Thus substituting $\hat{\gamma}$ for γ_0, we can now test the null $H_0 : \gamma = \gamma_0$ using the LR_1 statistic given by equation (8). The graph of the LR_1 statistic for γ in the context of the specification in column (2) of Table-3 is given by Figure-4a. We can see several things from this graph. First, it shows that there is only one threshold compensation level, as is expected from our multiple-equilibrium hypothesis. There are some dips in the LR_1 curve, but these do not come close to touching even the 1-percent significance level line. Hence, the hypothesis that any other compensation level (than the estimated value of 1.74) is the true threshold-level can be rejected even at 1-percent significance level. Second, the confidence intervals for the estimated γ for different probability levels can be read off directly from the LR_1 curve.

Having seen the threshold effect with respect to the compensation variable itself, we may now examine how coefficient values of other variables in the threshold regression compare with those in the baseline regression. Other control variables in this regression are the initial income level, *Lgdp70*, and ethno-linguistic fractionalization, *Ethfrac*. Both these variables have been thought to be part of $\mathbf{x_s}$, and hence we have just one coefficient for them each in the threshold regression to compare with the corresponding coefficients in the baseline regression. We notice that the estimated value of the *Ethfrac* coefficient in the threshold regression remains very close to its value in the baseline regression. The numerical magnitude changes from -0.03 only to -0.04, and the Standard Error Estimate (SEE) remains almost unchanged at 0.014. In contrast, the *Lgdp70* coefficient undergoes notable changes. The numerical magnitude changes from –1.37 to –1.96, and more importantly the SEE decreases from 0.76 to 0.64, suggesting that the initial income variable now becomes more significant.

To check the robustness of our basic conclusion regarding threshold effect, we now switch to Model-4 as the baseline regression. This model, as we know, includes the additional

variable *Legor_co* that represents the origin of legal system of a country. The column (3) of Table-3 reproduces the baseline results. In column-4 we see the results when the threshold effect is introduced with respect to the compensation variable only. We see that the results are very similar results to those obtained from using Model-2 as the baseline. First, the estimated value of the coefficient $\beta_{1,COMP}$ again proves negative (-0.43), and it proves insignificant, with a sample z-value of -0.46 only. The estimated value of $\beta_{2,COMP}$, on the other hand is positive (1.72) and has a sample z-value of 3.30, indicating that the coefficient is highly significant. Second, sample value of the F_1 statistic to test the null $H_0 : \beta_{1,COMP} = \beta_{2,COMP}$ against the alternative $H_A : \beta_{1,COMP} \neq \beta_{2,COMP}$ is found to be 144.34, and bootstrap distribution indicates that it has a p-value equaling 0.0462. Thus the null of absence of threshold effect is again rejected at 5-percent significance level. Third, the estimated value of γ again equals 1.74, showing the threshold value is robust to the choice of the baseline specification. Finally, to test whether any other value equals the true value γ_0, we compute the LR_1 statistic and plot it in Figure-4b. We see that there are no dips touching any of the significance lines other than at γ equaling 1.74. Thus the hypothesis that γ_0 is equal to any other value than 1.74 can again be safely rejected. Having thus probed into the robustness of the threshold effect with respect to the choice of baseline specification, we now turn to the important question of what other (explanatory variables) of the regression are affected by the compensation threshold. We do this in the context of Model-2 as the baseline specification.

In our discussion of section-5, we conjectured that *Ethfrac* might be a variable that displayed threshold effect. In order to examine this possibility we now change the specification of the threshold regression to allow the *Ethfrac* coefficient (in addition to the *Comp* coefficient) to vary with the threshold. In other words, we move *Ethfrac* from $\mathbf{x_s}$ to $\mathbf{x_d}$, and allow it to have two coefficients, $\beta_{1,ETH}$ and $\beta_{2,ETH}$, depending on whether compensation is below or above the threshold. (The initial income variable continues to be in $\mathbf{x_s}$.) The results from this specification of the threshold regression can be seen in column (5) of Table-3. The main features of these results are as follows. First, $\hat{\gamma}$ remains unchanged at 1.74, indicating that the estimated threshold value is also robust to some shifts of control variables between $\mathbf{x_s}$ to $\mathbf{x_d}$. Second, $\hat{\beta}_{1,COMP}$ and

$\hat{\beta}_{2,COMP}$ display the same pattern as was the case when *Ethfrac* was not in $\mathbf{x_d}$. As we can see, $\hat{\beta}_{1,COMP}$ is again negative (-0.05) and insignificant (*z*-value equaling -0.06), while $\hat{\beta}_{2,COMP}$ is positive (2.49) and is significant, with a *z*-value of 3.02. This confirms again that the source of positive relationship between compensation and QCA seen in the baseline regression is compensation's positive impact on QCA once it crosses the threshold level. Third, coming to the *Ethfrac* variable itself, we see that the value of $\hat{\beta}_{1,ETH}$ (-0.03) is almost the same as $\hat{\beta}_{ETH}$, the variable's coefficient in the baseline regression. The standard errors are also of similar size, suggesting significance of $\hat{\beta}_{1,ETH}$ (the *z*-value being –2.26). On the other hand, $\hat{\beta}_{2,ETH}$, though larger in absolute magnitude, now has an even larger standard error, suggesting that the coefficient is insignificant. (The *z*-value is –1.41 and has a *p*-value of 0.18.) This indicates that the main source of the negative relationship between ethno-linguistic fractionalization and economic growth found in the baseline regression is the formers negative influence on growth when compensation levels are lower than the threshold. At higher levels of compensation, this negative influence seems to lose its force. This would support the nepotism view of the role of ethno-linguistic fractionalization rather than the countervailing-power view of it.

To check whether the above informal conclusions hold up to formal testing, we conduct a test of the hypothesis $H_0 : \beta_{1,ETH} = \beta_{2,ETH}$ versus the alternative $H_A : \beta_{1,ETH} \neq \beta_{2,ETH}$ with $\beta_{1,COMP} \neq \beta_{2,COMP}$ as the maintained hypothesis under both the null and the alternative. Since the true value of γ is unknown, the standard *F*-tests do not apply. However, following the lines of computation of F_1 and its bootstrap distribution above, we can compute a F_2 statistic and its bootstrap distribution to test the hypothesis. The sample value of F_2 turns out to be 38.46, and its bootstrap *p*-value (based on 1000 replications) equals 0.092, indicating that the null can be rejected though not at a very 'high' significance level. Thus we see that there is evidence that some of the compensation threshold effect is conveyed through its impact on the working of the ethno-linguistic fractionalization variable.

Next, we check whether the compensation threshold has any influence on the coefficient of the initial income variable, *Lgdp70*. In our discussion of section-4, we observed that such influence was not likely if *Lgdp70* was thought to represent the 'objective' force of diminishing

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returns and hence not to depend on such 'subjective' factors as performance of the civil service. However, we also noticed that compensation threshold may have some influence on the coefficient of *Lgdp70* if the initial income variable was thought to represent mainly the technological diffusion potential, and the extent to which this potentiality is realized depended on the performance of the civil service.

To examine these hypotheses, we shift *Lgdp70* from $\mathbf{x_s}$ to $\mathbf{x_d}$ and allow it to have two coefficients, $\beta_{1,LGDP}$ and $\beta_{2,LGDP}$, in the threshold regression, depending on whether compensation is below or above the threshold level. The estimated values of $\beta_{1,LGDP}$ and $\beta_{2,LGDP}$ are found to be –1.88 and –1.51, respectively, with z-values of -2.95 and -1.99, respectively. These show that $\beta_{1,LGDP}$ and $\beta_{2,LGDP}$ are similar in sign, and both are significant. Their magnitudes are close too. This seems to suggest that compensation threshold does not affect the influence of the initial income variable that much. This would indicate that the initial income variable primarily captured the objective force of diminishing returns, and its influence was not affected greatly by QCA.

Again we can subject these conclusions to formal testing by computing the F_2 statistic described above to test the hypothesis $H_0 : \beta_{1,LGDP} = \beta_{2,LGDP}$ vesus the alternative $H_A : \beta_{1,LGDP} \neq \beta_{2,LGDP}$ with $\beta_{1,COMP} \neq \beta_{2,COMP}$ as the maintained hypothesis under both the null and the alternative. The sample value of F_2 turns out to be 18.46, and its bootstrap *p*-value equals 0.223, indicating that the null cannot be rejected at the conventional levels of significance.

We now proceed to summarize the results and to indicate the lines along which this research may be extended further in future. This is done in the following concluding section.

8. Concluding Remarks

This paper considers the relationship between civil service compensation and its performance as measured by economic growth performance of the economy. In particular, it puts forward a multiple-equilibrium hypothesis regarding this relationship and tests this hypothesis using the threshold regression methodology.

In general, the results support the multiple-equilibrium hypothesis. It is found that changes in compensation have more pronounced effect on growth once the compensation level is higher than the threshold level. On the other hand, as long as compensation level remains less than the threshold level, changes in compensation do not have much effect on growth. In terms of Van Rickeghem and Weder compensation variable, which represents the ratio of average civil service salary to the average manufacturing wage, the threshold compensation level appears to be 1.74.

This does not mean that we have found a magic number 1.74, and that all it needs to promote growth is to set the civil service salary level so that this ratio is satisfied. Fist of all, there is a difference between the threshold value of γ and the compensation level that separates 'Good' equilibrium from 'Bad' equilibrium. In a sense the econometric estimate of γ from threshold regression provides the lower cut off point beyond which the compensation variable has higher growth effect. In other words, instead of a specific *point*, the threshold regression indicates a *range*. Second, in this range the threshold levels for individual countries can be different, depending on their individual circumstances. Detailed research focused on concrete situation of individual countries is necessary to get at these more specific values.[34] Third, this range is not unlimited. There are always limits to out-of-sample prediction using results of a regression model. More importantly there is also the possibility of a second threshold indicating that at very high levels of compensation its growth effect tapers off.

The analysis presented in this paper should be regarded as a first step in application of the threshold regression methodology in studying an important issue of growth and productivity. There are many directions in which this analysis can be extended and sharpened further. First, as noted above, some of the compensation threshold effect was conveyed through its impact on the influence of ehtno-linguistic fractionalization variable. However, the results also showed very strong threshold effect of the compensation variable itself even after accounting for the threshold effect on *Ethfrac*. This indicates that the compensation variable was proxying for many other determinants of growth of productivity whose impact depends on the threshold. Our discussion

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[34] Schiavo-Campo et al. (1997a) also emphasize that, "… all such data can serve only as pointers for further analysis, and country-specific knowledge is required for meaningful interpretation." (p. vi) They further go on to say that: "We must again sound the same caveat here as for employment: specific wage policy recommendations cannot be based in such aggregate evidence as presented here." (p. vii) And, "An in-depth country-specific analysis is needed to justify any recommendation concerning the size of government employment." (p. vii).

of the multiple-equilibrium hypothesis in Section-2 listed a host of positive processes that are likely to be triggered by a rational level of compensation. Capturing these threshold effects will require a more elaborate framework and baseline specification, which are feasible if only more and better compensation data become available. Second, as we noted, the threshold effect is likely to taper off at higher compensation levels, leading to a second threshold. Therefore research may be extended to search for a second threshold at much higher levels of compensation.

The main obstacle in extending this research lies in the paucity of compensation data. As we saw, despite the progress made in recent years, compensation data still remains very limited in terms of coverage. Whatever data are available are plagued by numerous problems. Rauch and Evans' survey on bureaucracy has been a commendable effort. Unfortunately their compensation data are in categorical form. As part of research on this paper, an effort has been made at primary data collection on civil service compensation. However, it will need some more time before these data become ready for use in analysis. With these and more data on civil service compensation becoming available, it will be possible to accomplish many of the extensions mentioned above. Recent years have seen much progress in quantification and measurement of many aspects of institutions that were previously thought to be too difficult to measure and quantify. It may therefore be hoped that there will be much progress in gathering civil service compensation data in the coming years.

In general we would like to emphasize the qualitative aspects of the results obtained from this investigation than their quantitative aspects. The evidence indicates the possibility of multiple equilibrium in the civil service compensation-performance relationship and the existence of a threshold compensation level separating the Good Equilibrium from the Bad, even though we may not be exactly sure about the exact value of this threshold for a particular country. This qualitative result has significant policy implications, as mentioned in the introduction of this paper. It is hoped that the results of this paper will prompt governments to think more carefully about their civil service compensation policies.

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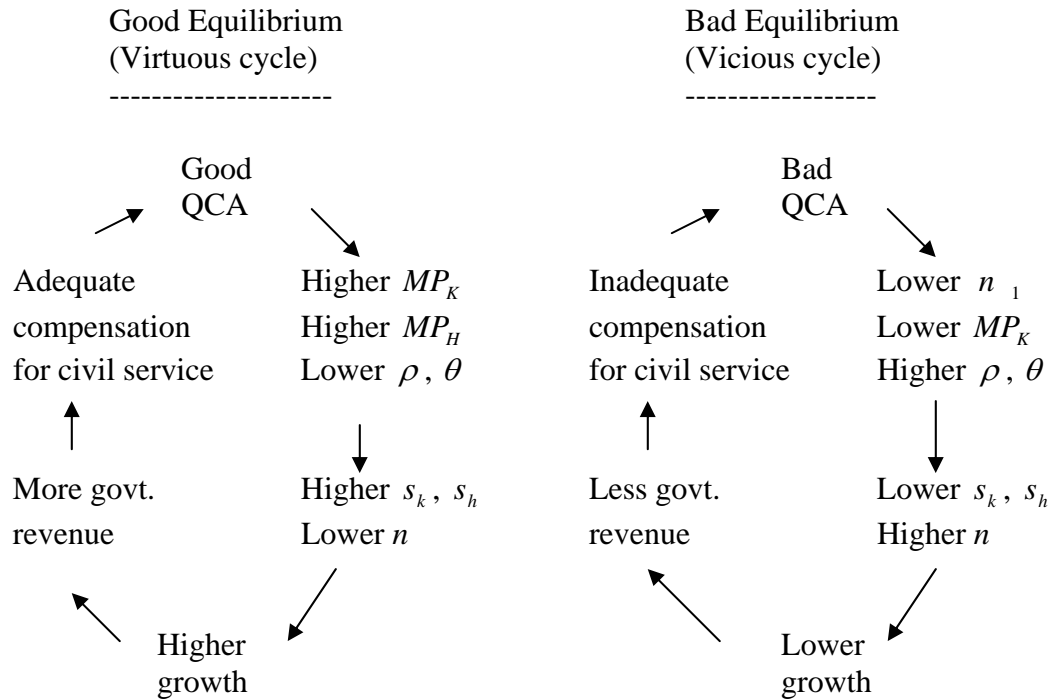
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Figure-2

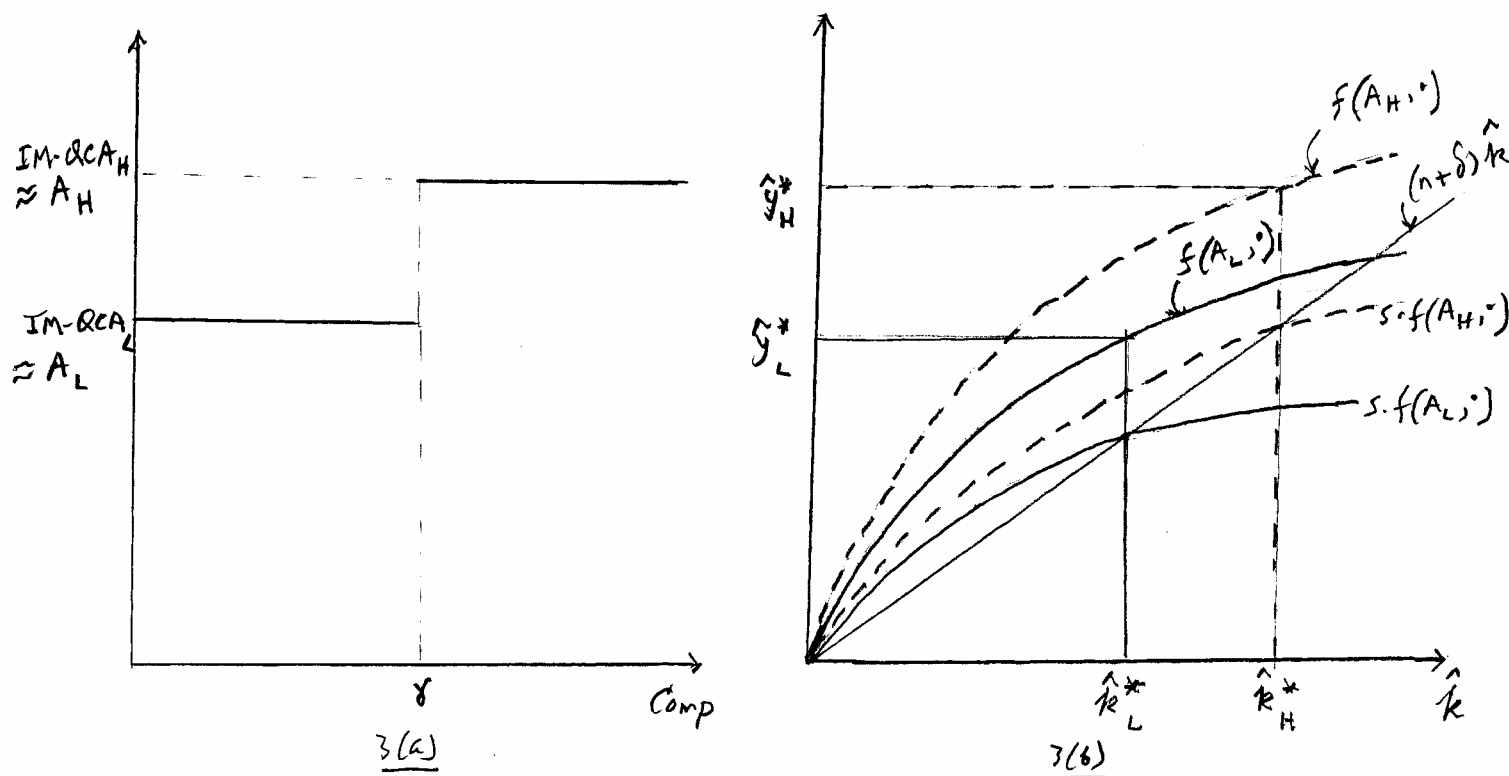# Multiple Equilibrium in the Quality of Civil Administration

Good Equilibrium
(Virtuous cycle)

Bad Equilibrium
(Vicious cycle)

Good
QCA

Bad
QCA

Adequate
compensation
for civil service

Higher MP_K
Higher MP_H
Lower ρ, θ

Inadequate
compensation
for civil service

Lower n $_1$
Lower MP_K
Higher ρ, θ

More govt.
revenue

Higher s_k, s_h
Lower n

Less govt.
revenue

Lower s_k, s_h
Higher n

Higher
growth

Lower
growth

Note to Figure-2:

Figure-2 provides schematic version of the concepts of 'Virtuous' and 'Vicious' cycles that often appear in researchers' descriptions of the state of civil service in different countries. The multiple-equilibrium hypothesis put forward in this paper is a formalization of this descriptive reality. The 'Virtuous' and 'Vicious' cycles correspond to 'Good' and 'Bad' equilibrium, respectively, of the multiple equilibrium hypothesis. The chains of causation yielding the two cycles or equilibrium are self-explanatory. However they depend on numerous assumptions. In a particular country and in a particular period some of these assumptions may not hold. However, the paper contends that across many countries and over time the depicted chains of causation will hold as broad or average tendencies. The empirical test presented in this paper can therefore be thought as joint test of the multiple-equilibrium hypothesis and the assumptions subsumed by chains of causation presented in these schemes.

Figure-3

Multiple Equilibrium in the Context of the Neoclassical Growth Model
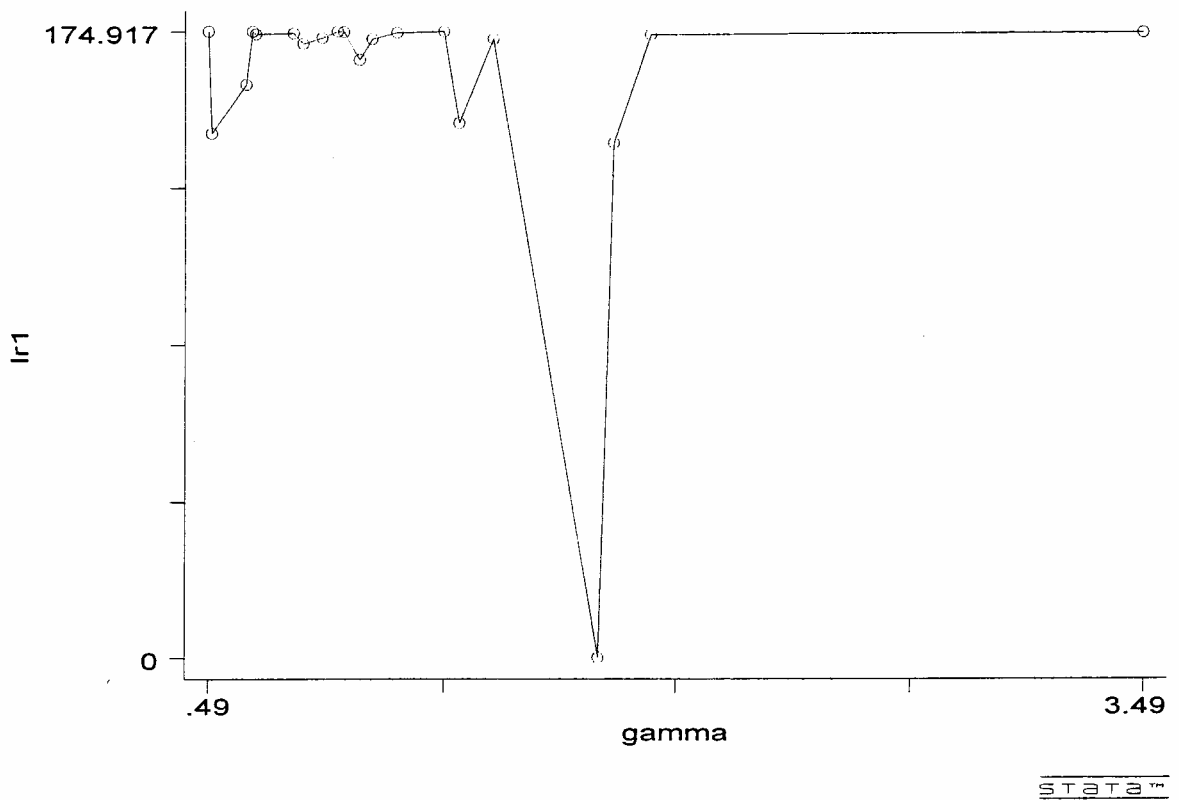

$3(a)$

$3(b)$

<u>Note to Figure-3:</u>

Figure-3(a) postulates a step function between IM-QCA and compensation, so that IM-QCA increases from $IM - QCA_L$ to $IM - QCA_H$, once compensation crosses the threshold value γ. This causes the productivity shift term of the aggregate production function to increase from A_L to A_H, since IM-QCA is a component of A. Figure-3(b) traces out the impact of the latter shift for the neoclassical growth model. The steady-state capital intensity (per effective labor) increases from $\hat{k}_L^*$ to $\hat{k}_H^*$, and the steady income (per effective labor) increases from $\hat{y}_L^*$ to $\hat{y}_H^*$. The higher income level makes it possible to pay higher compensation level, thus sustaining the equilibrium.

Likelihood Ratio Test for $H_0 : \gamma = \gamma_0$

Restricted Model: $\qquad Gr7090 = \beta_1 + \beta_{COMP} \cdot Comp + \beta_{LGDP} \cdot Lgdp70 + \beta_{ETH} \cdot Ethfrac + \varepsilon_R$

Unrestricted Model: $\qquad Gr7090 = \beta_1 + \beta_{1,COMP} \cdot Comp1 + \beta_{2,COMP} \cdot Comp2 + \beta_{LGDP} \cdot Lgdp70$
$$+ \beta_{ETH} \cdot Ethfrac + \varepsilon_{UR}$$

Note: The Likelihood Ratio statistic (LR_1) has an asymptotic distribution given by ξ such that

$P(\xi \leq x) = \left(1 - e^{-\frac{x}{2}}\right)^2$. The 1, 5, and 10 percent critical values of this distribution are 10.59, 7.35, and 6.53,

respectively.

Likelihood Ratio Test for $H_0 : \gamma = \gamma_0$

Restricted Model: $Gr7090 = \beta_1 + \beta_{COMP} \cdot Comp + \beta_{LGDP} \cdot Lgdp70 + \beta_{ETH} \cdot Ethfrac$
$$+ \beta_{LEGOR} \cdot Legor\_co + \varepsilon_R$$

Unrestricted Model: $Gr7090 = \beta_1 + \beta_{1,COMP} \cdot Comp1 + \beta_{2,COMP} \cdot Comp2 + \beta_{LGDP} \cdot Lgdp70$
$$+ \beta_{ETH} \cdot Ethfrac + \beta_{LEGOR} \cdot Legor\_co + \varepsilon_{UR}$$

Note: The Likelihood Ratio statistic (LR_1) has an asymptotic distribution given by ξ such that

$$P(\xi \leq x) = \left(1 - e^{-\frac{x}{2}}\right)^2$$. The 1, 5, and 10 percent critical values of this distribution are 10.59, 7.35, and 6.53,
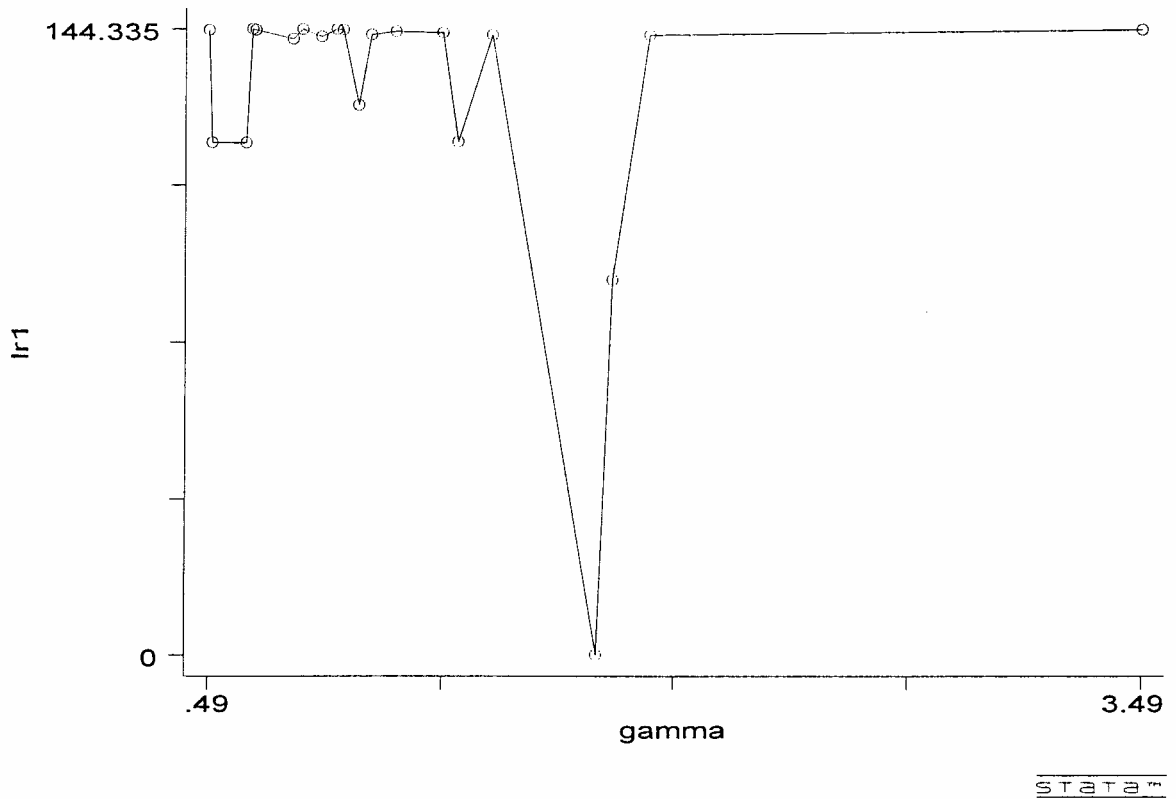
respectively.

Table-1

Baseline Specifications with RW Compensation Data
Dependent Variable: Per capita GDP growth rate for 1970-90

Model	(1)	(2)	(3)	(4)	(5)	(6)
Adj-R	.40	.50	.65	.53	.51	.48
F	.0031	.0014	.0046	.0018	.0042	.0109
Const	3.17	11.09	13.87	8.59	10.01	10.62
	(0.61)	(1.85)	(2.35)	(1.41)	(1.54)	(1.24)
Comp	2.39	2.26	2.32	1.81	1.75	1.74
	(3.98)	(4.10)	(4.50)	(2.90)	(2.75)	(2.62)
Lgdp70	-.50	-1.37	-1.74	-0.98	-1.14	-1.21
	(-0.70)	(-1.80)	(-2.25)	(-1.25)	(-1.38)	(-1.15)
Human70			0.15			
			(0.45)			
Ethfrac		-.03	-.04	-.04	-.04	-.05
		(-2.10)	(-2.18)	(-2.64)	(-2.66)	(-2.18)
Legor_co				1.36	1.72	1.91
				(1.42)	(1.57)	(0.93)
Rel_prot					-.04	-.04
					(0.71)	(-0.68)
Col_brit						-.19
						(-0.11)

Notes to Table-1:

1. These regressions use Rijckeghem and Weder (1997)'s compensation data, which measures average civil service salary as a ratio to average manufacturing wage. The sample covers 22 countries, which are: Bolivia, Botswana, Colombia, Costa Rica, Egypt, Ghana, Guatemala, Hong Kong, India, Jordan, Kenya, Korea, Sri Lanka, Morocco, Mexico, Panama, Peru, Singapore, El Salvador, Turkey, Uruguay, and Zimbabwe.

2. Abbreviations are as follows: *Comp* = Civil service compensation level; *Lgdp70* = Per capita GDP for the year 1970; *Human70* = Human capital stock level in 1970; *Ethfrac* = Ethno-linguistic fractionalization of the population; *Legor_co* = Legal syatem originates from Common Law; *Rel_prot* = Percentage of the population belonging to the Protestant religion; and *Col_brit* = Country was under the British colonial rule.

3. The numbers in parentheses are *t*-values.

Table-2

Economic Significance of the Baseline Regression Results

Variable	Mean (Standard Deviation)	Baseline Coefficient (Range)	Effect On Growth Rate (percentage point)
Compensation: (Ratio of civil service wage to manufacturing wage)	1.13 (0.66)	1.74 to 2.39	1.15 to 1.58 (of one standard deviation increase)
Ethfrac: (Ethno-lingustic Fractionalization)	37.5% (28%)	-.03 to -.05	-.84 to –1.40 (of one standard deviation increase)
Lgdp70: (Log of per capita income in 1970, the initial year.)	7.48 (0.56)	-.50 to – 1.74	-0.28 to -0.98 (of $1,000 increase at mean level of $1,772)
Legor_co: (Legal system originated from Common Law or not)	Dummy Variable	1.36 to 1.91	Statistically not significant
Rel_prot: (Percentage of protestants in the population)	6.59 (8.68)	-.04	Statistically not significant
Col_brit: (Colonial Past)	Dummy Variable	-.19	Statistically not significant
Human70: (Human capital stock in 1970, the initial year.)	3.24 (1.47)	0.15	Statistically not significant

Note to Table-2:

1. The sample covers 22 countries, which are: Bolivia, Botswana, Colombia, Costa Rica, Egypt, Ghana, Guatemala, Hong Kong, India, Jordan, Kenya, Korea, Sri Lanka, Morocco, Mexico, Panama, Peru, Singapore, El Salvador, Turkey, Uruguay, and Zimbabwe.

2. Data on *Ccompensation* are obtained from Van Rickeghem and Weder (1997). Data on Gr7090 and Lgdp70 are from Penn World Tables. Data on Human are from Barro and Lee (1993). Data on Ethfrac, Legor_co, Rel_prot, and Col_brit are from La Porta et al. (1998) and Triesman (2000).

Table-3

Threshold Regressions with RW Compensation Data
Dependent Variable: *Per capita GDP growth rate over 1970-90*

Model	(1)	(2)	(3)	(4)	(5)	(6)
Adj-R	.50	.68	.53	.67	.69	.68
F	.0014	.0001	.0018	.0002	.0002	0.002
$\hat{\gamma}_{min}$		1.74		1.74	1.74	1.74
F_1 *p*-value		174.92 (.0425)		144.34 (.0462)		
F_2 *p*-value					38.46 (.092)	18.46 (.223)
Const	11.09 (1.86)	17.82 (3.43)	8.59 (1.42)	16.05 (2.84)	16.31 (2.93)	16.67 (3.14)
Comp1		-.39 (-.44)		-.43 (-.47)	-.05 (-.06)	-.002 (-.002)
Comp	2.26 (4.11)		1.81 (2.91)			
Comp2		1.92 (4.25)		1.72 (3.31)	2.49 (3.02)	1.99 (.99)
Lgdp70_1						-1.88 (-2.95)
Lgdp70	-1.37 (-1.81)	-1.96 (-3.08)	-.98 (-1.25)	-1.72 (-2.45)	-1.82 (-2.76)	
Lgdp70_2						-1.51 (-1.99)
Ethfrac1					-.03 (-2.26)	
Ethfrac	-.03 (-2.21)	-.04 (-2.98)	-.04 (-2.65)	-.04 (-3.04)		-.03 (-2.36)
Ethfrac2					-.08 (-1.40)	
Legor_co			1.36 (1.43)	.70 (.85)		

Notes to Table-3:

1. These regressions use Rijckeghem and Weder (1997)'s compensation data, which measures average civil service salary as a ratio to average manufacturing wage. The sample covers 22 countries, which are: Bolivia, Botswana, Colombia, Costa Rica, Egypt, Ghana, Guatemala, Hong Kong, India, Jordan, Kenya, Korea, Sri Lanka, Morocco, Mexico, Panama, Peru, Singapore, El Salvador, Turkey, Uruguay, and Zimbabwe.

2. Abbreviations are as follows: *Comp* = Civil service compensation level; *Lgdp70* = Per capita GDP for the year 1970; *Human70* = Human capital stock level in 1970; *Ethfrac* = Ethno-linguistic fractionalization of the population; *Legor_co* = Legal system originates from Common Law. *Comp1* is the *Comp* variable when its value is less than the threshold, and *Comp2* is Comp variable when its value is greater than the threshold. *Ethfrac1* and *Ethfrac2* and *Lgdp70_1* and *Lgdp70_2* are defined analogously.

3. The numbers in parentheses are Standard Errors of Estimates (SEE).

4. The statistic F_1 tests the presence of the threshold effect in general, in this case as a test of

$H_0 : \beta_{1,COMP} = \beta_{2,COMP}$ against the alternative $H_A : \beta_{1,COMP} \neq \beta_{2,COMP}$

5. The statistic F_2 tests $H_0 : \beta_{1,LGDP} = \beta_{2,LGDP}$ vesus the alternative $H_A : \beta_{1,LGDP} \neq \beta_{2,LGDP}$ and

$H_0 : \beta_{1,ETH} = \beta_{2,ETH}$ versus the alternative $H_A : \beta_{1,ETH} \neq \beta_{2,ETH}$, as the case may be, with

$\beta_{1,COMP} \neq \beta_{2,COMP}$ as the maintained hypothesis under both the null and the alternative.