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Three Essays on Economic Reform: Effects on Human Development, Fertility, and Factor Shares

Khaled Ibrahim Abdel-Kader

Western Michigan University

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THREE ESSAYS ON ECONOMIC REFORM: EFFECTS ON HUMAN DEVELOPMENT, FERTILITY, AND FACTOR SHARES

Khaled Ibrahim Abdel-Kader, Ph.D.
Western Michigan University, 2002

This dissertation contains three essays on economic reform programs supported by the IMF and World Bank. Using appropriate theoretical and empirical models, we investigate the impact of reform on three aspects of economic development: (1) human development, (2) fertility, and (3) income shares of factors of production. In the first essay, we examine the long-run impact of reform on different measures of human development and income. Empirical results show that reform has long-run positive impact on GDP per capita and measures of human development. However, worse initial macroeconomic conditions offset this impact.

In the second essay, we examine the impact of reform on fertility in reforming countries relative to non-reforming countries. We argue that reform can reduce fertility by making capital more complementary to female labor, raising women's relative wage, and hence raising the opportunity cost of child-rearing. The results validate the predictions of the theoretical model and show that capital per head has a significant negative impact on fertility after reform as female labor and physical capital become more complementary.

In the third essay, we examine the distributional impact of reform on labor and capital in reforming countries. Using a simple theoretical model and assuming that
factors of production are paid less than their marginal products pre reform, we show that the impact of unemployment and capital accumulation on the functional distribution of income is ambiguous and depends solely on the size of the elasticity of substitution between capital and labor. Empirical results show that the elasticity of substitution is greater than one but decreases after reform. With lower elasticity of substitution after reform, the increase in capital per head is expected to raise capital's share relative to labor's share. However, reform has a positive impact on the shares of both factors. It was also concluded that labor and capital are highly underpaid in terms of their marginal products before reform and that reform removes this distortion in factor markets.
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ACKNOWLEDGMENTS

I would like to begin by thanking the two people who have contributed significantly to this study: Dr. Eskander Alvi and Dr. Matthew Higgins. I am highly indebted to Dr. Alvi for lending me valuable ideas and for his insightful suggestions and comments. I also thank him for his remarkable help and support by always making himself available for assistance and for reading and correcting many drafts of this dissertation. I am very grateful to Dr. Higgins for his tremendous help with the empirical work in this dissertation and throughout the graduate program. His thorough revision of earlier drafts of this manuscript and quick turnaround time are highly appreciated. I am also thankful to Dr. Jon Neill and Dr. Ahmed Hussen for the time they spent reading drafts of this manuscript and the suggestions they made at several stages of writing this dissertation.

I am also indebted to my father, Ibrahim, who taught me the lessons of patience and determination. I would like, however, to dedicate this dissertation to my family: my wife, Hanaa, and our three wonderful children; Yousef, Salim, and Lina. I am very grateful to my wife for standing always by me and for sharing with me all the stressful and joyful moments over the years of my graduate study. I do apologize to my son, Yousef, who involuntarily gave up his right to sit with me often over the last four years. One day, I hope he will realize the good reason why he was watching me night after night sitting on my desk or in front of a computer monitor.

Khaled Ibrahim Abdel-Kader

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PART I
INTRODUCTION

The last two decades have witnessed a number of studies that have tried to evaluate how economic reform and structural adjustment programs, supported by the International Monetary Fund (IMF) and World Bank (WB), have affected the economies of the implementing countries. Evaluating the impact of these programs on income distribution and human development has been controversial. Although reforming countries have higher growth prospects than their non-reforming peers, reform programs often include a number of policies that have negative impact on the poor, who are the majority in developing countries. The short-run consequences of reform include (a) reduction in public spending on health and education, (b) removing subsidies, (c) increasing unemployment, and (d) lowering the standard of living of the poor. On the other hand, as the economy gets rid of all of its structural weaknesses and deficits that led the country to adopt these programs in the first place, growth is realized and can be sustained for a long time. Hence, one might expect improvements in the status of the poor and status of human development indicators in the long-run.

Nonetheless, the existing literature on reform does not provide theoretical explanation or empirical evidence of the impact the economic reform had on human development and fertility. In addition, there is no single study we are aware of that examined the impact of reform on the income shares of factors of production. This
study attempts to fill this gap in the literature with theoretical frameworks along with econometric analysis. We propose to write three distinctive essays on the impact of reform on human development, fertility, and functional income distribution.

In the first essay, we examine the long-run impact of reform on different measures of human development and income using panel data for 40 reforming countries. Three questions are addressed in this essay: (1) what is the long-run impact of reform on GDP per capita? (2) What is the long-run impact of reform on human development? (3) What is the long-run impact of reform on human development and income when countries' initial macroeconomic conditions are incorporated?

Following the neoclassical framework, such as the well-known Solow model, we present a simple model of debt and reform. A key feature of this model is an underdevelopment trap that arises because of lack of resources. The main idea is that countries do not have enough resources to invest and accumulate capital, which is considered essential to growth and economic prosperity. It is assumed that income is insufficient to satisfy basic needs, so that all income is simply consumed, leaving nothing for investment. Therefore highly indebted countries have no choice but to apply to the IMF and WB so that loans could be provided at relatively low interest rates conditioning on economic adjustments and reforms. The model also shows that efficiency measures included in the IMF packages can also enhance productivity and eventually promote the investment leading to a further increase in capital and income per head. The model, therefore, suggests a rationale for reform and explains who
reforms and why reform works. Fixed effects specification is used to test empirically the implications of the theoretical model.

In addition, when the impact of the reform on human development is assessed, we should attribute variations in human development to both the policy choices and to the conditions that gave rise to those choices. Countries with favorable initial macroeconomic conditions (e.g. a lower debt to GDP ratio and higher GDP growth) have better chances to improve human development dimensions under a given reform program than does a country with worse initial conditions. To test this hypothesis, we use pooled OLS specifications after substituting the fixed effects with a vector of initial condition variables.

In the second essay, we pose two questions: (1) does reform have any impact on fertility? (2) If it does, what is the long-run impact of reform on fertility?

To answer these questions, we build on the Galor and Weil (1996) framework and argue that reform can reduce fertility by making specific types of capital available in the economy. These types of capital are usually more complementary to female labor than men's labor. This can include investments in banking, insurance, and telecommunication sectors which usually increase after reform. These sectors tend to absorb more female employment. In addition, privatization of the state-owned enterprises is one of the essential components of reform. The new private owners who take over these enterprises usually substitute labor with capital. Since physical capital can do better in replacing physical strength than it does replacing human capital, one would argue that women are more likely to have a comparative advantage over men.
in getting the newer jobs after reform. As the demand for female labor increases in these sectors, women's opportunity cost of child-rearing increases as their relative wage rises, and consequently fertility rates start to decline. To test this argument empirically, we first use a random coefficient model to estimate the complementarity between physical capital and female labor in samples of reforming and non-reforming countries. Second, we estimate a dynamic heterogeneous model to test for the impact of capital per head on fertility in the same two samples of countries.

In the third essay, we examine the distributional impact of reform on labor and capital in reforming countries. Reform is expected to result in higher rates of capital accumulation and lower rates of employment, at least shortly after reform. The question of whether reform would lead to changes in the shares of labor and capital in GDP is worth investigating. Even though unemployment rates can increase shortly after reform, the income share of labor remains ambiguous as reform leads to higher GDP growth and wage rates. In addition, the impact of reform on factor shares depends, to a great extent, on the degree of substitutability between capital and labor.

We use a simple theoretical model and assume that factors of production are paid less than their marginal products pre reform. This is meant to capture in a simple way a major economic inefficiency prior to reform. Policymakers almost always wanted higher employment of factors and to make that possible they kept factor prices below their marginal products. Also periods of hyperinflation led to a sharp decline in wages and interest rates in real term. In many developing countries for example real interest rates have been negative because of measures of financial
repression, which kept nominal interest rates low, and or inflation rates high. This has led to bias against capital and in favor of labor. On the demand side, demand for labor and capital was high as their prices were low in nominal and real terms. On the supply side, labor supply kept the labor market in equilibrium as population growth rates remained high. However, supply of capital was very limited as its real return was almost negative. This has led to the phenomena of capital flight and currency substitution.

We propose to derive a relation between unemployment, capital accumulation and the factor shares. We will also show that this relation depends on the size of the elasticity of substitution between capital and labor. To test this hypothesis, a random coefficient model to estimate the degree of substitutability between physical capital and labor is first specified and estimated. Second, we estimate a random coefficient model to examine the impact of unemployment and capital per head on factor shares after reform. Third, we use the estimates of the CES production function along with the estimates of the factor share equations to compute estimates of the difference between the prices and marginal products of labor and capital. This should give an idea about how labor and capital are underpaid before reform and whether reform removes the distortion in factor markets.

Studying the impact of reform programs is not novel. However, six things are considered new in this study:

1. In this study we examine the impact of reform on human development after at least eight years of reform in the implementing countries. Evaluating the impact
sooner would lead to premature conclusions. Though the macro effects are visible in
the short run, human development and fertility are slow to respond.

2. Previous studies mostly used qualitative analysis whereas this is more
rigorous, based on both theoretical and econometric analyses.

3. We consider a larger number of countries compared to previous studies.
Table 1 shows the list of these countries and the dates in which reform programs were
initiated.

4. We use additional definitions of human development since we use two sets
of human development measures as dependent variables. The first set includes
composite indexes. These indexes are the Human Development Index and the
Physical Quality of Life Index. The second set includes more focused measures of
human development including infant mortality rate, life expectancy at birth, and
literacy rate.

5. We examine the long-run impact of reform on human development by
incorporating the role of initial conditions.

6. We examine two aspects rarely studied under reform, fertility and
functional distribution of income.
<table>
<thead>
<tr>
<th>Reforming Countries</th>
<th>Date of Reform</th>
<th>Non-Reforming Countries</th>
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PART II

ECONOMIC REFORM PROGRAMS: A BACKGROUND

Historical Background

In the late 1970s and early 1980s the slowdown of growth, the debt crisis and worsening terms of trade overwhelmed many countries. Initially, the aim of the programs supported by the IMF and World Bank was to help developing countries respond to external shocks: the rise in oil prices, the decline in growth in the industrial countries, the rise in interest rates and the drop in capital inflows.

Components of Reform Programs

The economic reform and structural adjustment programs (ERSAPs) consist of two types of policies: (1) stabilization policies (short-term policies) and (2) structural adjustment policies (long-term policies). Stabilization policies include (a) cutting public spending, (b) eliminating large budget deficits and balance of payments deficits, (c) removing multiple exchange rate systems, (d) increasing interest rates in order to reduce domestic demand for credit and encourage domestic savings and capital inflows. Structural adjustment policies refer to the set of policies, which combines short-term stabilization measures and longer term adjustment measures. These policies aim to changing relative prices and institutions. They are designed to induce the efficiency of the economy so that it can attain sustained growth with less
government intervention. These policies include (a) tax reforms, (b) reform in the ownership and control, (c) deregulation of the economy so that private-sector activity is encouraged, (d) removing biases against agriculture and against private sector and foreign investment, and (e) overcoming excessive bureaucracy and the mismanaged public sector and privatization.

**Stabilization Programs**

These programs are designed by the IMF and are based on the neoclassical theory of the balance of payments. These stabilization programs are based on the monetarism-based approach to the balance of payments. According to this approach, the heavy indebtedness is a consequence of huge deficits in balance of payments, which result mainly from overspending, whether on consumption or investment. To this end, the IMF stabilization programs aim to reducing aggregate demand, which would reduce deficits in current account and hence reduce the size of foreign debt. Stabilization policies are also known as "demand management" policies.

Stabilization policies include three types of policies:

1. Policies related to the government budget including reductions in subsidies and transfer payments, minimizing the role of the state whether as an employment provider or as a major investor in the economy.

2. Policies related to the balance of payments including the devaluation of the local currency, trade liberalization\(^1\), and encouraging foreign investment.
3. Policies related to the monetary aggregates including increasing interest rates to discourage spending and encourage savings and reducing credit given to the government and public sectors.

**Structural Adjustment Programs**

These programs, recommended by the WB, are long-term programs that use the market mechanism to achieve better allocation of resources. According to the WB, these programs should ultimately achieve sustainable economic growth and alleviate poverty in the implementing countries since they help eliminating structural weaknesses in the economy (Corbo and Rojas 1992).

Structural adjustment programs include three types of policies:

1. Policies concern price liberalization, which means allowing market forces to control pricing mechanism in order to restore efficiency and eliminate price distortions. Moreover, the WB recommends that the government should keep its hands off the provision of services such as electricity, health, housing, transportation, and communications.

2. Privatizing state-owned enterprises by selling them to the private sector.

3. Policies that induce trade liberalization such as devaluation of the domestic currency, removing state monopoly over foreign trade, lowering tariffs on imports and removing protection given to domestic industry (Dabour 1999).
Cross Conditionality

The IMF makes its resources available to member countries that undertake efforts to correct maladjustments in their balance of payments. In giving financial assistance to those members, the IMF stresses the attainment of balance of payments as its main priority. To the extent that other economic objectives (e.g., price stability and growth) contribute to balance of payments viability, the IMF argues strongly for the adoption of policies to promote their achievement (Guitian 1987).

On the other hand, the WB provides, among five lending categories, structural adjustment loans (SALS) that focus on macroeconomic policies and associated institutional changes at the national level. According to Michalopulos (1987), The WB’s Operational Manual defines structural adjustment lending as “non-project lending to support programs of policy and institutional change necessary to modify the structure of an economy so that it can maintain both its growth rate and the viability of its balance of payments in the medium term” (Michalopulos 1987, p. 7).

The WB’s lending is usually coordinated with the IMF-supported programs in specific countries. This has been known as “cross conditionality” in the literature. While the WB has deferred to the fund on matters of monetary and exchange rate policy, it has been involved in institutional reform matters such as privatization. Usually, the WB requires adjusting countries to agree to conditions required by the IMF before concluding a loan agreement (Dabour 1999). On the other hand, the IMF requires adjusting countries to agree to conditions required by the WB before allowing them to use any of the “Fund facilities.” Streeten (1999) is an advocate for
extending the IMF-WB cross conditionality to the aspects of human development when reaching an agreement. Streeten calls for specifying the human and social conditions when assessing the effectiveness of loans given by the IMF and WB.
Economic reform and structural adjustment programs have been hotly debated over the last two decades. Evaluating the impact of these programs on income and different dimensions of human development has been controversial. Although adjusting countries have higher growth prospects than their non-adjusting peers, stabilization and structural adjustment programs supported by the International Monetary Fund (IMF) and World Bank (WB) often include a number of policies that have negative impact on the poor who are the majority in developing countries. Consequences of stabilization and structural adjustment policies include reduction in public spending on health and education, removing subsidies, increasing unemployment, and lowering the standard of living of the poor (Dabour 1999). This can be expected in the short run. On the other hand, as the economy gets rid of all of its structural weaknesses and deficits that led the country to adopt these programs in the first place, growth is realized and can be sustained for a long time. Hence, one might expect improvements in the status of the poor and status of human development indicators in the long run.

There are several reasons why studying the impact of reform programs on human development and income should be given a great deal of attention. First, improvement in health, education, and skills lead to higher productivity. Second,
improvement in human development leads to lower fertility rates. Streeten (1994) points out the importance of the replacement effect of fertility, since policies that reduce infant mortality rates are likely to lower the fertility rates. Third, improvements in human development would lead to poverty reduction and consequently contribute to democracy and more political stability. Finally, reforms are basically efficiency-enhancing measures that should impact incomes positively and therefore allow higher levels of health, longevity and education in the long run.

This essay examines the long-run impact of economic reform and structural adjustment programs on different measures of human development and income using panel data for 40 countries. Three questions are addressed in this essay: (1) what is the long-run impact of reform on GDP per capita? (2) What is the long run impact of reform on human development? (3) What is the long-run impact of reform on human development and income when countries’ initial macroeconomic conditions are incorporated?

Studying the impact of the IMF-supported reform programs is not novel. However, four things are new in this essay. First, in this study we examine the impact of IMF-supported reform programs on human development after at least eight years of reform in the implementing countries. Evaluating the impact sooner would lead to premature conclusions. Though the macro effects are visible in the short run, the human development variables are slow to respond and their full beneficial effects could be seen in the long run. Second, previous studies mostly used qualitative analysis whereas this is more rigorous, based on both theoretical and econometric
analyses. Third, we consider a larger number of countries compared to previous studies since we use panel data for 40 reforming countries. Table 1 shows the list of these countries and the dates in which IMF-supported reform programs were initiated. Fourth, we consider additional definitions of human development since we use two sets of human development measures as dependent variables. The first set includes composite indexes. These indexes are the Human Development Index (HDI) developed by the UNDP and the Physical Quality of Life Index (PQLI). The second set includes more focused measures of human development including infant mortality rate (IMR), life expectancy at birth (LE), and literacy rate (LR). Fifth, we examine the long-run impact of IMF-supported reform programs on human development by incorporating the role of initial conditions.

This essay is divided into five sections. In the first section, we review the literature. In the second section, we examine the impact of reform on the most comprehensive measure of economic efficiency - GDP per capita. We examine the impact of reform on different measures of human development in the third section. In the fourth section, the impact of reform on human development and income is examined by incorporating the initial macroeconomic conditions in the set of the explanatory variables, and the last section concludes.

Literature Review

The last two decades have witnessed a number of studies that have tried to evaluate how economic reform and structural adjustment programs, supported by the
IMF and the WB, have affected the economies of the implementing countries. In evaluating the impact of the IMF-supported reform programs on human development, some studies concluded that these programs have positive impact (Osmani 1994, Rieger 1995, Hojman 1996, and Gupta et al. 1998) while others (Corina et al. 1987, Dabour 1999, and Gupta et al. 1999) concluded that these programs lead to adverse effect on human development.

In the first campus, which finds positive impact of reform on human development, Osmani (1994) shows evidence from Sri Lanka that government subsidy is not the only determinant of nutritional standard since the "nutritional capability" does not depend only on income but also on health and educational status of the population. Therefore, he concludes that the cutback of government subsidies during the adjustment periods does not necessarily lead to loss in social welfare. Rieger (1995) traces out data on different measures of poverty and human development during the structural adjustment period in ASEAN countries. By all measures, he concludes that human development and income distribution were improving. This is due to the undertaken efforts by governments to improve the quality of human resources and adopting a "market-friendly and internationally competitive" approach to development (Lim 1994). Hojman (1996) concludes that structural adjustment policies have had only a modest impact on the infant mortality rates in Central American countries and the Caribbean (Hajman 1996). Gupta et al. (1998) conclude that in spite of fiscal restraints that the IMF-supported reform programs require, many reforming countries have had increases in public spending in
health and education than their non-reforming peers. As a result, reforming countries have witnessed improvements in social indicators.

In addition to the above studies, Maasland and Gaag (1992) found no evidence that social indicators (e.g., infant mortality) have deteriorated in adjusting countries. Aturupane (1994) found strong progress on infant mortality and primary enrollment in Sri Lanka during the period of implementing the reform program. Using Sri Lankan time-series data, Anand and Kanbur (1991) found that infant mortality rates were negatively correlated with both social spending and income growth, and that social spending had a stronger impact.

In the second category of studies, which finds negative impact of reform programs on human development, Corina et al. (1987) present a comprehensive study on the economic decline and human welfare in the early 1980s, the effects of adjustment policies between 1980 and 1985 on child welfare, the impact on government spending and how it worsens income distribution at the household level. Corina et al. (1988) present ten case studies that show how stabilization and adjustment programs have affected adversely children in the 1980s in terms of their health and welfare. Dabour (1999) examines the impact of structural adjustment policies on human resource development and poverty alleviation in adjusting countries with special attention to the experience of intensely-adjusting Organization of Islamic Conference (OIC) countries in the 1980s. He concludes that the consequences in terms of human suffering were more serious for the poor than for any other population group. Moreover, he believes that human development
indicators may have declined in many adjusting countries, regardless of whatever improvements have been achieved in their level of economic growth. Gupta et al. (1999) show that privatization can lead to job losses and wage cuts for workers and higher prices for consumers in the short run. In addition, privatization may worsen income distribution by transferring real assets from the state to the private sector and by reinforcing wage differentials that already exist in the private sector.

From the above literature, three issues can be identified:

1. Most of previous work has been case studies. Even though case studies allow one to analyze specifics of program design and implementation and to identify special circumstances surrounding the program, it may be difficult to generalize from the findings of only a few case studies (Khan 1990).

2. Previous studies mostly used qualitative analysis rather than quantitative analysis.

3. Most of these studies have evaluated the impact of the IMF-supported reform programs on human development in the short-run. In studying such impact, the time dimension is crucial in reaching an objective conclusion. The IMF reform packages can lead to changes in the macroeconomy over a short period of time. Increases in the interest rates can attract savings and capital inflows in a relatively short period of time. However, the impact of reform on human development may not be seen before several years have passed since implementing the programs.
The Role of GDP Per Capita

In this section, we explore how income per capita responds to reform measures. First, we review some of the studies that asked the question whether GDP growth is essential to human development. Second, we will explain a simple neoclassical growth model that incorporates debt. Third, we empirically examine the impact of reform programs on per capita income.


Also Anand and Ravallion (1993) used the time-series data to test the relative effects of income growth and health expenditure in Sri Lanka and found that average income and public health expenditure have significant effects. They conclude that Sri Lanka’s impressive record of progress in human development despite being a poor
country illustrates what the right sort of public action can achieve, independently of income growth.

Theoretical Background

Following the neoclassical framework, such as the well-known Solow model, we introduce a simple model of debt and reform. A key feature of this model is an underdevelopment trap that arises because of lack of resources. The main idea is that countries do not have enough resources to invest and accumulate capital, which is considered essential to growth and economic prosperity. It is assumed that income is insufficient to satisfy basic needs, so that all income is simply consumed, leaving nothing for investment. Thus the only way to grow, given lack of resources, is by borrowing to invest and accumulate capital. Panel B in Figures 1 and 2 shows the evolution of capital per head whereas panel A shows the corresponding income per head, as determined by the production function, \( y = f(k) \). In panel B, the macroeconomic equilibrium occurs when the capital evolution function, \( I(k) \), intersects with the replacement function, \( \psi(k) \). The slope of the replacement function reflects, among other things, how heavily the country relies on borrowings in order to grow. The level of capital per head, \( \hat{k} \), is the level that corresponds to the subsistence level of income beyond which countries start to save. Therefore, the slope of the replacement curve, \( \psi(k) \), rises steeply with \( k \leq \hat{k} \); and slowly for \( k \geq \hat{k} \) because borrowing drops and saving rises. When borrowing is not used to finance capital...
accumulation, the slope of the replacement line becomes constant. Thus, the following is true about the slope of the replacement function $\psi'(k)$.

$$\lim_{k \to k^-} \psi'(k) > \lim_{k \to k^+} \psi'(k).$$

In Figure 2, the equilibrium $E_1$, though stable in the usual sense, is not sustainable because it violates the no-ponzi condition. In other words, $E_1$ indicates that countries cannot accumulate capital without borrowing forever. Since no rational international credit institution would be willing to lend, given economic and political risks, some countries may end up at the origin with a corresponding income per head equal to $A$ (in Panel A) or remain temporarily in the vicinity of $E_1$. This is always true when the subsistence level of capital, $\hat{k}$, is above the equilibrium level of capital, $k_\ast$.

However, if $\hat{k}$ is below $k_\ast$, then the bad equilibrium, $E_1$, can be avoided. This case is shown in Figure 1, which represents the case of countries that do not borrow for a long period of time in order to grow. These countries essentially accumulate capital not only through borrowing but also by saving so that the transition to the steady state equilibrium, $E_1$, is made smoothly without getting caught in an underdevelopment trap.

Nonetheless, the story presented in Figure 2 is relevant to countries that were highly indebted in the late seventies and early eighties, like countries at point A or near $E_1$. These countries had no choice but to apply to the IMF and WB so that loans could be provided at much lower interest rates conditioning on economic adjustments.
and reforms. This is what has been known as "adjustment lending". If countries can borrow at interest rate $r' < r$, then the replacement curve shifts from $y_i(k)$ to $y_f(k)$ and eventually the equilibrium $E_2$ emerges as shown in Figure 3. On the other hand, efficiency measures included in the IMF packages can also enhance productivity and eventually raise the capital evolution function, $I(k)$, upward leading to a further increase in capital and income per head. This is shown in Figure 4.

So when income is below a certain level and is all consumed, the only way to possibly grow is by borrowing which likely leads to the bad equilibrium and hence the underdevelopment trap. Therefore, there are two ways in which IMF-WB reform programs can help: (1) efficiency gains reflected in the shift of the capital evolution function and (2) lower borrowing rates captured by the downward shift of the replacement function. The overall consequence is that the economy may shift from a bad to a good equilibrium, where capital per head and income per head are high. The model thus suggests a rationale for reform, and explains who reforms and why reform works.

Table 2 shows how GDP per capita growth increases over the 5 years after reform compared to the 5 years before. This shed some light about the validation of the above model. Nonetheless, a formal empirical test is conducted in the next section in order to test the validity of the model and whether reform really has a positive impact on income per head.
Figure 1. Equilibrium when $\hat{k} < \hat{k}$
Figure 2. Equilibrium when $\hat{k} > \dot{k}$
Figure 3. Equilibrium after Reform: Effect of Borrowing at Lower Interest Rates
Figure 4. Equilibrium after Reform: Effect of Efficiency Gains

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Empirical Specification

To examine the impact of economic reform on the GDP per capita, we use a variant of the empirical model proposed by Mankiw, Romer, and Weil (1992). We use a distributed lag model to account for the dynamics of the model and to capture the long-run impact of reform programs on GDP per capita. The following equation is estimated using fixed-effects estimation.

\[
y_{it} = \alpha_i + \phi y_{i,t-1} + \beta' X_{it} + \delta d_{it} + \omega' (d_{it} \cdot Z_{it}) + \xi_{it},
\]

\[i = 1, 2, ..., N, t = 1, 2, ..., T_i,\]

where \(N\) is the number of countries in the sample, \(T_i\) is the number of time periods during which data is available for country \(i\), \(y_{it}\) is GDP per capita, \(X_{it}\) is a vector of explanatory variables, and \(d_{it}\) is a dummy variable that takes two values as follows.

\[
d_{it} = \begin{cases} 
0 & \text{for all years before country } i \text{ undertakes reform} \\
1 & \text{for all years after country } i \text{ undertakes reform.}
\end{cases}
\]

Since the impact of reform programs may take a long time, we include a lagged value of the GDP per capita to account for the dynamic adjustment. Repeatedly back substituting for \(y_{i,t-j}\) in (1), the model can be written as follows.
Table 2
Average GDP Growth in a Sample of Reforming Countries

<table>
<thead>
<tr>
<th>Country</th>
<th>5 years before Reform</th>
<th>5 years after Reform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>1.5</td>
<td>8.1</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>4.9</td>
<td>3.9</td>
</tr>
<tr>
<td>Belize</td>
<td>4.3</td>
<td>3.6</td>
</tr>
<tr>
<td>Bolivia</td>
<td>-2.0</td>
<td>5.5</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>1.2</td>
<td>3.5</td>
</tr>
<tr>
<td>Burkina Faso</td>
<td>2.6</td>
<td>-0.8</td>
</tr>
<tr>
<td>Cameroon</td>
<td>5.4</td>
<td>3.3</td>
</tr>
<tr>
<td>Chile</td>
<td>2.1</td>
<td>3.4</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>0.4</td>
<td>0.3</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>3.3</td>
<td>8.2</td>
</tr>
<tr>
<td>Ecuador</td>
<td>2.3</td>
<td>3.0</td>
</tr>
<tr>
<td>Egypt</td>
<td>4.2</td>
<td>5.5</td>
</tr>
<tr>
<td>El Salvador</td>
<td>1.2</td>
<td>4.2</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>2.7</td>
<td>6.1</td>
</tr>
<tr>
<td>Ghana</td>
<td>-3.4</td>
<td>5.0</td>
</tr>
<tr>
<td>Guatemala</td>
<td>0.2</td>
<td>4.0</td>
</tr>
<tr>
<td>India</td>
<td>6.4</td>
<td>6.8</td>
</tr>
<tr>
<td>Jordan</td>
<td>4.0</td>
<td>3.1</td>
</tr>
<tr>
<td>Kenya</td>
<td>2.8</td>
<td>4.1</td>
</tr>
<tr>
<td>Korea, Rep.</td>
<td>6.3</td>
<td>5.0</td>
</tr>
<tr>
<td>Lesotho</td>
<td>3.4</td>
<td>4.8</td>
</tr>
<tr>
<td>Malawi</td>
<td>3.0</td>
<td>3.2</td>
</tr>
<tr>
<td>Mali</td>
<td>-0.8</td>
<td>1.5</td>
</tr>
<tr>
<td>Mauritius</td>
<td>1.3</td>
<td>5.6</td>
</tr>
<tr>
<td>Nepal</td>
<td>3.3</td>
<td>3.9</td>
</tr>
<tr>
<td>Nicaragua</td>
<td>2.8</td>
<td>3.3</td>
</tr>
<tr>
<td>Nigeria</td>
<td>0.4</td>
<td>-0.7</td>
</tr>
<tr>
<td>Panama</td>
<td>2.8</td>
<td>4.5</td>
</tr>
<tr>
<td>Peru</td>
<td>0.7</td>
<td>8.0</td>
</tr>
<tr>
<td>Philippines</td>
<td>1.9</td>
<td>5.2</td>
</tr>
<tr>
<td>Romania</td>
<td>-2.9</td>
<td>-6.6</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>4.2</td>
<td>4.7</td>
</tr>
<tr>
<td>Thailand</td>
<td>7.3</td>
<td>8.1</td>
</tr>
</tbody>
</table>
Table 2-Continued

<table>
<thead>
<tr>
<th>Country</th>
<th>5 years before Reform</th>
<th>5 years after Reform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tunisia</td>
<td>4.2</td>
<td>7.1</td>
</tr>
<tr>
<td>Turkey</td>
<td>2.3</td>
<td>7.5</td>
</tr>
<tr>
<td>Uruguay</td>
<td>-2.8</td>
<td>4.6</td>
</tr>
<tr>
<td>Zambia</td>
<td>0.3</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Source: Author's Calculations based on World Bank 2000.

\( y_t = \gamma_i + \beta^i \sum_{j=1}^{\infty} \phi^i X_{t-j} + \delta \sum_{j=1}^{\infty} \phi^i d_{t-j} + \omega \sum_{j=1}^{\infty} \phi^i (d_u \cdot Z_u) + u_t, \)

where \( y_t = (1 - \phi) \alpha_t \) and \( u_t = \epsilon_t - \phi \epsilon_{t-1} \). It is useful to describe the dynamic adjustment of the above distributed lag model in terms of its median lag and in terms of the long run response of income to reform programs. After estimating equation (1), the following two ratios will be calculated: \( 5 \)

1. The long-run response \( = \beta \sum_{j=0}^{\infty} \phi^j = (1 - \phi)^{-1} \beta \). This ratio measures the change in GDP per capita because of a one-unit increase in one of the explanatory variables, which remains in effect for all time. \( 2 \) The median lag \( = \frac{\log \frac{1}{2}}{\log \phi} \), which gives the number of years after which half of the effect of reform on GDP per capita is felt.

\( X_t \) is a vector that includes a set of explanatory variables. These variables are the investment to GDP ratio (INVESTMENT), the rate of population growth (POP), a proxy for the level of human capital in the economy, measured by the combined gross school enrollment ratio (SCHOOL), and the nominal exchange rate (EXCHANGE).
In addition to this set of regressors, two interaction terms are used. These interaction terms are $d^*\text{INVESTMENT}$ and $d^*\text{EXCHANGE}$ where INVESTMENT and EXCHANGE are included in the vector $Z_{it}$. We use these two interaction terms specifically because of their direct relevance to reform measures especially in the short run. We expect INVESTMENT and SCHOOL to have a positive impact and POP to have a negative impact on GDP per capita as the neoclassical growth theory predicts. Since reform programs require the devaluation of the local currency, which enhances exports and eventually increases GDP, we expect EXCHANGE to have a positive impact on GDP per capita. The parameter $\alpha_t$ captures the country specific effects such as the institutional and cultural background. These effects, as assumed, remain constant over time for the same country but vary from a country to another.

Results

Table 3 reports the results from estimating equation (1). Except the case of the coefficient on exchange rate after reform ($d^*\text{EXCHANGE}$), all coefficients are significant and have the expected signs. While investment to GDP ratio (INVESTMENT) and the level of human capital (SCHOOL) have positive impact on GDP per capita, population growth rate has a negative impact. Moreover, reform programs seem to enhance GDP per capita as our theoretical model predicts since the coefficient of the dummy variable is positive and significant.
Table 3

Regression Results for GDP per Capita and Long Run Response to Reform:
Fixed Effects Estimation

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>Coefficient</th>
<th>T-Ratio</th>
<th>Total Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONSTANT</td>
<td>0.611***</td>
<td>5.93</td>
<td>--</td>
</tr>
<tr>
<td>YLAG</td>
<td>0.89***</td>
<td>76.38</td>
<td>--</td>
</tr>
<tr>
<td>INVESTMENT</td>
<td>0.817***</td>
<td>6.69</td>
<td>7.43</td>
</tr>
<tr>
<td>SCHOOL</td>
<td>0.514**</td>
<td>1.96</td>
<td>4.67</td>
</tr>
<tr>
<td>POP</td>
<td>-0.21*</td>
<td>-1.65</td>
<td>-1.91</td>
</tr>
<tr>
<td>EXCHANGE</td>
<td>0.02*</td>
<td>1.74</td>
<td>0.18</td>
</tr>
<tr>
<td>d</td>
<td>0.534***</td>
<td>2.63</td>
<td>4.82</td>
</tr>
<tr>
<td>d*INVESTMENT</td>
<td>0.28**</td>
<td>1.94</td>
<td>2.55</td>
</tr>
<tr>
<td>d*EXCHANGE</td>
<td>0.015</td>
<td>1.52</td>
<td>--</td>
</tr>
<tr>
<td>Median Lag</td>
<td>5.95</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>F-ratio (Fixed Effects)</td>
<td>3.23</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>R-square</td>
<td>0.72</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Number of Countries</td>
<td>40</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Number of Observations</td>
<td>630</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Note: *** statistically significant at $P \leq 0.01$ level; ** statistically significant at $P \leq 0.05$ level; * statistically significant at $P \leq 0.1$ level.

We also report the total impact multipliers, which show the total effect of the reform programs on GDP per capita in the long run. For example, the long-run multiplier of GDP per capita with respect to INVESTMENT is $(7.34+2.55=9.98)$. 

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The Impact of Reform on Human Development

In this section, we first discuss the different measures of human development that we use in this essay. Second, we introduce the empirical specification. Third, we discuss the results.

Measuring Human Development

According to the United Nations Development program (UNDP), human development is defined as "enlarging people's choices" so that people live longer, healthier, acquire more knowledge, and have a decent standard of living." \(^7\) (UNDP 1990, p.10). Based on this definition, development doesn't mean only rising per capita incomes but also expansion of essential choices such as health and education.

There is consensus among students of economic development that per capita income is not a perfect measure of human development (Kelley 1991, Gillis et al. 1996, Ogwang 1997, Noorbkhsh 1998, and Meier 2000). Consequently, composite indexes such as the physical quality of life index (PQLI) and the human development index (HDI) have been developed over time. These indexes incorporate more than one dimension of development. The HDI is computed as an average of life expectancy, combined literacy rates and gross enrolment ratios, and GDP per capita adjusted for purchasing power parity.\(^8\) The PQLI is computed as an average of life expectancy, infant mortality rate, and literacy rate.\(^9\)

In this essay, two sets of human development measures are used as dependent variables. The first set includes composite indexes; the Human Development Index
(HDI) developed by the UNDP and the Physical Quality of Life Index (PQLI). The second set includes more focused measures of human development including infant mortality, life expectancy at birth, and literacy rate.

Composite Indexes

Morris (1979) sets six criteria that an objective composite index of human development should take into account. Among those criteria is that the index “should avoid standards that reflect society-specific values, measure results not means, and lend itself to international comparison” (Morris 1979, p. 21). In fact, these three conditions are met with respect to all human development measures we use in this essay. There is no doubt that people everywhere would prefer that newborn children not die, live longer than shorter lives, and get good education. In addition, these measures can be applied to all people regardless of culture. In contrast to GDP per capita as a measure of economic development, these measures show the results of the process of economic development not the means as GDP per capita does.¹⁰

The Physical Quality of Life Index (PQLI)

The Physical Quality of Life Index (PQLI) consists of three different indicators; (1) life expectancy at birth, (2) infant mortality, and (3) literacy rate. For each indicator, the performance of countries is based on a scale of 0 (worst) to 100 (best). The PQLI is calculated by averaging the three indicators, giving equal weight to each of them. The resulting PQLI is scaled on an index of 0 to 100.¹¹

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**The Human Development Index (HDI)**

The United Nations Development Program (UNDP) has come up with a composite index that goes beyond GDP per capita as a measure of development. Introduced in the first Human Development Report (HDR) in 1990, the HDI is a composite index that measures overall progress in a country in achieving human development. The HDI measures the average overall achievements in three basic dimensions: (1) longevity, (2) education and (3) a decent standard of living. It is measured by life expectancy, educational attainment (adult literacy and combined primary, secondary and tertiary enrolment) and adjusted income for the differences in purchasing power of local currencies.\(^2\)

**More-Focused Human Development Measures**

In order to check for the robustness of our results, we employ another set of human development measures in this essay. More specifically, we would like to test how sensitive our results would be when we change the measure of human development. For example, Ogwang (1994) found that only life expectancy at birth should be retained in the HDI since it contains most of the statistical information embedded in the three components. For this reason, we use life expectancy (LE) by itself as a measure of human development. In addition, Ogwang (1997) concludes that one could use only literacy rate as a measure of the quality of life without losing much information. That is why we also use literacy rate (LR) as another measure of
human development. We also use the infant mortality rate (IMR) as another measure of human development.

**Empirical Specification**

Theories of human capital formation and human resource development view human beings as means to increased income and wealth rather than as ends. These theories are concerned with human beings as inputs to increasing production. On the other hand, the human welfare approach looks at human beings as beneficiaries rather than participants in the development process (HDR 1999). Our interest in this study is to focus on the human welfare approach to development, keeping in mind that income dynamics is critical in producing sustainable human development. To examine the impact of reform on human development, we use the following specification.

\[(3)\ H_{it} = \alpha_i + \phi H_{it-1} + \beta' x_{it} + \delta d_{it} + \omega' (d'_{it} * z_{it}) + \epsilon_{it},\]

\[i = 1, 2, ..., N\ and \ t = 1, 2, ..., T_i,\] where \(N\) is the number of countries in the sample and \(T_i\) is the number of time periods during which data is available for country \(i\). \(H_{it}\) is the measure of human development, \(x_{it}\) is a vector of explanatory variables, \(d_{it}\) is a dummy variable that takes two values as specified before, and the parameters \(\alpha_i\) capture the country specific effects such as institutional and cultural background.

Since the impact of reform programs may take a long time, we include a lagged value of the human development measure to account for the dynamic adjustment. Repeatedly back substituting for \(H_{it-1}\) in (3), the model can be written as follows.
(4) $H_{it} = \gamma_i + \beta \sum_{j=1}^{\infty} \phi^j x_{i,t-j} + \delta \sum_{j=1}^{\infty} \phi^j d_{i,t-j} + \omega \sum_{j=1}^{\infty} \phi^j (d_{it} \cdot z_{it}) + u_{it},$

where $\gamma_i = (1 - \phi) \alpha_i$ and $u_{it} = \epsilon_{it} - \phi \epsilon_{i,t-1}$. Again, it is useful to describe the dynamic adjustment of the above distributed lag model in terms of its median lag and in terms of the long run response of the human development measures to reform programs.

After estimating equation (3) for each human development measure, the following two ratios will be calculated: (1) the long-run response $= \beta \sum_{j=0}^{\infty} \phi^j = (1 - \phi)^{-1} \beta$. This ratio measures the change in human development measures because of a one-unit increase in one of the explanatory variables, which remains in effect for all time. (2)

$$\text{The median lag} = \frac{\log \frac{1}{2}}{\log \phi}.$$  

The median lag gives the number of years after which half of the effect of the reform on human development measures is felt.

As we mentioned above, two sets of human development measures will be used as dependent variables. The first set includes composite indexes. These indexes are the Human Development Index (HDI) and the Physical Quality of Life Index (PQLI). The second set includes more focused measures of human development including infant mortality rate (IMR), life expectancy at birth (LE), and literacy rate (LR). The set of explanatory variables in $x_{it}$ include economic, social, and environmental variables. These variables are GDP Per capita (GDPPC), the square term of GDP Per capita $^{12}$ (GDPPC$^2$), government spending on health as a percentage of GDP (HEALTH), government spending on education as a percentage of GDP (EDUCATION), and so on.
(EDU), population growth (POP), female literacy rate (LR-FEMALE), female participation in the labor force (L-FEMALE), the rural population as a percentage of total population (RURAL), and the rate of vaccination coverage (IMMUN). Note that some of the regressors, such as IMMUN, LR-FEMALE, HEALTH, L-FEMALE, are not used in each equation. For example, IMMUN, LR-FEMALE, and L-FEMALE are likely to affect IMR and PQLI\textsuperscript{14} but not LR, LE, or HDI. On the other hand, HEALTH can affect all measures of human development but LR. The regressors in \( z_{it} \) are GDPPC, GDPPC\textsuperscript{2}, HEALTH, and EDU because we would like to see whether the impact of GDPPC, EDU, and HEALTH changes after reform or not.

There is a consensus in the literature on human development that variables such as per capita income, government spending on health and education are expected to have a positive impact on different measures of human development. Increases in any of those variables would raise HDI, PQLI, LR, and LE and reduce IMR. Income per capita can affect all human development measures through its effect on the rate of consumption of items affecting health, such as food, housing, sanitation, medical care, and education. However, diminishing returns to income occur. Therefore, one would expect the coefficient of GDP squared to be negative.

Population growth has long been seen as a liability not an asset in the process of economic development in developing countries. A decrease in the population growth rate is likely to lead to improvements in measures of human development. The same argument applies to countries that witnessed a decline in the percentage of rural population. In addition, the level of mother’s education is also crucial in reducing the
IMR. Educated mothers are more capable of demanding the attention of doctors and nurses. In addition, educated women are more likely to assume personal responsibility for the child with a diminished role for her mother or mother-in-law.

Results

The results of estimating equation (3) are presented in Tables 4 and 5. Equation (3) is estimated using different measures of human development, $H_{it}$, as dependent variables. The estimated five equations performed very well as many of the explanatory variables have the expected sign and are significant at conventional levels of significance. In all regressions, the coefficients of per capita GDP (GDPPC) in levels and square terms, the rate of vaccination coverage (IMMUN), the rural population as percentage of total population (RURAL), and the female literacy rate (LR-FEMALE) have always expected signs and are significant. The negative sign and significance of the coefficient on $(GDPPC^2)$ indicates that diminishing returns to per capita income are taking place when using any measure of human development. On the other hand, the coefficient of the population growth (POP) has opposite signs in all cases except the case of IMR and yet it is insignificant in two cases. The government spending on education, as a percentage of GDP (EDU), has the expected coefficient signs, however it is insignificant. The government spending on health, as a percentage of GDP (HEALTH), has the opposite coefficient signs in all cases except IMR. However, this coefficient is significant in the cases of LE and HDI only.
The results also show that reform programs have significant positive impact on human development measures. After reform, GDP per capita still has the expected sign in levels and square terms, EDU has positive and significant impact on LR, PQLI, and HDI. However, HEALTH is not significant at all after reform. Table 4 also shows the median lags, which are calculated based on the formula mentioned above. The median lags indicate that it takes 2.97 years for reform programs to have a half-way impact on LE, 1.67 years to have a half-way impact on IMR, 1.16 years to have a half-way impact on PQLI, and one year for half of the impact to be felt on HDI.

Table 5 also reports the total impact on the measures of human development due to the reform programs. These total effects represent the long run responses of human development to the reform programs. For example, the total effect of a hundred dollars increase in the GDP per capita would lead to an increase in LE by 4.14 years ((0.04+0.0014)*100), a reduction in IMR by 3.1 per thousands live birth ((-0.021-0.01)*100) and an increase in LR by 1.9% ((0.009+0.01)*100) on average.

Initial Conditions and Growth

In assessing the impact of the IMF-supported reform programs on human development, we should attribute variations in human development to both the policy choices and to the conditions that gave rise to those choices (Summers and Pritchett 1993).
### Table 4

Regression Results for Human Development Measures: Fixed Effects

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>LE</th>
<th>IMR</th>
<th>LR</th>
<th>PQLI</th>
<th>HDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERCEPT</td>
<td>13.58***</td>
<td>29.07***</td>
<td>0.594***</td>
<td>19.16***</td>
<td>0.267***</td>
</tr>
<tr>
<td></td>
<td>(6.83)</td>
<td>(2.36)</td>
<td>(2.49)</td>
<td>(5.62)</td>
<td>(14.19)</td>
</tr>
<tr>
<td>LAG</td>
<td>0.78***</td>
<td>0.66***</td>
<td>0.99***</td>
<td>0.55***</td>
<td>0.51***</td>
</tr>
<tr>
<td></td>
<td>(32.25)</td>
<td>(21.01)</td>
<td>(44.5)</td>
<td>(17.95)</td>
<td>(23.73)</td>
</tr>
<tr>
<td>GDPPC</td>
<td>0.0009***</td>
<td>-0.007***</td>
<td>0.0001***</td>
<td>0.001***</td>
<td>0.0004***</td>
</tr>
<tr>
<td></td>
<td>(3.83)</td>
<td>(-3.46)</td>
<td>(2.85)</td>
<td>(3.4)</td>
<td>(12.9)</td>
</tr>
<tr>
<td>GDPPC²</td>
<td>-8.3E-08***</td>
<td>6.6E-07**</td>
<td>-1.3E-08***</td>
<td>-1.2E-07***</td>
<td>-3.7E-09***</td>
</tr>
<tr>
<td></td>
<td>(-2.86)</td>
<td>(2.00)</td>
<td>(-3.38)</td>
<td>(-2.4)</td>
<td>(-10.35)</td>
</tr>
<tr>
<td>HEALTH</td>
<td>-0.099***</td>
<td>-0.287</td>
<td>--</td>
<td>-0.017</td>
<td>-0.001**</td>
</tr>
<tr>
<td></td>
<td>(-2.59)</td>
<td>(-1.02)</td>
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<td>(-0.22)</td>
<td>(-2.29)</td>
</tr>
<tr>
<td>EDU</td>
<td>0.015</td>
<td>0.044</td>
<td>0.001</td>
<td>0.016</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>(0.59)</td>
<td>(0.27)</td>
<td>(0.22)</td>
<td>(0.33)</td>
<td>(0.18)</td>
</tr>
<tr>
<td>IMMUN</td>
<td>--</td>
<td>-0.079***</td>
<td>--</td>
<td>0.024***</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-4.08)</td>
<td></td>
<td>(4.29)</td>
<td></td>
</tr>
<tr>
<td>POP</td>
<td>0.253***</td>
<td>0.433</td>
<td>0.221**</td>
<td>0.073</td>
<td>0.004***</td>
</tr>
<tr>
<td></td>
<td>(2.9)</td>
<td>(0.98)</td>
<td>(2.02)</td>
<td>(0.57)</td>
<td>(4.3)</td>
</tr>
<tr>
<td>RURAL</td>
<td>-0.039***</td>
<td>0.338***</td>
<td>-0.621***</td>
<td>-0.125***</td>
<td>-0.011***</td>
</tr>
<tr>
<td></td>
<td>(-2.15)</td>
<td>(2.71)</td>
<td>(-2.65)</td>
<td>(-3.33)</td>
<td>(-5.34)</td>
</tr>
<tr>
<td>L-FEMALE</td>
<td>--</td>
<td>0.063</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.29)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LR-FEMALE</td>
<td>--</td>
<td>-0.385***</td>
<td>--</td>
<td>0.215***</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-3.58)</td>
<td></td>
<td>(6.46)</td>
<td></td>
</tr>
</tbody>
</table>

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Table 4-Continued

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>Dependent Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LE</td>
</tr>
<tr>
<td>d</td>
<td>0.894*** (2.96)</td>
</tr>
<tr>
<td>d*GDPPC</td>
<td>0.0003** (1.95)</td>
</tr>
<tr>
<td>d*GDPPC^2</td>
<td>-4.9E-08** (-1.94)</td>
</tr>
<tr>
<td>d*HEALTH</td>
<td>0.014 (0.19)</td>
</tr>
<tr>
<td>d*EDU</td>
<td>0.03 (0.56)</td>
</tr>
</tbody>
</table>

Median Lag 2.97 1.67 68.97 1.16 1.00

Fixed Effects (F-Ratio) 2.28*** 2.97*** 2.28*** 5.53*** 14.43***

R-square 0.73 0.70 0.77 0.84 0.84

Number of Countries 40 40 40 40 40

Number of observations 712 541 712 542 695

Note: *** statistically significant at \( P \leq 0.01 \) level; ** statistically significant at \( P \leq 0.05 \) level; * statistically significant at \( P \leq 0.1 \) level. T-statistics are shown in parentheses.
Table 5

Long Run Response of Human Development Measures to Reform\textsuperscript{16}

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>Dependent Variables</th>
<th>LE</th>
<th>IMR</th>
<th>LR</th>
<th>PQLI</th>
<th>HDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDPPC</td>
<td></td>
<td>0.04</td>
<td>-0.021</td>
<td>0.009</td>
<td>0.003</td>
<td>0.0001</td>
</tr>
<tr>
<td>GDPPC\textsuperscript{2}</td>
<td></td>
<td>-3.8E-06</td>
<td>2.4E-05</td>
<td>-1.3E-05</td>
<td>-2.6E-07</td>
<td>-8E-08</td>
</tr>
<tr>
<td>HEALTH</td>
<td></td>
<td>-0.455</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>-0.002</td>
</tr>
<tr>
<td>EDU</td>
<td></td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>IMMUN</td>
<td></td>
<td>--</td>
<td>-0.232</td>
<td>--</td>
<td>0.053</td>
<td>--</td>
</tr>
<tr>
<td>POP</td>
<td></td>
<td>1.15</td>
<td>--</td>
<td>2.0</td>
<td>--</td>
<td>0.01</td>
</tr>
<tr>
<td>RURAL</td>
<td></td>
<td>-0.177</td>
<td>0.994</td>
<td>-0.6</td>
<td>-0.258</td>
<td>-0.002</td>
</tr>
<tr>
<td>L-FEMALE</td>
<td></td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>LR-FEMALE</td>
<td></td>
<td>--</td>
<td>-1.13</td>
<td>--</td>
<td>0.48</td>
<td>--</td>
</tr>
<tr>
<td>d</td>
<td></td>
<td>4.05</td>
<td>-2.16</td>
<td>24.8</td>
<td>2.06</td>
<td>0.62</td>
</tr>
<tr>
<td>d*GDPPC</td>
<td></td>
<td>0.0014</td>
<td>-0.01</td>
<td>0.01</td>
<td>0.013</td>
<td>0.00004</td>
</tr>
<tr>
<td>d*GDPPC\textsuperscript{2}</td>
<td></td>
<td>-2.2E-06</td>
<td>0.0002</td>
<td>-0.00001</td>
<td>-1.6E-06</td>
<td>-6E-08</td>
</tr>
<tr>
<td>d*HEALTH</td>
<td></td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>d*EDU</td>
<td></td>
<td>--</td>
<td>--</td>
<td>2.0</td>
<td>0.04</td>
<td>0.004</td>
</tr>
</tbody>
</table>

In the context of growth theory, a country with initial bad macroeconomic conditions is likely to converge to poverty trap and a lower steady state equilibrium. An initial high debt to GDP ratio means that a significant amount of resources is spent on debt.
servicing rather than capital accumulation. Countries that are highly indebted are likely to switch their resources from spending on human development and capital to building its foreign reserves and paying off its debt. Therefore, the country's initial macroeconomic conditions are crucial in determining the performance of human development dimensions. Countries with favorable initial macroeconomic conditions (e.g. a lower debt to GDP ratio and higher GDP growth) have better chances to improve human development dimensions under a given reform program than does a country with worse initial conditions.

**Empirical Specification**

To examine the impact of initial macroeconomic conditions on the performance of human development and GDP per capita in the reforming countries, we estimate the following two equations using pooled OLS regression. Since we found evidence for fixed effects in estimating equations (1) and (3), we will use the same two specifications but with replacing the country-specific effects $\alpha_i$ by the county-specific initial conditions vector $C_i$ as follows.

\[
(5) \quad H_{it} = \gamma C_i + \phi H_{i,t-1} + \beta' x_{it} + \delta d_{it} + \omega' (d'_{it} \cdot z_{it}) + \epsilon_{it},
\]

\[
(6) \quad y_{it} = \gamma C_i + \phi y_{i,t-1} + \beta' X_{it} + \delta d_{it} + \omega' (d'_{it} \cdot Z_{it}) + \xi_{it},
\]

where $C_i$ is a vector that contains variables of the initial conditions\(^\text{17}\). These variables are the initial GDP growth (INITIAL-GROW), and initial debt to GDP ratio (INITIAL-DEBT). These two variables are time-invariant since they remain constant.
over time but vary over countries. We expect unfavorable initial conditions to have a persistent negative impact on human development. Specifically, we expect negative signs for initial debt to GDP ratio (INITIAL-DEBT) and a positive sign for the coefficient of initial GDP growth (INITIAL-GROW).

Results

Estimation results for equation (5) are presented in Tables 6 and 7. The results indicate that except a few cases, the signs and the significance of the explanatory variables did not change tangibly. The coefficients on GDPPC, GDPPC^2, IMMUN, L-FEMALE, and LR-FEMALE are still significant and have the expected signs. The coefficients on HEALTH and EDU are still mostly insignificant in affecting human development measures. In the case of LE, PQLI, and HDI, the percentage of rural population loses its significance after introducing the initial conditions variables.

Reform programs still have positive and significant impact on human development measures. However, the magnitude of this impact is higher than the case of fixed-effects estimation. Per capita GDP is still significant and is still carrying the expected sign either in level or square term. However, reform does not change the way EDU and HEALTH affect human development measures. HEALTH is still insignificant and EDU loses its significance, except the case of LR, after incorporating the initial conditions variables. Most importantly, is the increase in all median lag values than the case of fixed-effects estimation.
Table 6
Impact of Initial Conditions on Human Development Measures: OLS Estimation

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>LE</th>
<th>IMR</th>
<th>LR</th>
<th>PQLI</th>
<th>HDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERCEPT</td>
<td>2.1*** (3.37)</td>
<td>7.76** (1.97)</td>
<td>1.29*** (11.52)</td>
<td>3.24*** (4.13)</td>
<td>0.03*** (4.13)</td>
</tr>
<tr>
<td>LAG</td>
<td>0.85*** (92.85)</td>
<td>0.911*** (62.05)</td>
<td>0.99*** (144.6)</td>
<td>0.81*** (55.65)</td>
<td>0.94*** (92.27)</td>
</tr>
<tr>
<td>GDPPC</td>
<td>0.0005*** (3.03)</td>
<td>-0.002* (-1.89)</td>
<td>0.0001** (2.01)</td>
<td>0.001*** (4.25)</td>
<td>0.0001*** (4.54)</td>
</tr>
<tr>
<td>GDPPC^2</td>
<td>-6.4E-08*** (-2.82)</td>
<td>1.7E-07** (2.26)</td>
<td>-2.2E-08*** (-4.15)</td>
<td>-1.7E-07*** (-4.15)</td>
<td>-1.5E-09*** (-4.52)</td>
</tr>
<tr>
<td>HEALTH</td>
<td>-0.055* (-1.73)</td>
<td>-0.035 (-0.14)</td>
<td>--</td>
<td>-0.034 (-0.43)</td>
<td>-0.004 (-0.79)</td>
</tr>
<tr>
<td>EDU</td>
<td>0.002 (0.11)</td>
<td>0.05 (0.35)</td>
<td>0.001 (0.2)</td>
<td>-0.07 (-1.56)</td>
<td>-0.003 (-1.15)</td>
</tr>
<tr>
<td>IMMUN</td>
<td>--</td>
<td>-0.032*** (2.56)</td>
<td>--</td>
<td>0.005* (1.81)</td>
<td>--</td>
</tr>
<tr>
<td>POP</td>
<td>0.099* (1.84)</td>
<td>0.379 (1.25)</td>
<td>0.146*** (10.54)</td>
<td>0.005 (0.057)</td>
<td>0.0002 (0.26)</td>
</tr>
<tr>
<td>RURAL</td>
<td>0.0001 (0.02)</td>
<td>0.019* (1.87)</td>
<td>-0.006*** (-5.9)</td>
<td>-0.004 (-0.65)</td>
<td>-0.001 (-1.48)</td>
</tr>
<tr>
<td>L-FEMALE</td>
<td>--</td>
<td>0.811** (2.07)</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>LR-FEMALE</td>
<td>--</td>
<td>-0.372*** (-2.56)</td>
<td>--</td>
<td>0.039*** (4.55)</td>
<td>--</td>
</tr>
</tbody>
</table>
### Table 6 -Continued

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>LE</th>
<th>IMR</th>
<th>LR</th>
<th>PQLI</th>
<th>HDI</th>
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</thead>
<tbody>
<tr>
<td>d</td>
<td>0.925**</td>
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<td>0.213***</td>
<td>0.927**</td>
<td>0.75***</td>
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<tr>
<td></td>
<td>(1.99)</td>
<td>(-2.11)</td>
<td>(3.31)</td>
<td>(1.96)</td>
<td>(2.33)</td>
</tr>
<tr>
<td>d*GDPPC</td>
<td>0.002**</td>
<td>-0.002**</td>
<td>0.0002***</td>
<td>0.001***</td>
<td>7.9E-06**</td>
</tr>
<tr>
<td></td>
<td>(1.97)</td>
<td>(-2.11)</td>
<td>(5.73)</td>
<td>(2.99)</td>
<td>(-3.5)</td>
</tr>
<tr>
<td>d*GDPPC^2</td>
<td>-4.1E-08**</td>
<td>8.9E-05*</td>
<td>-2.8E-08***</td>
<td>-1.3E-07***</td>
<td>1.3E-09***</td>
</tr>
<tr>
<td></td>
<td>(1.91)</td>
<td>(1.79)</td>
<td>(-5.24)</td>
<td>(-3.36)</td>
<td>(3.97)</td>
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<td>d*HEALTH</td>
<td>0.03</td>
<td>0.328</td>
<td>--</td>
<td>-0.036</td>
<td>0.0005</td>
</tr>
<tr>
<td></td>
<td>(0.52)</td>
<td>(0.96)</td>
<td></td>
<td>(-0.34)</td>
<td>(0.61)</td>
</tr>
<tr>
<td>d*EDU</td>
<td>0.044</td>
<td>-0.100</td>
<td>0.039***</td>
<td>-0.161</td>
<td>0.0009</td>
</tr>
<tr>
<td></td>
<td>(0.96)</td>
<td>(-0.39)</td>
<td>(3.8)</td>
<td>(1.03)</td>
<td>(1.37)</td>
</tr>
<tr>
<td>INITIAL-GROW</td>
<td>-0.429***</td>
<td>-0.096**</td>
<td>-0.004</td>
<td>0.048</td>
<td>-0.001*</td>
</tr>
<tr>
<td></td>
<td>(-3.63)</td>
<td>(-2.56)</td>
<td>(-0.95)</td>
<td>(1.42)</td>
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<tr>
<td>INITIAL-DEBT</td>
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<td>0.003*</td>
<td>-0.001***</td>
<td>-0.0003</td>
<td>-0.005**</td>
</tr>
<tr>
<td></td>
<td>(-1.89)</td>
<td>(1.74)</td>
<td>(-6.64)</td>
<td>(-0.34)</td>
<td>(1.95)</td>
</tr>
<tr>
<td>Median Lag</td>
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<td>99</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>R-square</td>
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<td>0.82</td>
<td>0.89</td>
<td>0.94</td>
<td>0.97</td>
</tr>
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</tr>
<tr>
<td>Number of observations</td>
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<td>541</td>
<td>712</td>
<td>542</td>
<td>695</td>
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</tbody>
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Note: *** statistically significant at $P \leq 0.01$ level; ** statistically significant at $P \leq 0.05$ level; * statistically significant at $P \leq 0.1$ level. T-statistics are shown in parentheses.
Table 7

Long Run Response of Human Development Measures to Reform:
Impact of Initial Conditions

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>LE</th>
<th>IMR</th>
<th>LR</th>
<th>PQLI</th>
<th>HDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDPPC</td>
<td>0.03</td>
<td>-0.02</td>
<td>0.01</td>
<td>0.005</td>
<td>0.0002</td>
</tr>
<tr>
<td>GDPPC$^2$</td>
<td>-1.3E-06</td>
<td>1.9E-06</td>
<td>-2.2E-06</td>
<td>-8.9E-07</td>
<td>-1.6E-07</td>
</tr>
<tr>
<td>HEALTH</td>
<td>-0.37</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>EDU</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>IMMUN</td>
<td>--</td>
<td>-0.36</td>
<td>--</td>
<td>0.026</td>
<td>--</td>
</tr>
<tr>
<td>POP</td>
<td>0.65</td>
<td>--</td>
<td>14.6</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>RURAL</td>
<td>--</td>
<td>0.21</td>
<td>-0.6</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>L-FEMALE</td>
<td>--</td>
<td>0.9</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>LR-FEMALE</td>
<td>--</td>
<td>-0.41</td>
<td>--</td>
<td>0.21</td>
<td>--</td>
</tr>
<tr>
<td>d</td>
<td>6.1</td>
<td>-12</td>
<td>21.3</td>
<td>4.88</td>
<td>12.65</td>
</tr>
<tr>
<td>d*GDPPC</td>
<td>0.01</td>
<td>-0.02</td>
<td>0.02</td>
<td>0.042</td>
<td>0.0001</td>
</tr>
<tr>
<td>d*GDPPC$^2$</td>
<td>-2.7E-06</td>
<td>0.001</td>
<td>-2.8E-06</td>
<td>-6.9E-07</td>
<td>-1.6E-07</td>
</tr>
<tr>
<td>d*HEALTH</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>d*EDU</td>
<td>--</td>
<td>--</td>
<td>3.9</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>INITIAL-GROW</td>
<td>-2.86</td>
<td>-1.07</td>
<td>-0.4</td>
<td>--</td>
<td>-0.002</td>
</tr>
<tr>
<td>INITIAL-DEBT</td>
<td>-0.043</td>
<td>0.03</td>
<td>-0.1</td>
<td>--</td>
<td>-0.008</td>
</tr>
</tbody>
</table>

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This indicates that after conditioning on initial conditions variables, it takes the reform a longer period of time to influence human development measures. This is also confirmed by looking at the total impact multipliers for \( d \) (reform) as they appear in Table 7. These total impact multipliers are larger than the case of fixed-effects estimation as reported in Table 5. This is also because the coefficients on the lagged dependent variables have increased. The coefficient on \( \text{INITIAL-DEBT} \) has its expected sign but it is insignificant only in the case of PQLI. Except the case of IMR, the coefficient on \( \text{INITIAL-GROW} \) has opposite signs of what we expected but it is not significant in the case of LR and PQLI. The negative sign of this variable suggests convergence in income per head. This indicates that countries that were growing slowly before reform realized not only higher GDP per capita but also higher growth than their peers that were initially growing faster. This higher growth seems to help human development measures.

Table 8 reports the results for estimating equation (6). We still get the same results as before in terms of the signs and significance. However the coefficient on \( \text{EXCHANGE} \) is not significant either before or after reform. In addition, the values of the total impact multipliers suggest that the impact of reform on GDP per capita is larger when initial conditions variables enter the regression equation. Also, there is evidence of convergence as the coefficient on \( \text{INITIAL-GROW} \) is negative and significant.
Table 8
Regression Results for GDP per Capita and Estimates of the Long Run Response to Reform: Impact of Initial Conditions

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>Coefficient</th>
<th>T-Ratio</th>
<th>Total Effect $^{19}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONSTANT</td>
<td>0.032</td>
<td>0.65</td>
<td>--</td>
</tr>
<tr>
<td>YLAG</td>
<td>0.91***</td>
<td>203.1</td>
<td>--</td>
</tr>
<tr>
<td>INVESTMENT</td>
<td>0.611***</td>
<td>6.68</td>
<td>6.79</td>
</tr>
<tr>
<td>SCHOOL</td>
<td>0.785**</td>
<td>2.33</td>
<td>8.72</td>
</tr>
<tr>
<td>POP</td>
<td>-0.38***</td>
<td>-2.91</td>
<td>-4.26</td>
</tr>
<tr>
<td>EXCHANGE</td>
<td>0.016</td>
<td>0.82</td>
<td>--</td>
</tr>
<tr>
<td>d</td>
<td>0.46**</td>
<td>2.09</td>
<td>5.11</td>
</tr>
<tr>
<td>d*INVESTMENT</td>
<td>0.25*</td>
<td>1.92</td>
<td>2.79</td>
</tr>
<tr>
<td>d*EXCHANGE</td>
<td>0.002</td>
<td>1.34</td>
<td>--</td>
</tr>
<tr>
<td>INITIAL-GROW</td>
<td>-0.03***</td>
<td>-3.63</td>
<td>-0.33</td>
</tr>
<tr>
<td>INITIAL-DEBT</td>
<td>-0.002*</td>
<td>-1.88</td>
<td>-0.022</td>
</tr>
<tr>
<td>Median Lag</td>
<td>10.1</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>R-square</td>
<td>0.94</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Number of Countries</td>
<td>40</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Number of Observations</td>
<td>630</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Note: *** statistically significant at $P \leq 0.01$ level; ** statistically significant at $P \leq 0.05$ level; * statistically significant at $P \leq 0.1$ level.
Conclusion

This essay examines the long-run impact of economic reform on different measures of human development and income using panel data for 40 countries. Three questions are addressed in this essay. First, what is the long-run impact of reform on GDP per capita? Second, what is the long-run impact of reform on human development? Third, what is the long-run impact of reform on human development and income when countries' initial macroeconomic conditions are incorporated? In answering the first question, we find evidence that economic reform programs have long-run positive impact on GDP per capita. This result suggests that there is another channel through which reform affects human development. In answering the second question, the results indicate that reform programs have long-run positive impact on human development measures. We also find that GDP per capita is very crucial to improvement in human development. This result is different from previous studies that de-emphasized the role of GDP per capita in improving human development. In answering the third question, we find that initial debt-GDP ratio and initial GDP growth have negative impact on human development measures and GDP per capita.
Although economic reform and structural adjustment programs have been adopted by many developing countries over the last 20 years, the relationship between fertility and economic reform has rarely been studied. In this essay, we investigate whether economic reform and structural adjustment programs, supported by the IMF and World Bank, have led to a period of demographic transition in the adjusting countries. The presumption is that economic reform changes the incentives that households face during adjustment periods. Table 9 shows how the average growth rates of the young non-working population have decreased in many reforming countries over the ten years following reform.

The existing literature does not, however, provide theoretical explanation or empirical evidence of the impact that economic reform had on fertility and hence on population growth. This essay attempts to fill this gap in the literature with a theoretical model along with an econometric analysis of the impact that capital accumulation, brought by reform, had on the growth rate of the young non-working population in the reforming countries.

In part III, it was concluded that reform programs have positive impact on measures of human development and income. Now, the question is how could reform
Table 9

Average Growth of the Young Non-Working Population in Reforming Countries

<table>
<thead>
<tr>
<th>Country</th>
<th>10 Years before Reform</th>
<th>10 Years after Reform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>2.0</td>
<td>0.7</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>3.0</td>
<td>0.8</td>
</tr>
<tr>
<td>Belize</td>
<td>2.4</td>
<td>1.7</td>
</tr>
<tr>
<td>Bolivia</td>
<td>2.1</td>
<td>1.9</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>-0.5</td>
<td>-3.4</td>
</tr>
<tr>
<td>Burkina Faso</td>
<td>2.5</td>
<td>2.3</td>
</tr>
<tr>
<td>Cameroon</td>
<td>2.9</td>
<td>2.7</td>
</tr>
<tr>
<td>Chile</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>2.2</td>
<td>1.4</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>2.0</td>
<td>0.9</td>
</tr>
<tr>
<td>Ecuador</td>
<td>2.6</td>
<td>1.0</td>
</tr>
<tr>
<td>Egypt</td>
<td>2.1</td>
<td>0.5</td>
</tr>
<tr>
<td>El Salvador</td>
<td>1.9</td>
<td>0.7</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>2.7</td>
<td>2.4</td>
</tr>
<tr>
<td>Ghana</td>
<td>2.3</td>
<td>2.7</td>
</tr>
<tr>
<td>Guatemala</td>
<td>2.6</td>
<td>2.0</td>
</tr>
<tr>
<td>India</td>
<td>1.9</td>
<td>1.1</td>
</tr>
<tr>
<td>Jordan</td>
<td>4.5</td>
<td>2.6</td>
</tr>
<tr>
<td>Kenya</td>
<td>3.7</td>
<td>2.1</td>
</tr>
<tr>
<td>Lesotho</td>
<td>2.3</td>
<td>2.0</td>
</tr>
<tr>
<td>Malawi</td>
<td>2.9</td>
<td>2.6</td>
</tr>
<tr>
<td>Mali</td>
<td>2.2</td>
<td>2.8</td>
</tr>
<tr>
<td>Mauritius</td>
<td>0.2</td>
<td>-0.7</td>
</tr>
<tr>
<td>Mexico</td>
<td>2.5</td>
<td>0.2</td>
</tr>
<tr>
<td>Morocco</td>
<td>2.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Nepal</td>
<td>2.5</td>
<td>2.2</td>
</tr>
<tr>
<td>Nicaragua</td>
<td>2.8</td>
<td>1.8</td>
</tr>
<tr>
<td>Nigeria</td>
<td>3.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Panama</td>
<td>2.1</td>
<td>0.6</td>
</tr>
<tr>
<td>Papua New Guinea</td>
<td>2.2</td>
<td>1.8</td>
</tr>
<tr>
<td>Peru</td>
<td>2.4</td>
<td>0.9</td>
</tr>
<tr>
<td>Philippines</td>
<td>2.3</td>
<td>1.7</td>
</tr>
</tbody>
</table>
end up affecting fertility through the change in the incentives that households face in the reforming countries. On one hand, reform results in higher female literacy rates and school enrollment rates. This by itself can not have a substantial impact on fertility unless there is a demand for female labor brought by reform. A higher demand for female labor would increase the women’s relative wage and hence the opportunity cost for females to raise children. On the other hand, improvements in the health status, especially in infant mortality rates, resulting from reform policies, can also lead to a lower fertility rates because the “replacement motive” of fertility starts to be less important. In addition, reform is an efficiency-enhancing package of policies that would make assets other than children available and worthy to invest in. One can conjecture that reform would change the incentives of having children as an asset for old-age support.

We pose two questions in this essay: (1) does reform have any impact on fertility? (2) If it does, what would be the long-run impact of reform on fertility? To
Table 10

Average Rate of Female Labor Participation and Capital per Head

<table>
<thead>
<tr>
<th>Country</th>
<th>Female Labor Participation</th>
<th>Capital per Head</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 Years before Reform</td>
<td>5 Years after Reform</td>
</tr>
<tr>
<td>Argentina</td>
<td>27.1</td>
<td>29.7</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>40.7</td>
<td>41.9</td>
</tr>
<tr>
<td>Belize</td>
<td>19.6</td>
<td>21.8</td>
</tr>
<tr>
<td>Bolivia</td>
<td>32.4</td>
<td>36.9</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>45.1</td>
<td>48.2</td>
</tr>
<tr>
<td>Burkina Faso</td>
<td>48.3</td>
<td>46.7</td>
</tr>
<tr>
<td>Cameron</td>
<td>37.3</td>
<td>37.4</td>
</tr>
<tr>
<td>Chile</td>
<td>24.2</td>
<td>30.7</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>18.9</td>
<td>28.3</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>20.6</td>
<td>27.9</td>
</tr>
<tr>
<td>Ecuador</td>
<td>19.0</td>
<td>25.3</td>
</tr>
<tr>
<td>Egypt</td>
<td>26.0</td>
<td>28.7</td>
</tr>
<tr>
<td>El Salvador</td>
<td>23.5</td>
<td>33.8</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>42.1</td>
<td>40.8</td>
</tr>
<tr>
<td>Ghana</td>
<td>50.3</td>
<td>50.8</td>
</tr>
<tr>
<td>Guatemala</td>
<td>20.4</td>
<td>25.5</td>
</tr>
<tr>
<td>India</td>
<td>33.5</td>
<td>31.7</td>
</tr>
<tr>
<td>Jordan</td>
<td>14.3</td>
<td>20.6</td>
</tr>
<tr>
<td>Kenya</td>
<td>45.5</td>
<td>46.0</td>
</tr>
<tr>
<td>Lesotho</td>
<td>38.8</td>
<td>36.7</td>
</tr>
<tr>
<td>Malawi</td>
<td>50.5</td>
<td>49.2</td>
</tr>
<tr>
<td>Mali</td>
<td>46.6</td>
<td>46.5</td>
</tr>
<tr>
<td>Mauritius</td>
<td>22.3</td>
<td>30.5</td>
</tr>
<tr>
<td>Mexico</td>
<td>21.6</td>
<td>30.8</td>
</tr>
<tr>
<td>Morocco</td>
<td>31.6</td>
<td>34.5</td>
</tr>
<tr>
<td>Nepal</td>
<td>39.3</td>
<td>40.3</td>
</tr>
<tr>
<td>Nicaragua</td>
<td>25.7</td>
<td>33.8</td>
</tr>
<tr>
<td>Nigeria</td>
<td>36.6</td>
<td>35.8</td>
</tr>
<tr>
<td>Panama</td>
<td>26.2</td>
<td>33.0</td>
</tr>
<tr>
<td>Papua New Guinea</td>
<td>41.6</td>
<td>41.7</td>
</tr>
</tbody>
</table>
answer these questions, we build on the Galor and Weil (1996) framework and argue that reform can reduce fertility by making specific types of capital available in the economy. These types of capital are usually more complementary to female labor than men’s labor. This can include investments in banking, insurance, and telecommunication sectors which usually increase after reform. These sectors tend to absorb more female employment. Table 10 shows how average rates of female labor participation and capital per head have increased over the 5 years following reform. In addition, privatization of the state-owned enterprises is one of the essential components of reform. The new private owners who take over these enterprises usually substitute labor with capital. Since “physical capital does a better job replacing human strength than it does replacing human capital” (Galor and Weil 1996, p. 377), one would argue that women are more likely to have a comparative advantage over men in getting the newer jobs after reform. As the demand for female labor increases in these sectors, women’s opportunity cost of child-rearing increases

<table>
<thead>
<tr>
<th>Country</th>
<th>Female Labor Participation</th>
<th>Capital per Head</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 Years before Reform</td>
<td>5 Years after Reform</td>
</tr>
<tr>
<td>Philippines</td>
<td>33.4</td>
<td>36.7</td>
</tr>
<tr>
<td></td>
<td>167.1</td>
<td>296.6</td>
</tr>
<tr>
<td>Romania</td>
<td>44.7</td>
<td>44.4</td>
</tr>
<tr>
<td></td>
<td>759.5</td>
<td>502.6</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>26.5</td>
<td>35.0</td>
</tr>
<tr>
<td></td>
<td>106.8</td>
<td>242.2</td>
</tr>
<tr>
<td>Tunisia</td>
<td>25.0</td>
<td>29.8</td>
</tr>
<tr>
<td></td>
<td>350.2</td>
<td>759.8</td>
</tr>
<tr>
<td>Turkey</td>
<td>37.8</td>
<td>35.6</td>
</tr>
<tr>
<td></td>
<td>326.1</td>
<td>886.3</td>
</tr>
<tr>
<td>Uruguay</td>
<td>27.9</td>
<td>39.1</td>
</tr>
<tr>
<td></td>
<td>403.4</td>
<td>996.7</td>
</tr>
<tr>
<td>Zambia</td>
<td>45.1</td>
<td>45.5</td>
</tr>
<tr>
<td></td>
<td>223.7</td>
<td>108.1</td>
</tr>
</tbody>
</table>

Author’s Calculations based on World Bank 2001.
as their relative wage rises, and consequently fertility rates start to decline. To test this argument empirically, we first use a random coefficient model to estimate the complementarity between physical capital and female labor in samples of reforming and non-reforming countries. Second, we estimate a dynamic heterogeneous model to test for the impact of capital per head on fertility in the same two samples of countries.

The essay is organized as follows. We review the existing literature about the relationship between fertility and reform in the first section of the essay. In the second section, we introduce the theoretical model by building on Galor and Weil's (1996) framework. We also drive the dynamical system in the model and examine the steady state equilibrium. In the fourth section, we present the empirical specification and the results of testing for the complementarity between capital and female labor. We empirically examine the impact of reform on fertility in the fifth section and the last section concludes.

Literature Review

Studying the demographic impact of reform is still novel. Only a few reasons have been cited in the literature to explain how reform affects fertility rates. However, most of these explanations have focused on the role of the income effect and how it dominates the substitution effect (Chase 1998, Cerrutti 2000, Montgomery 1993, Schultz and Yi 1999).
Chase (1998) argues that families may reevaluate their fertility decisions based on the change in the economic environment after reform e.g. the new wage structure, job uncertainty and the higher cost of having children because of the reduced subsidies. He concludes that job uncertainty affects the probability of having children while earnings change affects the fertility timing decisions. Cerrutti (2000) uses the “added worker effect” hypothesis to explain the increase in female labor participation in Argentina in response to high unemployment rates and higher job instability during periods of structural adjustment and economic reform. Cerrutti’s argument, which is supported empirically, implies that fertility reduction can be expected during periods of structural adjustment because of the added-worker effect. Montgomery (1993) argues that contractions in incomes accompanying structural adjustment may be expressed in postponed or lower lifetime fertility. Schultz and Yi (1999) hypothesized that the reforms in China during 1980s increased the private monetary and opportunity cost of childbearing and intensified market competition for the adoption of new production technologies that encouraged parents to educate their children better, while increasing the mobility of the rural labor force and thereby discouraging and delaying childbearing among rural Chinese.

The above studies have neither looked at how capital accumulation resulting from reform affects fertility nor have they examined the long run impact of these reform policies on fertility. This essay is designed to fill this gap in the literature.
Theoretical Background

Reviewing the literature reveals that two approaches have been followed to endogenize fertility in micro models. In the first approach, children enter parents’ utility function and are treated as consumption good. Examples of this approach are Barro and Becker (1988) and (1989); Becker, Murphy and Tamura (1990); Galor and Weil (1996) and (2000); Kremer and Chen (2000); and Chakrabarti (1999). The second approach treats children as investment—a source of old age support. Examples of this approach are Srinivasan (1988); Raut and Srinivasan (1994); Azariadis and Drazen (1993).

Following Galor and Weil (1996), we use an overlapping generations model (OLG) where people live for two periods. In the first period, the couple raises children and saves. In the second period, parents do not work and only consume from savings from the first period. The model includes four elements: production, utility maximization by the household, the dynamical system, and the steady state equilibrium.

Production

There are three factors of production: physical capital, $K$, physical labor, $L$, and non-physical or mental labor, $F$. Physical labor requires strength and therefore men have a comparative advantage in performing this kind of labor. Mental labor can be performed by both men and women. For simplicity we assume a complete
specialization where men provide only physical labor while women provide only mental labor. The key assumption here is that capital is more complementary to female labor after reform. In other words, reform makes available a specific kind of capital that is more complementary to female labor, makes women more productive and therefore raises women’s relative wage after reform.

The post reform complementarity is captured in the following CES production function.

\[
Y_t = A[\delta K_t^\rho + (1 - \delta) F_t^\rho]^{\frac{1}{\rho}} + BL_t,
\]

where \(A, B > 0, \delta \in (0, 1)\) and \(\rho \in (-\infty, 1)\). If \(\rho \in (-\infty, 0)\) it implies that the elasticity of substitution between physical capital and mental labor is smaller than one. As \(\rho\) increases in absolute value the complementarity between capital and mental labor increase. It is assumed here that the post reform \(\rho\) is negative and large in absolute value, representing significant complementarity between capital and female labor. Before reform, however, \(\rho\) is assumed to be close to unity. A key idea in this formulation is that reform makes available capital that is complementary to female labor. The above production function can be rewritten in per-couple term as follows.

\[
y_t = A[\delta k_t^\rho + (1 - \delta) f_t^\rho]^{\frac{1}{\rho}} + B,
\]

where \(k_t \equiv \frac{K_t}{L_t}\) is the per-couple stock of physical capital and \(f_t \equiv \frac{F_t}{L_t}\) is the per-couple stock of mental labor. We also assume that women are superior to men in their
child-rearing abilities. Since men will always supply one unit of physical labor and women will supply between zero and one unit of mental labor, the variable $f_i$ will take values between zero and one. Assuming competitive markets after reform, all factors of production are paid wages equal to marginal products as follows.

(9) $W_{it}^m = B,$

(10) $W_{it}^f = A(1 - \delta) f_i^{\rho - 1} [\partial_i^{\rho} + (1 - \delta) f_i^{\rho}]^{\frac{1 - \rho}{\rho}},$

where $W_{it}^m$ is the wage paid to physical labor supplied by men and $W_{it}^f$ is the wage paid to mental labor supplied by women.

**Utility Maximization Problem**

In this model, children enter parents’ utility function as consumption goods. Based on this assumption, an increase in men’s income increases the demand for children, assuming that women raise children full-time. When women participate in the labor force, the increase in the household’s income has income and substitution effects working in opposite directions and therefore the demand for children becomes ambiguous. One way to avoid this theoretical ambiguity of the impact of income on fertility is to assume a semi-log utility function where the substitution effect dominates the income effects. This assumption indicates that fertility declines as countries develop. In this model, we follow Galor and Weil (1996) by assuming that
fertility declines only if women's relative wage increases as a result of the accumulation of female-specific capital brought by reform.

We assume that the utility function of a couple is as follows.

\[(11) \quad U_t = \theta \ln(n_t) + (1 - \theta) \ln(c_{t+1}).\]

This means that couples receive utility from the number of children they have, \(n_t\), and consumption in the last period of life, \(c_{t+1}\), where consumption in time period \(t+1\) is given by the following equation.

\[(12) \quad c_{t+1} = S_t (1 + r_{t+1}),\]

where \(S_t\) is savings and \(r_{t+1}\) is the real rate of interest at time period \(t+1\). The couple maximizes utility by choosing the number of children to have given the total amount of time that can be devoted to child-rearing and labor market activities. The more children a couple decides to have, the less saving a couple has and therefore less income and consumption in the future. We assume that the only input required to raise children is time. In the first period the couple faces the following budget constraint.

\[(13) \quad W_t^{f} + S_t \leq (1 - t)(W_t^{m} + W_t^{f}) + R_t, \quad \text{if } \tau_t = 1
\]

\[W_t^{f} \tau_t + S_t \leq (1 - t)(W_t^{m} + W_t^{f}) + R_t, \quad \text{if } \tau_t \leq 1,\]

where \(t\) is the income tax rate and \(R_t\) is the amount of in-kind transfers a couple gets, like subsidized education and health services. The fraction \(\tau_t\) is part of the time.
endowment parents spend on raising children. This fraction can take the value zero if both parents work full-time, the value one if the man is working full-time while the woman is bearing children full time, or the value two if both parents are bearing children full-time.\textsuperscript{23} The above household's problem can be seen as deciding what fraction of its time should be spent working, and thus saving for future consumption, and what fraction should be spent raising children. Solving the maximization problem would yield the following optimal number of children.\textsuperscript{24}

\begin{equation}
(14) \quad n_t = \theta \left[ \frac{(1-t)W_t^m + R_t}{W_t^f} + (1-t) \right].
\end{equation}

Equation (14) shows that any increase in women's wage, $W_t^f$, as a result of the increase in demand for female labor after reform can reduce fertility. In addition, reform can reduce fertility through the decrease in transfers, $R_t$, and increase in taxes, $t$, associated with reform. Since we do not have data on $R_t$ and $t$ to test their impact on fertility after reform, we will only focus on the impact $W_t^f$ has on fertility. Thus

\begin{equation}
(15) \quad \min_t \{ 1, \theta \left[ \frac{(1-t)W_t^m + R_t}{W_t^f} + (1-t) \right] \}.
\end{equation}

It can easily be shown that $\frac{\partial n_t}{\partial W_t^f} < 0, \frac{\partial n_t}{\partial t} < 0, \frac{\partial n_t}{\partial R_t} > 0$. Solving for $S_t$,

\begin{equation}
(16) \quad S_t = \begin{cases} 
(1-t)W_t^m - tW_t^f + R_t & \text{if } n_t = 1 \\
(1-\theta)[(1-t)(W_t^f + W_t^m) + R_t] & \text{if } n_t < 1.
\end{cases}
\end{equation}
Since \( f_t = \frac{F_t}{L_t} \) and \( F_t = (1 - \nu_t)L_t \), therefore

\[
(17) \quad f_t = 1 - \nu_t.
\]

Using (9), (10), (15) we can show that the optimal number of children can be given by (18).

\[
(18) \quad \nu_t = \min \left\{ 1, \frac{\theta(1 + \frac{(1-t)B + R_t}{A(1-\delta)(1-\nu_t)^{\rho-1}[\delta_{\nu_t}^\rho + (1-\delta)(1-\nu_t)^\rho]}^{1-\rho} - t)}{1-t} \right\}.
\]

Let \( h(\nu_t, k_t) \equiv \nu_t - \theta(1 + \frac{(1-t)B + R_t}{A(1-\delta)(1-\nu_t)^{\rho-1}[\delta_{\nu_t}^\rho + (1-\delta)(1-\nu_t)^\rho]}^{1-\rho} - t) = 0. \)

Following the implicit function theorem (Galor and Weil 1996, p. 380) and since

\[
\frac{\partial h(\nu_t, k_t)}{\partial \nu_t} \text{ is strictly monotonic and nonvanishing } \forall k_t \geq 0, \text{ there exist a differentiable and invertible function } \Lambda(k_t) \text{ such that}
\]

\[
(19) \quad \nu_t = \min[1, \Lambda(k_t)],
\]

where \( \Lambda'(k_t) < 0 \quad \forall k_t \geq 0 \) and \( k_t = \Lambda^{-1}(1). \)

In other words,
where \( k \) is the critical level of capital that reform brings about so that female labor is more complementary to capital.

Figures 5 and 6 shows the kinked budget constraint, drawn in bold, facing the couple before reform. The slope of the lower portion of the constraint differs according to the size of \( W_{tf} \) relative to \( W_{tm} \). Figure 5 shows the budget constraint when \( W_{tm} > W_{t} \) while Figure 6 shows the budget constraint when \( W_{tm} < W_{t} \). In each case, there are three possibilities. First, if an indifference curve is tangent to the upper portion of the budget constraint, women raise children full-time and men devote part-time to raise children as well. This possibility is ruled out in this model since it is not appealing for developing countries as we mentioned before. The second possibility is the border-line case when men and women completely specialize; men work full-time while women raise children full-time. This possibility occurs exactly at the kink of the budget constraint. The third possibility is when an indifference curve is tangent to the budget constraint at the lower portion of it. In this case, women raise children only part-time while men work full-time. Since we see women participating in the labor force, we only consider the third possibility in this model. Assuming that \( t \) and\( R_t \) are held constant, an increase in the women’s wage from \( W_{t} \) to \( W_{t}^{f} \) rotates only

\[
\tau_{n} = \begin{cases} \Lambda(k,) & \text{if } k, \geq k, \\ 1 & \text{if } k, \leq k., \end{cases}
\]
Figure 5. The Impact of Reform on Fertility: $w^m > w^f$

Figure 6. The Impact of Reform on Fertility: $w^m < w^f$
the lower portion of the budget constraint to the right and causes fertility to decrease from \( n_i \) to \( n_i' \).

The Dynamical System

The stock of capital at time period \( t+1 \) is determined by the aggregate supply of savings at time \( t \) as follows.

\[(21) \quad K_{t+1} = L_t S_t.\]

The number of working-age households at time \( t+1 \) is

\[(22) \quad L_{t+1} = L_t n_t.\]

The capital per physical labor is

\[(23) \quad k_{t+1} = \frac{K_{t+1}}{L_{t+1}} = \frac{S_t}{n_t}.\]

It can be shown that

\[(24) \quad k_{t+1} = \begin{cases} 
\frac{\tau[(1-t)W_t^n - tW_i^f + R_i]}{n_t} & \text{if } n_t = 1 \\
\frac{\tau(1-\theta)}{\theta} W_i^f & \text{if } n_t < 1.
\end{cases}\]
Using (9), (10), (17), (21), and (24), the dynamic equilibrium sequence is determined by

\[
(25) \quad k_{t+1} = \psi(k_t) = \begin{cases} 
\tau \left\{ (1-t)B + R_t - tA(1-\delta)[1 - \Lambda(k_t)]^{\rho-1}[\delta k_t^{\rho} + (1-\delta)(1 - \Lambda(k_t))^{\rho-1}] \right\} & \text{if } 0 < k_t < k \\
\tau A \frac{(1-\theta)(1-\delta)}{\theta} [1 - \Lambda(k_t)]^{\rho-1} \{\delta k_t^{\rho} + (1-\delta)(1 - \Lambda(k_t))^{\rho-1}\} & \text{if } k < k_t < \infty.
\end{cases}
\]

It can be shown that \( \psi(0) > 0 \) and the usual Inada Conditions,

\[
\lim_{k_t \to 0} \psi'(k_t) = \infty
\]

(26)

\[
\lim_{k_t \to \infty} \psi'(k_t) = 0,
\]

are satisfied so that \( \psi(k_t) \) cuts the 45° from above to ensure steady state equilibrium as shown in Figure 7.

**Steady State Equilibrium**

The steady state equilibrium is the level of capital per head, \( \bar{k} \), at which

\( \bar{k} = \psi(\bar{k}) \)

and the steady state rate of fertility is given as follows.

\[
(27) \quad \bar{n} = \begin{cases} 
\frac{\Lambda(\bar{k})}{\tau} & \text{if } \bar{k} \geq k \\
\frac{1}{\tau} & \text{if } \bar{k} \leq k.
\end{cases}
\]
It can also be verified using \( \psi'(k,*) \) that the slope of the dynamical system in a close neighborhood to the right of \( k \) is greater than that in a close neighborhood to the left of \( k \). That is,

\[
\lim_{k \to k^+} \psi'(k) > \lim_{k \to k^-} \psi'(k).
\]

Figure 7 describes the dynamical system. At point \( a \), \( \psi(0) > 0 \), which means that all savings come from physical labor provided by men and female labor is zero. At point \( b \), the condition (28) is satisfied so that there is a jump in the slope of the capital evolution function, \( \psi(k_1) \), around \( k \). The reason is that at \( k \), reform brings female-specific capital which attracts women to participate in the labor force, savings increase, and therefore capital accumulation increases subsequently. At point \( c \), \( \lim_{k \to k^+} \psi'(k,*) = 0 \), and the economy reaches a unique steady state equilibrium where capital accumulation is high, female labor participation is high, female wages are high, and fertility is low. It should be noted that without reform, the steady state equilibrium occurs at a low level of capital per head around \( k \) where the wage given to female labor is close to zero, female labor participation is very low, and fertility is high. This case is presented in Figure 8 where there is no jump in the capital evolution function.
Figure 7. A Globally Stable Steady State Equilibrium After Reform

Figure 8. A Globally Stable Steady State Equilibrium Without Reform

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Testing for the Complementarity between Capital and Female Labor

Empirical Specification

Assume the following CES aggregate production function.

\[ y_t = A[\beta_1 k_t^\rho + \beta_2 f_t^\rho]^{\frac{1}{\rho}}, \]

where \( y_t \) is real GDP per capita, \( k_t \) is the per-couple stock of physical capital and \( f_t \) is the per-couple stock of mental labor and \( \beta_1 + \beta_2 = 1 \). The parameter \( \rho \) is equal to \( \frac{1-\sigma}{\sigma} \), where \( \sigma \) is the elasticity of substitution between mental labor and physical capital. By following Artus (1984), we adopt the following linear transformation of (29).

\[ y_t = a + \beta_1 k_t + \beta_2 f_t - \frac{1}{2} \rho \beta_1 \beta_2 (k_t - f_t)^2, \]

or more compactly,

\[ y_t = a + \beta_1 k_t + \beta_2 f_t + \beta_3 (k_t - f_t)^2, \]

where \( \dot{y}_t, \dot{f}_t, \) and \( \dot{k}_t \) are the logarithms of \( y_t, f_t, \) and \( k_t \) respectively and \( \beta_3 = -\frac{1}{2} \rho \beta_1 \beta_2. \)
In estimating panel data models, most studies pool data from different countries, a procedure that assumes the homogeneity of all countries in the sample. This assumption is not very realistic in a sense that the underlying structure of the dependent variables differs from one country to another. A number of studies including Hildreth and Houck (1968), Swamy (1970, 1971, 1974), Feige and Swamy (1974), Hsiao (1975), Iscan (1997), and Pesaran and Smith (1995) have suggested the use of parameter heterogeneity in estimating panel data models. Following the above-mentioned studies, we assume that the data are generated so that the coefficients are constant over time but vary randomly across countries, and that the distribution of the coefficients is independent of the regressors. We estimate the following heterogeneous empirical version of equation (35).

\[
  y_{it} = a_i + \beta_{1i} k_{it} + \beta_{2i} j_{it} + \beta_{3i} (k_{it} - f_{it})^2 + \beta_{4i} d_{it} \cdot k_{it} + \beta_{5i} d_{it} \cdot j_{it} + \beta_{6i} d_{it} \cdot (k_{it} - f_{it})^2 + \epsilon_{it},
\]

\(i = 1, 2, \ldots, 38, t = 1960, 1961, \ldots, 1999\), where \(d_{it}\) is a dummy variable that takes two values as follows.

\[
d_{it} = \begin{cases} 
0 & \text{for all years before country } i \text{ undertakes reform} \\
1 & \text{for all years after country } i \text{ undertakes reform.} 
\end{cases}
\]

The coefficients \(a_i, \beta_{1i}, \beta_{2i}, \beta_{3i}, \beta_{4i}, \beta_{5i}, \beta_{6i}\) vary across countries according to the following random coefficient model

\[
a_i = a_i + \eta_{ai}, \quad \beta_{1i} = \beta_{1i} + \eta_{1i}, \quad \beta_{2i} = \beta_{2i} + \eta_{2i}, \quad j = 1, 2, \ldots, 6,
\]
where $\eta_{o,t}$ and $\eta_{p,t}$ are assumed to have zero means and constant covariances.

After estimating equation (32) for the sample of reforming countries, we retrieve the estimates for the measure of complementarity between capital and female labor, $\hat{\rho}$. We also estimate another version of equation (32) for the sample of non-reforming countries as follows.

$$(32)' \quad y_{it} = a_i + \beta_{1i} k_{it} + \beta_{2i} f_{it} + \beta_{3i} (k_{it} - f_{it})^2 + \epsilon_{it},$$

$i = 1, 2, \ldots, 25, t = 1960, 1961, \ldots, 1999$. The measure of complementarity between capital and female labor, $\hat{\rho}$, can be estimated as $\hat{\rho} = \frac{-2\hat{\beta}_3}{\hat{\beta}_1 \hat{\beta}_2}$.

Under the assumptions given by (33), equations (32) and (32)' can be estimated using two methods. We can estimate separate regression for each country using OLS and then average the obtained estimates. In this case standards errors are computed by taking the square roots of the average variances of parameter estimates. This procedure is the unweighted regression which assumes parameter interdependence across countries. We can also use the Generalized Least Squares (GLS) weighted average proposed by Swamy (1971). Both methods will give us consistent estimates of the parameters (Pesaran and Smith 1995).
Results

Table 11 reports the alternative estimates of the parameters in equations (32) and (32)' for the samples of reforming and non-reforming countries respectively. In each sample, we estimate the equations using weighted GLS regression and unweighted regression by running individual OLS regression for each country in the sample and taking the arithmetic average of the parameter estimates. As the homogeneity test indicates in the two samples, we fail to accept parameter homogeneity since the value of $\chi^2$ is significant at any level of significance. All the parameter estimates, using weighted or unweighted regression, are significant at conventional significance levels.

Table 12, which reports the estimates of the complementarity degree between female labor and capital, $\rho$, is derived from Table 11. When $\rho \in (-\infty, 0)$, the elasticity of substitution between capital and female labor is smaller than one. As $\rho$ increases in absolute value, the complementarity between capital and female labor increases. The parameter, $\rho$, is positive in the case of non-reforming countries which indicates modest substitutability between female labor and capital in those countries. However, the complementarity measure, $\rho$, is negative in the case of reforming countries and is even more so after adopting reform program. This result indicates that reform has augmented the complementarity between female labor and capital, a condition required to reduce fertility as the theoretical model predicts.
Table 11

Alternative Estimates of the CES Production Function

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>Reforming Countries</th>
<th>Non-Reforming Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weighted Regression</td>
<td>Unweighted Regression</td>
</tr>
<tr>
<td>$K_{it}$</td>
<td>0.588*** (0.045)</td>
<td>-0.371* (0.220)</td>
</tr>
<tr>
<td>$F_{it}$</td>
<td>0.380*** (0.047)</td>
<td>0.837*** (0.291)</td>
</tr>
<tr>
<td>$(K_{it} - F_{it})^2$</td>
<td>0.119*** (0.004)</td>
<td>0.178*** (0.015)</td>
</tr>
<tr>
<td>$d_{it}K_{it}$</td>
<td>0.112** (0.054)</td>
<td>0.101* (0.068)</td>
</tr>
<tr>
<td>$d_{it}F_{it}$</td>
<td>0.130** (0.064)</td>
<td>0.262*** (0.083)</td>
</tr>
<tr>
<td>$d_{it}(K_{it} - F_{it})^2$</td>
<td>0.215*** (0.005)</td>
<td>0.307*** (0.035)</td>
</tr>
<tr>
<td>$\chi^2$ (Homogeneity Test)</td>
<td>193.75***</td>
<td>--</td>
</tr>
</tbody>
</table>

Note: *** statistically significant at $P \leq 0.01$ level; ** statistically significant at $P \leq 0.05$ level; * statistically significant at $P \leq 0.1$ level. Standard errors are in parentheses.
Table 12

Estimates of the Degree of Complementarity between Capital and Female Labor

<table>
<thead>
<tr>
<th></th>
<th>Reforming Countries</th>
<th>Non-Reforming Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weighted Regression</td>
<td>Unweighted Regression</td>
</tr>
<tr>
<td>Before Reform</td>
<td>-1.065</td>
<td>-0.925</td>
</tr>
<tr>
<td>After Reform</td>
<td>-1.871</td>
<td>-1.865</td>
</tr>
</tbody>
</table>

The Impact of Reform on Fertility

**Empirical Specification**

We use an autoregressive distributed lag model to account for the dynamics of reform and to capture its long-run impact on fertility. Once again, we assume that the data are generated so that the coefficients are constant over time but vary randomly across countries, and that the distribution of the coefficients is independent of the regressors. The assumption of coefficient heterogeneity allows for the possibility that fertility rates in different countries may respond differently to reform. This is consistent with the notion that the 38 reforming countries in our sample are heterogeneous in terms of the cultural, religious, and historical backgrounds, which ultimately affect the way fertility responds to reform. Because the impact of reform programs can take a long time, we include two lags of the dependent variable as regressors to account for the dynamic adjustment.
Following Pesaran and Smith (1995), we assume the following heterogeneous dynamic model.

\[ \begin{align*}
(34) \quad & N_{it} = \phi_{i1} N_{i,t-1} + \phi_{i2} N_{i,t-2} + \beta_{i1} y_{it} + \beta_{i2} y_{it}^2 + \beta_{i3} k_{it} + \beta_{i4} d_{it} + \beta_{i5} (d_{it} \cdot k_{it}) + \xi_{it}, \\
& i = 1, 2, \ldots, 38, \quad t = 1960, 1961, \ldots, 1999, \\
& N_{it} \text{ is the young non-working population as a proxy for the fertility rate, } y_{it} \text{ is per capita income, } k_{it} \text{ is capital per head, and } d_{it} \text{ is a dummy variable that takes two values as follows.} \\
& d_{it} = \begin{cases} 
0 & \text{for all years before country } i \text{ undertakes reform} \\
1 & \text{for all years after country } i \text{ undertakes reform.}
\end{cases}
\end{align*} \]

The coefficients $\phi_{i1}, \phi_{i2}, \text{ and } \beta_{i3}$ vary across countries according to the following random coefficient model

\[ \begin{align*}
(35) \quad & \phi_{i1} = \phi_1 + \nu_{i1}, \quad \phi_{i2} = \phi_2 + \nu_{i2}, \quad \beta_{j1} = \beta_j + \mu_{ji},
\end{align*} \]

where $\nu_{i1}, \nu_{i2}, \text{ and } \mu_{ji}$ are assumed to have zero means and constant covariances and $j = 1, 2, \ldots, 5$. This is the standard specification of the random coefficient model which introduces parameter heterogeneity through the short-run coefficients, $\phi_{i1}, \phi_{i2}, \text{ and } \beta_{j1}$ (Pesaran and Smith 1995, p. 81). An alternative specification of the random model can be introduced by assuming that the long-run coefficients, $\phi_{ji} = \frac{\beta_{ji}}{(1 - \phi_{i1} - \phi_{i2})}$, where $j = 1, 2, \ldots, 5$, vary randomly across countries so that

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where $e_{ij}$ has zero mean and constant covariance. The average long-run impact of per capita income and capital per head on fertility can now be defined either in terms of the average of the short-run coefficients, $\frac{\bar{\beta}_j}{(1 - \bar{\phi}_1 - \bar{\phi}_2)}$, or the average of the long-run coefficients $\bar{\delta}_j$, where

\[
\bar{\beta}_j = \frac{\sum_{i=1}^{N} \beta_{ji}}{N}, \quad \bar{\phi}_1 = \frac{\sum_{i=1}^{N} \phi_{1i}}{N}, \quad \bar{\phi}_2 = \frac{\sum_{i=1}^{N} \phi_{2i}}{N}, \quad \bar{\delta}_j = \frac{\sum_{i=1}^{N} \delta_{ji}}{N}.
\]

Again, under the assumptions given by (35) and (36), equation (34) can be estimated using two methods. We can estimate separate regression for each country using OLS and then average the obtained estimates. In this case standards errors are computed by taking the square roots of the average variances of parameter estimates. This procedure is the \textit{unweighted} regression which assumes parameter interdependence across countries. We can also use the Generalized Least Squares (GLS) \textit{weighted} average proposed by Swamy (1971). Both methods will yield consistent estimates of $\phi$, $\beta$ and $\delta$ under both (39) and (40) (Pesaran and Smith 1995).

Equation (34) is estimated for the sample of 38 reforming countries to examine the impact of capital per head and per capita income on fertility before and after reform. To compare the impact of capital and income per head on fertility in
reforming countries with non-reforming countries, we estimate another version of equation (34) for the sample of non-reforming countries as follows.

\[ N_{it} = \phi_{it} N_{i,t-1} + \phi_{2i} N_{i,t-2} + \beta_{1i} y_{it} + \beta_{2i} y_{it}^2 + \beta_{3i} k_{it} + \xi_{it}, \]

\( i = 1, 2, \ldots, 25, t = 1960, 1961, \ldots, 1999, \) and \( N_{it}, y_{it}, \) and \( k_{it} \) are defined as before. Again, the average long-run impact of per capita income and capital per head on fertility can be defined as the average of the short-run coefficients,

\[ \frac{\bar{\beta}_j}{(1 - \phi_1 - \phi_2)}, \text{ where } j = 1, 2, 3. \]

Results

Table 13 reports the estimates of equations (34) and (34') for the samples of reforming and non-reforming countries and using the weighted and unweighted regressions. In the sample of non-reforming countries, all of the coefficients are insignificant with the exception of the coefficients on the first lag of the growth rate of the young non-working population and on capital per head in the case of the unweighted regression. This result shows that a $100 increase in capital per head can reduce the growth rate of young non-working population by 16%. This could indicate that this set of non-reforming countries do not require reform to reduce fertility since capital per head can have a significant negative impact even without the complementarity between capital and female labor.
The results in Table 13 also indicate that income per head has a negative impact on fertility in levels, which suggests that the substitution effect outweighs income effect as income per head rises. The growth rate of the young non-working population is expected to decrease by 3% in the case of weighted regression and 2% in the case of unweighted regression when income per head increases by 100 dollars.

The results in Table 13 are also interesting as the nonlinear shape, implied by the income coefficients in the case of weighted regression, has a U profile. That is fertility is expected to decrease when income per head increases and at a certain level of income per head this relationship reverses. Simple computation implies that the impact of income per head on fertility becomes positive at a level of income around $1636.

More importantly, capital per head has a significant negative impact on fertility only after reform regardless of the estimation method used. As shown in Table 13, a $1000 increase in capital per head after reform is expected to reduce the growth rate of the young non-working population by 1.4%, using weighted regression, and 2.2% using unweighted regression. This result is very consistent with the theoretical model which predicts that reform reduces fertility by making more capital available, attracting more women to work as capital becomes more complementary to female labor, raising the women's relative wage, and raising the opportunity cost of child-rearing. Although the coefficient on capital per head is negative before reform, in the case of weighted regression, it is not significant.
### Table 13
Estimates of the Dynamic Population Growth Equations

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>Reforming Countries</th>
<th>Non-Reforming Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weighted Regression</td>
<td>Unweighted Regression</td>
</tr>
<tr>
<td>$N_{i,t-1}$</td>
<td>0.749*** (0.028)</td>
<td>0.932*** (0.104)</td>
</tr>
<tr>
<td>$N_{i,t-2}$</td>
<td>-0.221*** (0.028)</td>
<td>-0.731*** (0.106)</td>
</tr>
<tr>
<td>$y_{it}$</td>
<td>-0.0296* (0.0158)</td>
<td>-0.020*** (0.002)</td>
</tr>
<tr>
<td>$y_{it}^2$</td>
<td>0.0020* (0.0012)</td>
<td>0.001 (0.173)</td>
</tr>
<tr>
<td>$k_{it}$</td>
<td>-0.0003 (0.0008)</td>
<td>0.004 (0.295)</td>
</tr>
<tr>
<td>$d_{it}$</td>
<td>-0.0014** (0.0007)</td>
<td>-0.0022*** (0.008)</td>
</tr>
<tr>
<td>$d_{it}$</td>
<td>-0.0003 (0.0009)</td>
<td>-0.0007 (0.485)</td>
</tr>
<tr>
<td>$\chi^2$ (Homogeneity Test)</td>
<td>459.46***</td>
<td>--</td>
</tr>
</tbody>
</table>

Note: *** statistically significant at $P \leq 0.01$ level; ** statistically significant at $P \leq 0.05$ level; * statistically significant at $P \leq 0.1$ level. Standard errors are in parentheses.

Again, the homogeneity test results in a rejection for parameter homogeneity since the value of $\chi^2$ is significant at conventional levels of significance in the two samples.
Table 14

Heterogeneous Panel Estimates of the Long Run Coefficients

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>Reforming Countries</th>
<th>Non-Reforming Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weighted Regression</td>
<td>Unweighted Regression</td>
</tr>
<tr>
<td>$y_{it}$</td>
<td>-0.063</td>
<td>-0.025</td>
</tr>
<tr>
<td>$y_{it}^2$</td>
<td>0.004</td>
<td>--</td>
</tr>
<tr>
<td>$k_{it}$</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>$d_{it}k_{it}$</td>
<td>-0.003</td>
<td>-0.0028</td>
</tr>
<tr>
<td>$d_{it}$</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Note: long-run coefficients are based on significant coefficients in Table 13.

Table 14 reports the long-run coefficients which measures the total impact of reform on fertility. These total effects represent the long run responses of fertility to reform. For example, the total effect of a hundred dollars increase in the GDP per capita would be a decrease in the growth rate of the young non-working population by 6.3% on average. Results in Table 14 also show that the growth rate of the young non-working population decreases in the long-run by 3% due to a $1000 increase in capital per head after reform.

Conclusion

The purpose of this essay is to examine the impact of the economic reform programs on fertility in reforming countries. We extend the Galor and Weil’s (1996)
model to show that reform can reduce fertility by making capital more complementary to female labor than men's labor, raising the women's relative wage, and raising the opportunity cost of child-rearing. Without the increase in complementarity between capital and female labor, women's wage stays low and the economy converges to a lower steady state equilibrium where capital and output per head are low, female labor participation is low and fertility is high. To test this empirically, a random coefficient regression model to estimate the complementarity between physical capital and female labor in samples of reforming and non-reforming countries was specified and estimated. This model proved to be appropriate as the hypothesis that coefficients are fixed across countries was rejected. As the results indicate, the estimate of the complementarity parameter is positive in the case of non-reforming countries while negative in the case of reforming countries and is even more so after reform. We then test for the impact of capital per head on fertility. To do this, we estimate a dynamic heterogeneous model by using weighted and unweighted regressions. The results indicate that capital per head has a significant negative impact on fertility after reform regardless of the regression method used. This result is very consistent with the predictions of the theoretical model.
PART V

THE IMPACT OF REFORM ON EFFICIENCY AND FACTOR SHARES: ARE FACTORS OF PRODUCTION PAID THEIR MARGINAL PRODUCTS?

The purpose of this essay is to examine the distributional impact of reform on labor and capital in reforming countries. Before adopting IMF-supported reform programs, policy makers in developing countries have emphasized the role of labor by either keeping wages artificially below market-clearing levels or by employing labor surplus in the state sector at very low wages. In the meantime, measures of financial repression resulted in lower rates of return to capital. This kind of bias in favor of labor and against capital has been a common feature of inefficiency in developing countries during the sixties and seventies, where both factors have been paid less than their marginal products.

Reform is an efficiency-enhancing set of policies that is designed to eliminate this bias against capital, through privatization, laying off unwanted workers in the state sector, encouraging foreign direct investment, raising nominal interest rates, lowering inflation rates, and liberalizing good and factor prices. Macro stabilization programs call for a reduction in the government budget deficit through reductions in subsidies and transfer payments, increasing taxes, and minimizing the role of the state as an employment provider. In addition, the monetary policy under reform calls for increases in nominal interest rates to discourage spending and encourage savings and
reduce credit given to the government and public sectors. These policies usually lead to a sharp increase in the real return to capital accompanied by a modest decrease in the share of labor as governments try not to increase unemployment rates drastically for social and political reasons.

So reform is expected to result in higher rates of capital accumulation and lower rates of employment, at least shortly after reform. Table 15 shows that the average unemployment rates and capital per head have increased after reform in a sample of selected reforming countries. So, the question of whether reform would lead to changes in the shares of labor and capital in GDP is worth investigating. Even though unemployment rates can increase shortly after reform, the income share of labor remains ambiguous as reform leads to increase in wages and GDP growth rates. In addition, the impact of reform on factor shares depends, to a great extent, on the degree of substitutability between capital and labor.

In this essay, we use a simple theoretical model and assume that factors of production are paid less than their marginal products before reform to derive a relation between unemployment, capital accumulation and the functional distribution of income. We also show that this relation depends on the size of the elasticity of substitution between capital and labor. To test this hypothesis, a random coefficient model to estimate the degree of substitutability between physical capital and labor is first specified and estimated. Second, we estimate a random coefficient model to examine the impact of unemployment and capital per head on factor shares after reform. Third, we use the estimates of the CES production function along with the
estimates of the factor share equations to compute estimates of the degree of
dispersion between the prices and marginal products of labor and capital. This would
give an idea about how labor and capital are underpaid pre reform and whether
reform removes the distortion in factor markets.

Table 15

Average Unemployment Rates and Capital per Head before and after Reform:
Selected Reforming Countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Average Unemployment</th>
<th>Average Capital Per Head</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 Years before Reform</td>
<td>5 Years after Reform</td>
</tr>
<tr>
<td>Argentina</td>
<td>3.9</td>
<td>9.6</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>1.8</td>
<td>2.1</td>
</tr>
<tr>
<td>Belize</td>
<td>2.5</td>
<td>8.9</td>
</tr>
<tr>
<td>Bolivia</td>
<td>3.9</td>
<td>5.8</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>1.3</td>
<td>16.2</td>
</tr>
<tr>
<td>Chile</td>
<td>8.1</td>
<td>8.4</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>7.6</td>
<td>6.7</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>3.3</td>
<td>15.4</td>
</tr>
<tr>
<td>Ecuador</td>
<td>2.4</td>
<td>7.7</td>
</tr>
<tr>
<td>Egypt</td>
<td>6.0</td>
<td>12.1</td>
</tr>
<tr>
<td>El Salvador</td>
<td>8.4</td>
<td>15.0</td>
</tr>
<tr>
<td>Mexico</td>
<td>3.1</td>
<td>9.7</td>
</tr>
<tr>
<td>Morocco</td>
<td>7.7</td>
<td>16.5</td>
</tr>
<tr>
<td>Panama</td>
<td>8.4</td>
<td>13.9</td>
</tr>
<tr>
<td>Peru</td>
<td>4.5</td>
<td>7.6</td>
</tr>
<tr>
<td>Philippines</td>
<td>5.2</td>
<td>8.2</td>
</tr>
<tr>
<td>Romania</td>
<td>3.3</td>
<td>7.1</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>5.4</td>
<td>12.1</td>
</tr>
<tr>
<td>Turkey</td>
<td>11.5</td>
<td>11.4</td>
</tr>
<tr>
<td>Uruguay</td>
<td>5.7</td>
<td>11.7</td>
</tr>
</tbody>
</table>

The essay contains five sections: (1) review of the literature on functional
distribution of income, (2) theoretical framework, (3) empirical specifications of the
random coefficient models to be estimated, (4) empirical results, and (5) conclusions.

Literature Review

Many case studies have been undertaken to evaluate the impact of reform and
structural adjustment programs on personal distribution of income (Gindling 2001,
Wang 2000, and Gustafsson and Shi 2001). However, there is no single study we are
aware of that has examined the impact of reform on the functional distribution of
income.

The literature on functional distribution of income goes back to the classical
work by Kaldor (1956), which explains the alternative theories of distribution, and
Ferguson and Pfouts (1962). The area of functional distribution of income was not of
much interest to economists during the period from mid-sixties to late eighties. Work
in this area has revived in the early nineties when some economists started to explain
the different channels by which factor shares can change. Factor share have been seen
to be influenced by fiscal policy (Bertola 1993), monetary shocks (Koray 1989),
changes in capital intensities (McCallum 1985 and Rowthorn 1999), and technology
(Yuhn 1991, Rowthorn 1999, and Leightner 1992). Others have examined the
relevance of elasticity of substitution to the relationship between economic growth
and factor shares (Rowthorn 1999 and Yuhn 1991). Very recently, the hypothesis of factor shares constancy was investigated (Collin 2002).

The current literature lacks studies on the impact of reform on factor shares. In addition, the literature does not provide estimates of the size of distortion when factor markets are not competitive and hence factors of production are not paid their marginal products. This essay discusses the implications of reform on factor shares by theoretically showing that factor shares depend on capital accumulation, unemployment, and the size of the distortion in factor markets. However, the impact of unemployment on factor shares depends on the size of the elasticity of substitution relative to unity. We also estimate this size of distortion in the factor market and show how it changes after reform.

Theoretical Background

Assume the following CES aggregate production function.

\[ Y_t = A \left[ \alpha L_t^{\sigma-1} + (1 - \alpha) K_t^{\sigma-1} \right]^{\frac{\sigma}{\sigma-1}}, \]

where \( Y_t \) is real GDP, \( L_t \) and \( K_t \) are labor and capital and \( \sigma \) is the elasticity of substitution between labor and capital. The marginal products of labor and capital can be given by the following two expressions respectively.

\[ \frac{\partial Y_t}{\partial L_t} = \alpha \left( \frac{Y_t}{L_t} \right)^{\frac{1}{\sigma}}, \]

\[ \frac{\partial Y_t}{\partial K_t} = (1 - \alpha) \left( \frac{Y_t}{K_t} \right)^{\frac{1}{\sigma-1}}. \]
Assume that factors of production are paid less than their marginal products before reform. This is meant to capture in a simple way a major economic inefficiency prior to reform. Policymakers almost always wanted higher employment of factors and to make that possible they kept factor prices below their marginal products. Also periods of hyperinflation led to a sharp decline in wages and interest rates in real term. In many developing countries for example real interest rates have been negative because of measures of financial repression, which kept nominal interest rates low, and or inflation rates high. This has led to bias against capital and in favor of labor. On the demand side, demand for labor and capital was high as their prices were low in nominal and real terms. On the supply side, labor supply kept the labor market in equilibrium as population growth rates remained high. However, supply of capital was very limited as its real return was almost negative. This has led to the phenomena of capital flight and currency substitution.

The real wages and interest rates can be expressed as follows.

\[
\frac{\partial Y_i}{\partial K_i} = (1 - \alpha)(\frac{Y_i}{K_i})^{\frac{1}{\sigma}}. \tag{39}
\]

\[
\text{Assume that factors of production are paid less than their marginal products before reform. This is meant to capture in a simple way a major economic inefficiency prior to reform. Policymakers almost always wanted higher employment of factors and to make that possible they kept factor prices below their marginal products. Also periods of hyperinflation led to a sharp decline in wages and interest rates in real term. In many developing countries for example real interest rates have been negative because of measures of financial repression, which kept nominal interest rates low, and or inflation rates high. This has led to bias against capital and in favor of labor. On the demand side, demand for labor and capital was high as their prices were low in nominal and real terms. On the supply side, labor supply kept the labor market in equilibrium as population growth rates remained high. However, supply of capital was very limited as its real return was almost negative. This has led to the phenomena of capital flight and currency substitution.}

The real wages and interest rates can be expressed as follows.

\[
W_i = \alpha(1 - z_1)(\frac{Y_i}{L_i})^{\frac{1}{\sigma}}, \tag{40}
\]

\[
R_i = (1 - \alpha)(1 - z_2)(\frac{Y_i}{K_i})^{\frac{1}{\sigma}}, \tag{41}
\]
where \( z_i > 0, i = 1, 2 \), denotes the deviation between factor prices and marginal products and represent the economic inefficiency. It follows that the factor shares of labor and capital, \( S_t^L \) and \( S_t^K \) respectively, can be expressed as follows.

\[
(42) \quad S_t^L = \frac{W_t L_t}{Y_t} = \alpha (1 - z_1) \left( \frac{Y_t}{L_t} \right)^{\frac{1}{\sigma - 1}},
\]

\[
(43) \quad S_t^K = \frac{R_t K_t}{Y_t} = (1 - \alpha) (1 - z_2) \left( \frac{Y_t}{K_t} \right)^{\frac{1}{\sigma - 1}}.
\]

It can be shown that \( \frac{Y_t}{L_t} \) can be expressed as follows.

\[
(44) \quad \frac{Y_t}{L_t} = A \left[ \alpha + (1 - \alpha) \left( \frac{K_t}{L_t} \right)^{\frac{\sigma - 1}{\sigma}} \right]^{\sigma - 1}.
\]

Let \( k_t = \frac{K_t}{N_t} \) be the capital per head and \( u_t = 1 - \frac{L_t}{N_t} \) be the rate of unemployment, where \( N_t \) is the total labor force\(^{36} \), and therefore \( \frac{K_t}{L_t} \) can be written as follows.

\[
(45) \quad \frac{K_t}{L_t} \equiv \frac{K_t}{N_t} \frac{N_t}{L_t} = \frac{k_t}{1 - u_t}.
\]

If we plug (45) in (44), the following expression emerges.

\[
(46) \quad \frac{Y_t}{L_t} = A \left[ \alpha + (1 - \alpha) \left( \frac{k_t}{1 - u_t} \right)^{\frac{\sigma - 1}{\sigma}} \right]^{\sigma - 1}.
\]

By substituting (46) in (42), we obtain the following expression for the income share of labor.
Similarly, it can be shown that \( \frac{Y_t}{K_t} \) can be expressed as follows.

\[
(48) \quad \frac{Y_t}{K_t} = A[(1 - \alpha) + \alpha(\frac{1 - u_t}{k_t})^{\frac{1}{\sigma}}]^{\frac{\sigma}{\sigma - 1}}.
\]

By substituting (48) in (43), we obtain the following expression for the income share of capital.

\[
(49) \quad S_t^K = (1 - \alpha)(1 - z_t)A^{\frac{1 - \sigma}{\sigma}}[(1 - \alpha) + \alpha(\frac{1 - u_t}{k_t})^{\frac{1}{\sigma}}]^{\frac{\sigma}{\sigma - 1}}.
\]

Equations (47) and (49) are the basic expressions that we use to examine the implications of reform on factor shares. In principle, reform has always been seen as a set of policies that, among other things, increases unemployment, increases capital accumulation, and gets rid of all features of economic inefficiency in the reforming economy. To restore efficiency, factors of production have to be paid their marginal products after reform. So it is important to sign three partial derivatives of equations (47) and (49) with respect to \( z_t > 0, i = 1, 2, k_t \), and \( u_t \) in order to evaluate the impact of reform on the factor shares.\(^{27}\) It turns out that the impact of unemployment and capital accumulation on the functional distribution of income is ambiguous and depends solely on the size of the elasticity of substitution between capital and labor, \( \sigma \). When the value of the elasticity of substitution between labor and capital is greater
than unity, we have $\frac{\partial S^L_i}{\partial u_i} < 0$; $\frac{\partial S^L_i}{\partial k_i} < 0$; $\frac{\partial S^K_i}{\partial u_i} > 0$; $\frac{\partial S^K_i}{\partial k_i} > 0$. When the elasticity of substitution between labor and capital is less than unity, we find that $\frac{\partial S^L_i}{\partial u_i} > 0$; $\frac{\partial S^L_i}{\partial k_i} > 0$; $\frac{\partial S^K_i}{\partial u_i} < 0$; $\frac{\partial S^K_i}{\partial k_i} < 0$. However the partial derivatives with respect to $z_1$ and $z_2$ do not depend upon the size of $\sigma$, where $\frac{\partial S^L_i}{\partial z_1} < 0$, $\frac{\partial S^K_i}{\partial z_2} < 0$ are always true.

The signs of the partial derivatives imply that reform can increase capital's share and reduce labor's share only when the degree of substitution between labor and capital is high. That is higher rates of capital accumulation replaces laid off labor and, therefore, helps capital to gain higher share in GDP. On the other hand, reform can increase labor's share when there is less than unity degree of substitutability between labor and capital. We find that reform affects shares in two ways: by (1) lowering $z_1$ and $z_2$ and (2) reducing $\sigma$, though $\sigma$ stays just close unity. The second possibility seems more intuitive for two reasons. First, governments of reforming countries try to avoid social and political instability by keeping unemployment at socially acceptable rates. Second, if female labor participation increases after reform as it becomes complementary to capital, the elasticity of substitution between capital and total labor force is likely to decrease after reform.
Empirical Specifications

In estimating panel data models, most studies pool data from different countries, a procedure that assumes the homogeneity of all countries in the sample. This assumption is not very realistic in a sense that the underlying structure of the dependent variables differs from one country to another. A number of studies including Hildreth and Houck (1968), Swamy (1970, 1971, 1974), Feige and Swamy (1974), Hsiao (1975), Iscan (1997), and Pesaran and Smith (1995) have suggested the use of parameter heterogeneity in estimating panel data models. Following the above-mentioned studies, we assume that the data are generated so that the coefficients are constant over time but vary randomly across countries, and that the distribution of the coefficients is independent of the regressors. Assume the following CES aggregate production function.

\[
(50) \quad Y_t = A \left[ \alpha L_t^{\sigma-1} + (1 - \alpha) K_t^{\sigma-1} \right]^{\frac{\sigma}{\sigma-1}},
\]

where \( Y_t \) is real GDP, \( L_t \) and \( K_t \) are labor and capital and \( \sigma \) is the elasticity of substitution between labor and capital. Because the specified production function is nonlinear in the parameters, we follow Artus (1984) by adopting the following linear transformation.

\[
(51) \quad \ln Y_t = \ln A + \alpha \ln L_t + (1 - \alpha) \ln K_t - \frac{1}{2} \alpha(1 - \alpha) \left( \frac{1 - \sigma}{\sigma} \right) (\ln K_t - \ln L_t)^2.
\]
Because labor and capital are paid less than their marginal products before reform, their income shares can be expressed as follows\(^2\).

\[
(52) \quad S_{i,L} \equiv (1-z_i) \frac{\partial \ln Y_i}{\partial \ln L_i} = (1-z_i)[\alpha - \alpha(1-\alpha)(\frac{1-\sigma}{\sigma})\ln\left(\frac{K_i}{L_i}\right)],
\]

\[
(53) \quad S_{i,K} \equiv (1-z_i) \frac{\partial \ln Y_i}{\partial \ln K_i} = (1-z_i)[(1-\alpha) - \alpha(1-\alpha)(\frac{1-\sigma}{\sigma})\ln\left(\frac{K_i}{L_i}\right)].
\]

Recall that \(u_i = 1 - \frac{L_i}{N_i}\) and therefore

\[
L_i = N_i(1-u_i),
\]

\[
(54) \quad \ln\left(\frac{K_i}{L_i}\right) = \ln\left(\frac{K_i}{N_i(1-u_i)}\right) = \ln\left(\frac{k_i}{1-u_i}\right).
\]

By plugging equation (54) in (52) and (53), the following two equations emerge.

\[
(55) \quad S_{i,K} = \alpha(1-z_i) - \alpha(1-\alpha)(1-z_i)(\frac{1-\sigma}{\sigma})\ln k_i + \alpha(1-\alpha)(1-z_i)(\frac{1-\sigma}{\sigma})\ln(1-u_i),
\]

\[
(56) \quad S_{i,K} = (1-\alpha)(1-z_i) - \alpha(1-\alpha)(1-z_i)(\frac{1-\sigma}{\sigma})\ln k_i + \alpha(1-\alpha)(1-z_i)(\frac{1-\sigma}{\sigma})\ln(1-u_i).
\]

Our estimation strategy is to first estimate the following heterogeneous empirical version of equation (51) in order to estimate the elasticity of substitution, \(\sigma\), between labor and capital.
\( y_{it} = a_i + \beta_i' x_{it} + \delta_i' (d_{it} \cdot x_{it}) + \varepsilon_{it}. \)

where 

\( i = 1, 2, \ldots, 32, \quad t = 1960, 1961, \ldots, 1999, \)

and 

\( d_{it} \) is a dummy variable that takes two values as follows.

\[
d_{it} = \begin{cases} 
0 & \text{for all years before country } i \text{ undertakes reform} \\
1 & \text{for all years after country } i \text{ undertakes reform.} 
\end{cases}
\]

The coefficients \( a_i, \beta_j', \) and \( \delta_j', \) where \( j = 1, 2, 3, \) vary across countries according to the following random coefficient model

\begin{align*}
(58) \quad a_i &= a + \eta_{0i}, \\
\beta_j &= \beta_j + \eta_{ji}, \\
\delta_j &= \delta_j + \nu_{ji}, \quad j = 1, 2, 3,
\end{align*}

where \( \eta_{0i}, \eta_{ji}, \) and \( \nu_{ji} \) are assumed to have zero means and constant covariances.

After estimating equation (57), we estimate the following heterogeneous empirical versions of equations (55) and (56) to investigate the impact of reform on the income shares of labor and capital.

\begin{align*}
(59) \quad S_{il}^L &= b_i + \gamma_i' w_{it} + \delta_i d_{it} + \delta_i' (d_{it} \cdot w_{it}) + \xi_{il}, \\
(60) \quad S_{ik}^K &= c_i + \phi_i' w_{it} + \delta_i d_{it} + \lambda_i' (d_{it} \cdot w_{it}) + \epsilon_{ik}.
\end{align*}
\( i = 1, 2, \ldots, 32, \ t = 1980, 1981, \ldots, 1999, \) where \( \gamma'_i = (\gamma_{u_i}, \gamma_{2i}), \ \vartheta'_i = (\vartheta_{u_i}, \vartheta_{2i}), \ 
abla' = (\lambda_{u_i}, \lambda_{2i}), \ w_{it} \) is a vector that includes the logarithm of \( k_{it} \) and \( u_{it}, \ 
abla^L_t \) and \( \nabla^K_t \) are the factor shares of labor and capital respectively, and \( d_{it} \) is a dummy variable that takes two values as specified before. Again, the coefficients \( b_i, c_i, \gamma_{ji}, \vartheta_{ji}, \phi_{ji}, \) and \( \lambda_{ji}, \) where \( j = 1, 2, \) vary across countries according to the following random coefficient model

\[
\begin{align*}
\beta_j &= \beta + \mu_j, \\
c_j &= c + \psi_j, \\
\delta_{ji} &= \delta_j + \tau_{ji}, \\
\gamma_{ji} &= \gamma_j + \omega_{ji}, \\
\theta_{ji} &= \theta_j + \zeta_{ji}, \\
\phi_{ji} &= \phi_j + \pi_{ji}, \\
\lambda_{ji} &= \lambda_j + \eta_{ji}, \\
\mu_j, \psi_j, \tau_{ji}, \omega_{ji}, \pi_{ji}, \eta_{ji}, \text{ and } \zeta_{ji} \text{ are assumed to have zero means and constant covariances.}
\end{align*}
\]

Equations (57), (59), and (60) are estimated by pooling a set of 32 developing countries, 12 of which never undertook reform programs. Under the assumptions given by (58) and (61), equations (57), (59), and (60) can be estimated using two methods. We can estimate separate regression for each country using OLS and then average the obtained estimates. According to equation (57), the mean responses of GDP to changes in the factors of production are \( \bar{\beta}_j \) before reform and \( \bar{\beta}_j + \bar{\delta}_j \) after reform, where \( \bar{\beta}_j = \frac{\sum_{i=1}^{N} \beta_{ji}}{N} \) and \( \bar{\delta}_j = \frac{\sum_{i=1}^{N} \delta_{ji}}{N}. \) By the same token, the mean responses of labor's share to changes in capital per head and unemployment rates respectively are \( \bar{\gamma}_j \) before reform and \( \bar{\gamma}_j + \bar{\delta}_j \) after reform, whereas the mean responses of
capital's share to changes in capital per head and unemployment rates respectively are \( \bar{\phi}_j \) before reform and \( \bar{\phi}_j + \bar{\lambda}_j \) after reform, where

\[
\bar{\gamma}_j = \frac{\sum_{i=1}^{N} \gamma_{ji}}{N}, \quad \bar{\theta}_j = \frac{\sum_{i=1}^{N} \theta_{ji}}{N}, \quad \bar{\phi}_j = \frac{\sum_{i=1}^{N} \phi_{ji}}{N}, \quad \bar{\lambda}_j = \frac{\sum_{i=1}^{N} \lambda_{ji}}{N},
\]

and standard errors are computed by taking the square roots of the average variances of parameter estimates. This procedure is the unweighted regression which assumes parameter interdependence across countries. We can also use the Generalized Least Squares (GLS) weighted average proposed by Swamy (1971) to estimate equations (57), (59), and (60). Both methods will give us consistent estimates of the parameters (Pesaran and Smith 1995).

By comparing equations (59) and (60) to equations (55) and (56), we can also get estimates for \( z_1 \) and \( z_2 \) pre and post reform. This would give an idea about the size of distortion in factor markets by measuring the difference between what labor and capital are paid and what their marginal products are. As assumed in the theoretical model, labor and capital are paid less than marginal products by proportions \( z_1 \) and \( z_2 \) respectively. By using the estimates of \( \alpha \) and \( 1-\alpha \) from equation (57) along with the estimates of the intercepts and the dummy variable coefficients from equations (59) and (60), we can compute estimates of the degree of variation between the prices and marginal products of labor (\( z_1 \)) and capital (\( z_2 \)).
Empirical Results

Table 16 reports the alternative estimates of the parameters in equation (57). We estimate the equation using weighted GLS regression and unweighted regression by running individual OLS regression for each country in the sample and taking the arithmetic average of the parameter estimates.\(^{29}\) As the homogeneity test indicates, we fail to accept parameter homogeneity since the value of \(\chi^2\) is significant at any conventional level of significance. All the parameter estimates, using weighted or unweighted regression, are significant at conventional levels of significance.

### Table 16

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>Weighted Regression</th>
<th>Unweighted Regression</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Standard Error</td>
</tr>
<tr>
<td>(\ln L_{it})</td>
<td>0.937***</td>
<td>0.048</td>
</tr>
<tr>
<td>(\ln K_{it})</td>
<td>0.073*</td>
<td>0.045</td>
</tr>
<tr>
<td>((\ln K_{it} - \ln L_{it})^2)</td>
<td>0.025***</td>
<td>0.004</td>
</tr>
<tr>
<td>(d_{it} * L_{it})</td>
<td>0.124***</td>
<td>0.032</td>
</tr>
<tr>
<td>(d_{it} * K_{it})</td>
<td>0.945***</td>
<td>0.028</td>
</tr>
<tr>
<td>(d_{it} * (\ln K_{it} - \ln L_{it})^2)</td>
<td>0.008***</td>
<td>0.003</td>
</tr>
<tr>
<td>(\chi^2) (Homogeneity Test)</td>
<td>345.92***</td>
<td>--</td>
</tr>
</tbody>
</table>

Note: *** statistically significant at \(P \leq 0.01\) level; ** statistically significant at \(P \leq 0.05\) level; * statistically significant at \(P \leq 0.1\) level.
Table (17), which reports the estimates of the mean elasticity of substitution between labor and capital, $\sigma$, across the distribution of countries is based on estimates reported in Table (16). Depending on the estimation method, the mean elasticity of substitution varies from 1.78 to 3.38 in the pre reform period and in the non-reforming countries. The value of the elasticity of substitution decreases significantly during the reform period to 1.03 using weighted regression and 1.14 using unweighted regression. Nonetheless, the results in Table 17 show that regardless of the method of estimation, the elasticity of substitution between capital and labor is greater than one. This result, to some extent, supports our finding in part IV that capital and female labor become more complementary after reform. That is physical capital can do a good job replacing physical labor provided mostly by men but can not easily substitute mental labor provided mostly by women. It was concluded that female labor participation has increased after reform in response to the existence of a new type of capital after reform. In the meantime, reform has been accused for the increase in unemployment rates of males in many developing countries. So if there is complementarity between female labor and capital, one would expect the elasticity of substitution between capital and total labor force to decrease as a result of reform.

Tables 18-20 contain the main results of the essay. Table 18 reports the estimates for equation (59) while Table 19 reports the estimates for equation (60). In both tables, income shares do not seem to depend on either unemployment rate or capital per head pre reform.
Table 17

Implied Values of the Mean Elasticity of Substitution between Capital and Labor (σ)

<table>
<thead>
<tr>
<th></th>
<th>Weighted Regression</th>
<th>Unweighted Regression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre Reform</td>
<td>3.38</td>
<td>1.78</td>
</tr>
<tr>
<td>Post Reform</td>
<td>1.03</td>
<td>1.14</td>
</tr>
</tbody>
</table>

This implies that the income shares of labor and capital are constant before reform as the CONSTANT term is always significant in both equations regardless of the estimation method used. However, factor shares are not constant in the post reform period as the coefficient on capital per head is statistically significant at 1% in the case of labor’s share, $S_{it}^L$, equation and 10% in the case of capital’s share, $S_{it}^K$, equation. This indicates that unemployment has no significance influence on factor shares pre or post reform whereas the accumulation of capital per head reduces the labor’s share and raises the capital’s share in the post reform period. Table 18 shows that, after reform, the labor’s share of GDP is expected to decrease by 0.3% in the case of weighted regression and 0.54% in the case of unweighted regression when capital per head increases by 100 dollars. Table 19 indicates that the capital’s share of GDP is expected to increase by 8.8% in the case of weighted regression and 15.2% in the case of unweighted regression when capital per head increases by 100 dollars. This result supports the theoretical prediction that capital accumulation can increase capital’s share and decrease labor’s share when the value of the elasticity of substitution is greater than one. The result also shows that capital accumulation has a
more dramatic impact on capital’s share than on labor’s share. This is tied to our result that the degree of substitutability between capital and labor decreases in the post reform period so that the decrease in labor’s share is not as large as the increase in capital’s share. In addition, the coefficient on the dummy variable is always significant at 10% level in both equations. Table 18 shows that there is a one-time upward shift in the intercept of equation (69) by 0.394 in the case of the weighted regression and 0.595 in the case of the unweighted regression.

Table 18
Estimates of the Labor’s Share Equation

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>Weighted Regression</th>
<th>Unweighted Regression</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Standard Error</td>
</tr>
<tr>
<td>$k_{lt}$</td>
<td>0.002</td>
<td>0.007</td>
</tr>
<tr>
<td>$u_{lt}$</td>
<td>0.182</td>
<td>0.555</td>
</tr>
<tr>
<td>$d_{lt}$</td>
<td>0.394***</td>
<td>0.059</td>
</tr>
<tr>
<td>$d_{it}*k_{lt}$</td>
<td>-0.003***</td>
<td>0.001</td>
</tr>
<tr>
<td>$d_{it}*u_{lt}$</td>
<td>-0.179</td>
<td>0.827</td>
</tr>
<tr>
<td>CONSTANT</td>
<td>0.429**</td>
<td>0.215</td>
</tr>
<tr>
<td>$\chi^2$ (Homogeneity Test)</td>
<td>762.99***</td>
<td>--</td>
</tr>
</tbody>
</table>

Note: *** statistically significant at $P \leq 0.01$ level; ** statistically significant at $P \leq 0.05$ level; * statistically significant at $P \leq 0.1$ level.
There is also a one-time upward shift in the intercept of equation (60) by 0.695 in the case of the weighted regression and 0.499 in the case of the unweighted regression as shown in Table 19.

Table 19
Estimates of the Capital’s Share Equation

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>Weighted Regression</th>
<th></th>
<th>Unweighted Regression</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Standard Error</td>
<td>Coefficient</td>
<td>Standard Error</td>
</tr>
<tr>
<td>$k_{it}$</td>
<td>0.018</td>
<td>0.078</td>
<td>-0.029</td>
<td>0.068</td>
</tr>
<tr>
<td>$u_{it}$</td>
<td>0.287</td>
<td>0.979</td>
<td>0.233</td>
<td>0.319</td>
</tr>
<tr>
<td>$d_{it}$</td>
<td>0.695***</td>
<td>0.013</td>
<td>0.499***</td>
<td>0.018</td>
</tr>
<tr>
<td>$d_{it}^*k_{it}$</td>
<td>0.088*</td>
<td>0.055</td>
<td>0.152*</td>
<td>0.084</td>
</tr>
<tr>
<td>$d_{it}^*u_{it}$</td>
<td>0.353</td>
<td>0.695</td>
<td>-0.399</td>
<td>0.288</td>
</tr>
<tr>
<td>CONSTANT</td>
<td>0.416**</td>
<td>0.205</td>
<td>0.691***</td>
<td>0.046</td>
</tr>
<tr>
<td>$\chi^2$ (Homogeneity Test)</td>
<td>743.94</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Note: *** statistically significant at $P \leq 0.01$ level; ** statistically significant at $P \leq 0.05$ level; * statistically significant at $P \leq 0.1$ level.

Table 20 reports interesting results about how factors of production are underpaid before reform. By using the estimates of $\alpha$ and $1-\alpha$ from Table 16 along with the estimates of the intercepts and the dummy variable coefficients from Tables 18 and 19, we are able to compute estimates of the difference between the prices and marginal products of labor and capital. As was assumed in the theoretical model,
labor and capital are paid less than marginal products by \( z_1 \) and \( z_2 \) respectively. This denotes factor market imperfections and the periods of hyperinflation which led to a sharp decline in wages and interest rates in real term. In many developing countries for example real interest rates have been negative because of measures of financial repression, which kept nominal interest rates low, and or inflation rates high.

According to Table 20, \( z_1 \) takes the value 0.54-0.69 before reform and 0.22-0.18 after reform, depending on the estimation method. This implies that labor is paid only between 31% and 46% of its marginal product pre reform and between 78% and 82% post reform. On the other hand, \( z_2 \) takes the value 0.864-4.7 before reform and 0.091-0.184 after reform, depending on the estimation method used. This implies that capital is paid only between -370% and 14% of its marginal product pre reform and between 82% and 91% post reform. This shows how labor and capital are highly underpaid before reform and how reform increases the returns to factors of production and reduces the distortion in these markets.

Table 20

<table>
<thead>
<tr>
<th></th>
<th>( z_1 )</th>
<th>( z_2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weighted Regression</td>
<td>Unweighted Regression</td>
</tr>
<tr>
<td>Pre Reform</td>
<td>0.542</td>
<td>0.689</td>
</tr>
<tr>
<td>Post Reform</td>
<td>0.223</td>
<td>0.178</td>
</tr>
</tbody>
</table>
To sum up, reform has distributional implications by increasing the income share of labor and capital by lowering $z_1$ and $z_2$ and lowering $\sigma$. With lower $\sigma$ after reform, the increase in capital per head is expected to raise the capital’s share relative to the labor’s share.

Conclusion

The purpose of this essay is to examine the distributional impact of reform on labor and capital in reforming countries. Using a simple theoretical model and assuming that factors of production are paid less than their marginal products pre-reform, we show that the impact of unemployment and capital accumulation on the functional distribution of income is ambiguous and depends solely on the size of the elasticity of substitution between capital and labor. To test this empirically, a random coefficient model to estimate the substitutability between physical capital and labor was specified and estimated. This model proved to be appropriate as the hypothesis that coefficients are fixed across countries was rejected. As the results indicate, the estimate of the elasticity of substitution is greater than one but decreases after reform. This result, to some extent, supports our finding in the second essay that capital and female labor become more complementary after reform. More importantly, we estimate two equations for the income shares of labor and capital. The results show that income shares do not depend on either unemployment rate or capital per head pre-reform. This implies that the income shares of labor and capital are constant before reform. However, reform itself has a sizable positive impact on factor shares. Also,
factor shares are not constant in the post reform period as increases in capital per head reduces the labor’s share and raises capital’s share in the post reform period. It was also concluded that labor is paid only between 31% and 46% of its marginal product pre reform and between 78% and 82% post reform. On the other hand, capital is paid between -370% and 14% of its marginal product pre reform and between 82% and 91% post reform. This shows how labor and capital are highly underpaid before reform and how reform increases the returns to factors of production and reduces the distorsion in factor markets. The increase in factor shares after is primarily generated by lowering the inefficiency proportions in factor markets and also by a falling elasticity of substitution between factors of production.
PART VI

SUMMARY AND CONCLUSIONS

Using theoretical frameworks along with econometric analyses, the three essays in this dissertation examine the impact of reform on human development, fertility, and functional income distribution. The first essay examines the long-run impact of economic reform and structural adjustment programs on different measures of human development and income using panel data for 40 countries. Three questions are addressed in this essay: (1) what is the long-run impact of reform on GDP per capita? (2) What is the long-run impact of reform on human development? (3) What is the long-run impact of reform on human development and income when countries’ initial macroeconomic conditions are incorporated? In answering the first question, we find evidence that economic reform programs have long-run positive impact on GDP per capita. This result suggests that there is another channel through which reform affects human development. The result also confirms the implications of our theoretical framework. In answering the second question, the results indicate that reform programs have long-run positive impact on human development measures. We also find that GDP per capita is very crucial to improvement in human development. This result is different from previous studies that de-emphasized the role of GDP per capita in improving human development. In answering the third question, we find that initial debt-GDP ratio and initial GDP growth have negative impact on human development measures and GDP per capita.
The purpose of the second essay is to examine the impact of the economic reform programs on fertility in reforming countries. We argue that reform can reduce fertility by making capital more complementary to female labor, raising women’s relative wage, and hence raising the opportunity cost of child-rearing. Without the increase in complementarity between capital and female labor, women’s wage stays low and the economy converges to a lower steady state equilibrium where capital and output per head are low, female labor participation is low and fertility is high. To test this empirically, a random coefficient regression model to estimate the complementarity between physical capital and female labor in samples of reforming and non-reforming countries was specified and estimated. This model proved to be appropriate as the hypothesis that coefficients are fixed across countries was rejected. As the results indicate, the estimate of the complementarity parameter is positive in the case of non-reforming countries while negative in the case of reforming countries and is even more so after adopting reform program. We then test for the impact of capital per head on fertility. To do this, we estimate a dynamic heterogeneous model by using weighted and unweighted regressions. The results show that capital per head has a significant negative impact on fertility after reform regardless of the estimation method used. This result is consistent with the predictions of the theoretical model.

The purpose of the third essay is to examine the distributional impact of reform on labor and capital in reforming countries. Using a simple theoretical model, we assume that factors of production are paid less than their marginal products before reform, suggesting inefficiency in factor markets. We show that the impact of
unemployment and capital accumulation on the functional distribution of income is ambiguous and depends solely on the size of the elasticity of substitution between capital and labor. To test this empirically, a random coefficient model to estimate the substitutability between physical capital and labor was specified and estimated. This model proved to be appropriate as the hypothesis that coefficients are fixed across countries was rejected. As the results show, the estimate of the elasticity of substitution is greater than one but decreases after reform. This result, to some extent, supports our finding in the first essay that capital and female labor are more complementary after reform. More importantly, we estimate two equations for the income shares of labor and capital. The results show that income shares do not depend on either unemployment rate or capital per head before reform. This implies that the income shares of labor and capital are constant before reform.

With lower elasticity of substitution after reform, the increase in capital per head is expected to raise the capital's share relative to the labor's share. However, reform has a positive impact on the shares of both factors. It was also concluded that labor and capital are highly underpaid in terms of their marginal products before reform and that reform removes this distortion in factor markets. The results show that labor is paid only between 31% and 46% of its marginal product pre reform and between 78% and 82% post reform. On the other hand, capital is paid between -370% and 14% of its marginal product pre reform and between 82% and 91% post reform. This shows how labor and capital are severely underpaid in terms of their marginal products before reform and how reform removes this distortion in factor markets.
Nonetheless, one should be careful when interpreting the empirical results in this study. First, even though reform seems to impact human development positively, it has only a level effect not a long-run growth effect. Regression results in the first essay indicate that the median lag is short so that half the impact of reform on human development is felt in the first 10 years, on average, following reform. Also, if we look at the long-run responses of human development measures to reform, we find that, depending on the dependent variable, these responses are usually modest in terms of their magnitude. The same observation is valid in the second essay where it was concluded that reform reduces fertility by affecting the women's opportunity cost of having children. If we look at the long-run impact of reform on fertility, we find that reform, through the increase in the accumulation of capital, can reduce the growth rate of the young non-working population by only 3%. Although reform seems to have a significant negative impact on fertility, it does not have a sizable impact especially if we know that a $1000 increase in physical capital per head would lead to a decrease in fertility by only 3% in the long-run. In addition income per head seems to have a larger impact on fertility since a $100 increase in per capita income reduces fertility by 6.3% in the long-run.

Second, we also should be aware of the data limitations in this study. Most of the data used in the three essays are macro-level data. Ideally, micro-level data would be more appropriate to use especially in the second essay where we study the impact of the accumulation of capital per head, brought by reform, on fertility rates in reforming countries. We have used the level of capital per head instead of sector-
specific capital per head. However, it would be more interesting to test directly the impact of capital per head in women-attracting sectors (e.g. insurance, banking, and telecommunications) on fertility. But we also realize the fact that this kind of data is hard to find for the samples of developing countries we have. The only way we can directly test the impact of capital per head in women-attracting sectors on fertility is by conducting a case study where data for individual countries can be found more easily. Third, the issue of data quality and availability is worth acknowledging especially when interpreting some of the results in the third essay. We have concluded, based on the empirical results, that labor and capital are severely underpaid in terms of their marginal products before reform and that reform removes this distortion in factor markets by raising the real returns to factors of production and consequently raising their shares in GDP. Nonetheless, the magnitude of the wedge between the marginal product of capital and its real return seems to be overestimated. In principle, the wedge between the marginal product of the factor and its real return should be between zero and 1 and decreasing after reform as the theoretical model predicts. This was validated by our empirical results. However, we believe that the overestimated size of the wedge between the marginal product of capital and its real return, using weighted regression, was due to the quality of data we used in this essay since we spliced data on factor shares from different sources.
ENDNOTES

1 This includes canceling quantitative restrictions on imports, canceling tariffs, and eliminating exchange controls.

2 Although conditionality has traditionally been applied to macroeconomic and institutional policies, it has been applied to environmental, political, and human rights recently.

3 See appendix A for more details about the IMF different facilities.

4 In academic and policy discussions on the role of government intervention, Sri Lanka has become a test case because of the country's very impressive record in health and education.

5 For more details about how these expressions are derived, see Pindyck and Rubinfeld, 1991, p. 205.

6 Calculated for significant coefficients only.

7 According to the UNDP, human development can also be augmented by political freedom, human rights, and personal self-respect.

8 Before 1995, mean-years of schooling was used instead of the combined enrollment ratios.

9 For more details about how these composite indexes are computed, see Appendix B.

10 For more details about the drawbacks of GDP per capita as a measure of economic development, see Meier (2000).

11 For more details on how the PQLI is calculated, see Appendix B.

12 For more details on how the HDI is calculated, see Appendix B.

13 This accounts for the diminishing returns to GDP.

14 Since IMR is a part of PQLI.

15 The calculated median lag for LR seems puzzling here since it is very large in magnitude. This can be explained by the fact that the coefficient on the lagged LR is almost one which suggests the non-stationarity nature of the data on LR.
The responses are calculated only for coefficients found significant in Table 4.

These are calculated as averages over the five-year period before initiating the reform program.

The responses are calculated for only coefficients found significant in Table 6.

Calculated for significant coefficients only.

This can include investments in banking, insurance, and telecommunication sectors which usually increase after reform. These kinds of investment tend to absorb more female employment.

An alternative specification of this production function is to assume the existence of two types of capital, one is complementary to female labor and the other is complementary to men's labor. In this case, we assume that output is produced using two kinds of capital, $K_{1f}$, which is complementary to female labor, $(F_f)$ and $K_{2m}$, which is complementary to men's labor $(L_m)$ as follows.

$$Y_t = A_1{\delta}_1 K_{1f}^{\rho_1} + (1-\delta_1) F_{f}^{\rho_1} + A_2{\delta}_2 K_{2m}^{\rho_2} + (1-\delta_2) L_{m}^{\rho_2}.$$

See Kremer and Chen (2000) for example.

We rule out the possibility that this fraction is greater than one since we are applying this model to a sample of developing countries in which men rarely get involved in child-rearing activities.

The utility maximization problem can be solved by substituting the expression for $S_t$ from the second part of the budget constraint into the equation for $c_t$, and then plugging the whole expression into the utility function and differentiating with respect to $n_t$.

We compute the long-run response of fertility to capital per head and per capita income only as the average of the short-run coefficients.

According to the World Development Indicators (WDI), total labor force comprises people who meet the International Labor Organization definition of the economically active population: all people who supply labor for the production of goods and services during a specified period. It includes both the employed and the unemployed.

See Appendix C.
Note that when \( \sigma = 1 \), which is the case of Cobb-Douglas production function, the income shares of labor and capital become \((1 - z_1)\alpha\) and \((1 - z_2)(1 - \alpha)\) respectively.

Standards errors were computed by taking the square roots of the average variances of parameter estimates. This procedure assumes parameter interdependence across countries.
Appendix A

How the IMF Lends
The IMF lends to member countries that have temporary balance of payments problems. The reserve assets that the member borrows from the IMF are usually deposited in its central bank, and are freely available for use by the member country in the same manner as all other international reserves. A main function of the IMF is to provide loans to countries experiencing balance-of-payments problems so that they can restore conditions for sustainable economic growth. The financial assistance provided by the IMF enables countries to rebuild their international reserves, stabilize their currencies, and continue paying for imports without having to impose trade restrictions or capital controls. Unlike development banks, the IMF does not lend for specific projects.

The process of IMF lending

IMF loans are usually provided under an "arrangement", which stipulates the conditions the country must meet in order to gain access to the loan. All arrangements must be approved by the Executive Board, whose 24 directors represent the IMF's 183 member countries. Arrangements are based on economic programs formulated by countries in consultation with the IMF, and presented to the Executive Board in a "letter of intent". Loans are then released in phased installments as the program is carried out.
The changing nature of IMF lending

The volume of loans provided by the IMF has fluctuated significantly over time. The oil shock of the 1970s and the debt crisis of the 1980s were both followed by sharp increases in IMF lending. In the 1990s, the transition process in Central and Eastern Europe and the crises in emerging market economies led to another surge in the demand for IMF resources.

Concessional and non-concessional lending

Over the years, the IMF has developed a number of loan instruments, or "facilities", that are tailored to address the specific circumstances of its diverse membership. Low-income countries may borrow at a concessional interest rate through the Poverty Reduction and Growth Facility (PRGF). Non-concessional loans are provided through five main facilities: (1) Stand-By Arrangements (SBA), (2) the Extended Fund Facility (EFF), (3) the Supplemental Reserve Facility (SRF), (4) the Contingent Credit Lines (CCL), and (5) the Compensatory Financing Facility (CFF). Except for the PRGF, all facilities are subject to the IMF's market-related interest rate, known as the "rate of charge", and some carry an interest rate premium, a "surcharge". The rate of charge is based on the SDR interest rate, which is revised weekly to take account of changes in short-term interest rates in the major international money markets.
IMF Facilities

1. Stand-By Arrangements (SBA): The SBA is designed to address short-term balance-of-payments problems and is the most widely used facility of the IMF. The length of a SBA is typically 12-18 months. Repayment must take place within a maximum of 5 years, but countries are expected to repay within 2-4 years.

2. Extended Fund Facility (EFF): This facility was established in 1974 to help countries address more protracted balance-of-payments problems with roots in the structure of the economy. Arrangements under the EFF are thus longer (3 years) and the repayment period can extend to 10 years, although repayment is expected within 4½ -7 years.

3. Supplemental Reserve Facility (SRF): The SRF was introduced in 1997 to meet a need for very short-term financing on a large scale. The sudden loss of market confidence experienced by emerging market economies in the 1990s led to massive outflows of capital, which required loans on a much larger scale than anything the IMF had previously been asked to provide. Countries must repay the loan after a maximum of 2.5 years, but are expected to repay one year earlier. All SRF loans carry a substantial surcharge of 3-5 percentage points.

4. Contingent Credit Line (CCL): The CCL differs from other IMF facilities in that it aims to help members prevent crises. Established in 1997, it is designed for countries implementing sound economic policies, which may find themselves threatened by a
crisis elsewhere in the world economy—a phenomenon known as "financial contagion". The CCL is subject to the same repayment conditions as the SRF, but carries a smaller surcharge.

5. *Compensatory Financing Facility (CFF):* The CFF was established in the 1960s to assist countries experiencing either a sudden shortfall in export earnings or an increase in the cost of food imports caused by fluctuating world commodity prices. The financial terms are the same as those applying to the SBA, except that CFF loans carry no surcharge.

6. *Emergency Assistance (EA):* The IMF provides emergency assistance to countries that have experienced a natural disaster or are emerging from conflict. Emergency loans are subject to the basic rate of charge and must be repaid within 5 years.

7. *Poverty Reduction and Growth Facility (PRGF):* The IMF for many years provided assistance to low-income countries through the Enhanced Structural Adjustment Facility (ESAF). In 1999, however, a decision was made to strengthen the focus on poverty, and the ESAF was replaced by the PRGF. Loans under the PRGF are based on a Poverty Reduction Strategy Paper (PRSP), which is prepared by the country in cooperation with civil society and other development partners, in particular the World Bank. The interest rate levied on PRGF loans is only 0.5 percent, and loans may be repaid over a maximum period of 10 years.
Appendix B

Data and Variable Definitions
Sampling Periods and Criteria

All data used in this study are annual and unbalanced and were taken from five sources: (1) the World Development Indicators (WDI) CD-ROM, (2) the international financial statistics (IFS) CD-ROM, (3) the Government Finance Statistics (GFS), (4) the World Development Reports (WDR), and (5) the Human Development Reports (HDR). We used two criteria in choosing the countries included in the samples. First, we selected reforming and non-reforming countries for which data were available. Second, we chose developing countries that have had reform programs no later than 1992. Given the length of the process, examining the impact of reform, especially on fertility and human development, only a few years after reform reveals very little about its effectiveness in the long run. Since the change in fertility and human development is a long run process, we have chosen countries where at least eight years have passed after the initiation of the reform. In addition, we have chosen a set of non-reforming countries that had initial conditions similar to the reforming countries, and yet did not adopt reform programs until 1999.

The sampling period in the first essay is 1975-1999 during which we have unbalanced panel data for 40 reforming countries. Due to data limitation on human development measures, we did not have data for non-reforming countries in this essay. In the second essay, we use a data set for 63 developing countries, 25 of which have not adopted reform programs until 1999, and in the third essay, we use data for 20 reforming and 12 non-reforming countries. With the exception of the estimation of
factor shares equations in the third essay, the sampling period is 1960-1999 in the second and third essay.

In the second essay, three variables are used to conduct the test for complementarity between capital and female labor. They are logarithm of GDP, logarithm of gross capital formation, and logarithm of female labor, as a proxy for mental labor. In estimating the equation for fertility, we used three variables; logarithm of the young population (under 15 years of age) as a proxy for fertility, logarithm of per capita income, and logarithm of capital per head. Capital per head is calculated by dividing the gross fixed capital formation (gross domestic fixed investment) by the total population ages 15-64. Total population between the ages 15 to 64 is the number of people who could potentially be economically active.

In the third essay, three variables are used to estimate the elasticity of substitution between capital and labor. They are logarithm of GDP, logarithm of gross capital formation, and logarithm of labor. In estimating the equations for factor shares, we used two variables; the unemployment rate, and logarithm of capital per head. Capital per head is calculated by dividing the gross fixed capital formation (gross domestic fixed investment) by the total population ages 15-64. Labor’s share in GDP was readily available on the WDI CD-ROM while capital’s share was calculated by multiplying real interest rates by gross domestic fixed investment and dividing by GDP.
Variable Definitions and Data Sources

**GDP per capita. PPP (current international dollars)**

GDP per capita based on purchasing power parity (PPP). PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States.

Source: World Development Indicators CD-ROM.

**GDP Growth**

GDP growth is the annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 1995 U.S. dollars.

Source: World Development Indicators CD-ROM.

**Health Expenditure (% of GDP)**

Total health expenditure is the public health expenditures as a ratio of GDP. Health expenditure is government expenditure since the public sector plays the important role in financing social services in most developing countries. It covers the provision of health services (preventive and curative), family planning activities, nutrition activities, and emergency aid designated for health but does not include provision of water and sanitation.

Education Expenditure (% of GDP)

Total education expenditure is the public health expenditures as a ratio of GDP. Education expenditure is government expenditure since the public sector plays the important role in financing social services in most developing countries.


Fertility Rate

Total fertility rate represents the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with prevailing age-specific fertility rates.

Source: World Development Indicators CD-ROM.

Population Growth (annual %)

Population growth is the annual population growth rate. Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship—except for refugees not permanently settled in the country of asylum, who are generally considered part of the population of the country of origin.

Source: World Development Indicators CD-ROM.
Rural Population (% of total population)

Rural population is calculated as the difference between the total population and the urban population.

Source: World Development Indicators CD-ROM.

Total External Debt (current US$)

Total external debt is debt owed to nonresidents repayable in foreign currency, goods, or services. Total external debt is the sum of public, publicly guaranteed, and private non-guaranteed long-term debt, use of IMF credit, and short-term debt. Short-term debt includes all debt having an original maturity of one year or less and interest in arrears on long-term debt.

Source: World Development Indicators CD-ROM.

Gross Primary School Enrollment

Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Preprimary education refers to the initial stage of organized instruction, designed primarily to introduce very young children to a school-type environment.

**Gross Secondary School Enrollment**

Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Secondary education completes the provision of basic education that began at the primary level, and aims at laying the foundations for lifelong learning and human development, by offering more subject- or skill-oriented instruction using more specialized teachers.


**Gross Tertiary School Enrollment**

Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Tertiary education, whether or not to an advanced research qualification, normally requires, as a minimum condition of admission, the successful completion of education at the secondary level.


**Infant Mortality Rate (per 1,000 live births)**

Infant mortality rate is the number of infants dying before reaching one year of age, per 1,000 live births in a given year.
Life Expectancy at Birth (years)

Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.


Adult Illiteracy Rate (% of people ages 15 and above)

Adult illiteracy rate is the percentage of people ages 15 and above who cannot, with understanding, read and write a short, simple statement on their everyday life.


Female Adult Illiteracy Rate (% of females ages 15 and above)

Adult illiteracy rate is the percentage of people ages 15 and above who cannot, with understanding, read and write a short, simple statement on their everyday life.


Female Labor Force (% of total labor force)

Female labor force, as a percentage of the total, shows the extent to which women are active in the labor force. Labor force comprises all people who meet the International Labor Organization's definition of the economically active population.
Source: World Development Indicators CD-ROM.

**Exchange Rate (local currency units per US$, period average)**

Official exchange rate refers to the exchange rate determined by national authorities or to the rate determined in the legally sanctioned exchange market. It is calculated as an annual average based on monthly averages (local currency units relative to the U.S. dollar).

Source: World Development Indicators CD-ROM.

**Gross Fixed Capital Formation (constant 1995 US$)**

Gross fixed capital formation (gross domestic fixed investment) includes land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings.

Source: World Development Indicators CD-ROM.

**GDP (constant 1995 US$)**

GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 1995 U.S. dollars.
Dollar figures for GDP are converted from domestic currencies using 1995 official exchange rates. For a few countries where the official exchange rate does not reflect the rate effectively applied to actual foreign exchange transactions, an alternative conversion factor is used.

Source: World Development Indicators CD-ROM.

**Total Labor Force**

Total labor force comprises people who meet the International Labor Organization definition of the economically active population: all people who supply labor for the production of goods and services during a specified period. It includes both the employed and the unemployed. While national practices vary in the treatment of such groups as the armed forces and seasonal or part-time workers, in general the labor force includes the armed forces, the unemployed, and first-time job-seekers, but excludes homemakers and other unpaid caregivers and workers in the informal sector.

Source: World Development Indicators CD-ROM.

**GDP per Capita (constant 1995 US$)**

GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.
Source: World Development Indicators CD-ROM.

**Wages and Salaries (% of GDP)**

Wages and salaries consist of all payments in cash, but not in kind, to employees in return for services rendered, before deduction of withholding taxes and employee contributions to social security and pension funds.

Source: World Development Indicators CD-ROM.

**Real Interest Rate (%)**

Real interest rate is the lending interest rate adjusted for inflation as measured by the GDP deflator.

Source: World Development Indicators CD-ROM.

**Immunization Coverage (% of children under 12 months)**

Child immunization measures the rate of vaccination coverage of children under one year of age. A child is considered adequately immunized against diphtheria, pertussis (or whooping cough), and tetanus (DPT) after receiving three doses of vaccine.

Source: World Development Reports.

**Population Ages 15-64**

Total population between the ages 15 to 64 is the number of people who could potentially be economically active.
Source: World Development Indicators CD-ROM.

**Unemployment Rate (% of total labor force)**

Unemployment refers to the share of the labor force that is without work but available for and seeking employment. Definitions of labor force and unemployment differ by country.

Source: World Development Indicators CD-ROM.

**The Physical Quality of Life Index (PQLI)**

The Physical Quality of Life Index (PQLI) consists of three different indicators: (1) life expectancy at birth, (2) infant mortality, and (3) literacy rate. For each indicator, the performance of countries is based on a scale of 0 (worst) to 100 (best). The PQLI is calculated by averaging the three indicators, giving equal weight to each of them and the resulting PQLI is scaled on an index of 0 to 100. The formula for calculating PQLI is as follows.

\[ PQLI = \frac{\text{Life Expectancy Index} + \text{Infant Mortality Index} + \text{Literacy Index}}{3}, \]

where years of life expectancy are converted to an index number according to the following formula.

\[ \text{(A2)} \quad \frac{\text{Life Expectancy at Age One} - 38}{0.43}. \]

The lowest rate of life expectancy reported after World War II was 38 years for Vietnam in 1950 (Morris 1979). This rate is assigned the value of 0 on the 0 to 100
scale. The best life expectancy rate achieved so far is 81 years for Japan in 1999. This rate is assigned the value of 100 on the 0 to 100 scale.

The infant mortality rate is converted to an index number according to the formula:

\[
\text{Index} = \frac{229 - \text{Infant Mortality Rate per Thousand}}{2.26}
\]

"Gabon's infant mortality rate of 229 deaths per thousand live births is the worst recorded by the United Nations for any country since 1950." (Morris 1979, p. 43).

This rate is assigned the value of 0 on the 0 to 100 scale. The best infant mortality achieved so far is 3 deaths per thousand of 1000 live births. Hong Kong, Iceland, and Singapore share this low level in 1999. This rate is assigned the value of 100 on the 0 to 100 scale. Using a range of 229 to 3 deaths per thousand means that a 2.26% change in the infant mortality rate will show up as a 1% change in the infant mortality index. Literacy index numbers correspond to the actual data.

Source: author calculations.

**The Human Development Index (HDI)**

The United Nations Development Program (UNDP) has come up with a composite index that goes beyond GDP per capita as a measure of development. Introduced in the first Human Development Report (HDR) in 1990, the HDI is a composite index that measures overall progress in a country in achieving human development. The HDI measures the average overall achievements in three basic dimensions: (1) longevity, (2) education and a (3) decent standard of living. It is measured by life expectancy, educational attainment (adult literacy and combined primary, secondary
and tertiary enrolment) and adjusted income for the differences in purchasing power of local currencies. HDI is calculated as follows.

\[(A4) \quad HDI = \frac{Life \text{ Expectancy Index} + \text{Adjusted Real GDP Per Capita Index} + \text{Education Attainment Index}}{3}\]

where

\[(A5) \quad \text{Educational Attainment Index} = \frac{2(\text{Adult Literacy Index}) + (\text{Combined School Enrollment Ratio})}{3}\]

For the construction of the indexes, fixed minimum and maximum values have been established for each of these indicators. life expectancy at birth: 25 years and 85 years; adult literacy: 0% and 100%; combined gross enrollment ratio: 0% and 100%; and real GDP per capita (PPPS): $100 and $40,000 (PPPS).

For any component of the HDI, individual indices can be computed according to the general formula:

\[(A6) \quad \text{Index} = \frac{\text{Actual } x_i \text{ value} - \text{Minimum } x_i \text{ value}}{\text{Maximum } x_i \text{ value} - \text{Minimum } x_i \text{ value}}.\]

The construction of the income index is a little more complex. The world average income of $5,835 (PPPS) in 1994 is taken as the threshold level (\(y^*\)), and any income above this level is discounted using the following formulation based on Atkinson’s formula for the utility of income (Meier 2000, p.2).
\[ W(y) = y^* \quad \text{for } 0 < y < y^* \]
\[ = y^* + 2[(y-y^*)^{1/2}] \quad \text{for } y^* \leq y \leq 2y^* \]
\[ = y^* + 2(y^*)^{1/2} + 3[(y-2y^*)^{1/3}] \quad \text{for } 2y^* \leq y \leq 3y^* \]
\[ = y^* + 2(y^*)^{1/2} + 3(y^*)^{1/3} + 4[(y-3y^*)^{1/4}] \quad \text{for } 3y^* \leq y \leq 4y^* \]

The discounted value of the maximum income of $40,000 (PPP$) is calculated as follows:

\[ W(y) = y^* + 2(y^*)^{1/2} + 3(y^*)^{1/3} + 4(y^*)^{1/4} + 5(y^*)^{1/5} + 6(y^*)^{1/6} + 7(y^*)^{1/7} + 8[(y-7y^*)^{1/8}] \]

Appendix C

Partial Derivatives of Factor Shares Equations
The partial derivatives of equations (51) and (53) with respect to \( z_i \), \( z_2 \), \( k_i \), and \( u_i \) are as follows.

\[
\frac{\partial S_i^L}{\partial z_i} = -\alpha A^{-\frac{1-\sigma}{\sigma}} \left[ \alpha + (1-\alpha)(\frac{k_i}{1-u_i})^{-\frac{\sigma-1}{\sigma}} \right], \quad (A7)
\]

\[
\frac{\partial S_i^L}{\partial u_i} = -\alpha(1-\alpha)(1-z_i)(\frac{\sigma-1}{\sigma})A^{-\frac{1-\sigma}{\sigma}} \left( \frac{1}{1-u_i} \right)^{\frac{1}{\sigma}} \left[ \alpha + (1-\alpha)(\frac{k_i}{1-u_i})^{-\frac{\sigma-1}{\sigma}} \right], \quad (A8)
\]

\[
\frac{\partial S_i^L}{\partial k_i} = -\alpha(1-\alpha)(1-z_i)(\frac{\sigma-1}{\sigma})A^{-\frac{1-\sigma}{\sigma}} \left( \frac{1}{1-u_i} \right)^{\frac{1}{\sigma}} \left[ \alpha + (1-\alpha)(\frac{k_i}{1-u_i})^{-\frac{\sigma-1}{\sigma}} \right], \quad (A9)
\]

\[
\frac{\partial S_i^L}{\partial z_2} = -\alpha(1-\alpha)A^{-\frac{1-\sigma}{\sigma}} \left[ (1-\alpha) + \alpha \left( \frac{1-u_i}{k_i} \right)^{-\frac{\sigma-1}{\sigma}} \right], \quad (A10)
\]

\[
\frac{\partial S_i^L}{\partial u_i} = \alpha(1-\alpha)(1-z_2)(\frac{\sigma-1}{\sigma})A^{-\frac{1-\sigma}{\sigma}} \left( \frac{1}{1-u_i} \right)^{\frac{1}{\sigma}} \left[ (1-\alpha) + \alpha \left( \frac{1-u_i}{k_i} \right)^{-\frac{\sigma-1}{\sigma}} \right], \quad (A11)
\]

\[
\frac{\partial S_i^L}{\partial k_i} = \alpha(1-\alpha)(1-z_2)(\frac{\sigma-1}{\sigma})A^{-\frac{1-\sigma}{\sigma}} \left( \frac{1}{k_i^2} \right) \left( \frac{1-u_i}{k_i} \right)^{\frac{1}{\sigma}} \left[ (1-\alpha) + \alpha \left( \frac{1-u_i}{k_i} \right)^{-\frac{\sigma-1}{\sigma}} \right]. \quad (A12)
\]
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