Contents

1 Introduction **2**

2 Theory **8**

2.0.1 Demographics 8

2.0.2 Preferences 8

2.0.3 Technology 8

2.1 Capital Account Liberalization in the Solow Model 10

3 Solow Model's Predicted Effects **13**

4 Methodology and Empirical Results **18**

4.1 Economic Interpretation 22

5 Conclusion **25**

Capital Account Liberalization: A New Look

Anthony Diercks

February 22, 2012

1 Introduction

What are the effects of capital account liberalization on growth? How should we measure these effects? Are the effects only found in the short run, long run, both, or neither? Are these effects economically meaningful? The goal of this paper is to answer these questions by modeling the effects of a capital account liberalization in the Solow economy. Based on parameters that are accepted in the literature, the model provides empirical predictions that can then be taken to the data to look at both short run and long run dynamics.

The above questions have been addressed extensively in the literature (see Eichengreen 2001, Edison et al 2004, Kose et al 2009 for surveys). However, previous papers have focused only on the short run or long run effects. Papers that have focused only on the short run have measured the effects on growth only up to five years after a liberalization (Henry 2003, 2007). Papers that focus on the long run often look at time periods of greater than 30 years (Rodrik 1998, Quinn 1997, Kraay 1998, Edwards 2001, ODonnell 2001, Durham 2004, Chanda 2005, Klein and Olivei 2006). To my knowledge, no one has attempted to establish what is occuring in the data in the medium term. This is important because it could help provide empirical explanations for why papers that look at the long run often find results that are contrary to results found in papers focusing on the short run.

Economic theory predicts that liberalizing the capital account will allow financial resources to flow from developed countries, where capital is abundant, to developing countries, where capital is scarce. The flow of financial resources into the developing countries should

lead to a decreased cost of capital, increased investment, and higher output (Henry 2003).

Based on these potential benefits, many developing countries over the past 30 years have undertaken a liberalization of the capital account. With a significant number of countries undergoing this transformation, numerous papers have attempted to determine if the economic theory holds empirically.

Skeptics of the above theory argue that these predictions do not hold in the real world, especially in developing countries, where distortions may be more likely to affect the outcomes (Rodrik 1998). The comprehensive surveys of the literature (Eichengreen 2001, Edison et al 2004, Kose et al 2009) deliver no clear endorsement of the theory. Only three of the fourteen studies surveyed by Kose et al (2009) find a significant positive relationship between capital account openness and economic growth.

In contrast to these surveys, Henry (2007) argues that these papers are not actually testing predictions of the theory. Many of the papers in the above surveys perform purely cross sectional regressions that search for correlation between capital account openness and economic growth (Rodrik 1998, Quinn 1997, Kraay 1998, Edwards 2001, ODonnell 2001, Durham 2004, Chanda 2005, Klein and Olivei 2006). These papers are therefore implicitly testing if capital account liberalization has permanent effects on long run growth rates.

If one strictly adheres to neoclassical exogenous growth theory with no regard for alternative theories, as Henry (2007) does (the word "endogenous" is never mentioned), then the cross sectional framework offers little value. This is because neoclassical theory predicts that the effects of liberalizing a capital poor country will be temporary, not permanent. The cross sectional regression is intended for long run averages, so significant short run effects may be missed when using this method. This temporary change in growth is important, because it permanently raises a country's standard of living.

Why do so many papers use cross sectional regressions? Cross sectional regressions provide a simple method for establishing correlation between openness and growth. The difficulty in determining precise capital account liberalization dates causes most papers to instead examine openness (Eichengreen, 2001). Openness is often measured in the literature based on the IMF dichotomous indicator for the presence of "Restrictions on payments for capital transactions." The simplicity of the variable has made it very popular, and it has often been transformed to represent the percentage of years a country has been open during

the time period studied. In other words, this variable (often called SHARE) is the fraction of years that the IMF judged the country to be free from "restrictions on payments for capital account transactions."

From the perspective of neoclassical theory, the use of SHARE to represent openness leads to results that tell us very little about the actual impact of capital account liberalization. Therefore, the difference between openness and opening is very important. For example, a country that recently liberalized could see a temporary increase in growth, but its SHARE value would be low or close to zero. A country that was completely open for the entire sample would have a SHARE value of 1, but its growth would remain the same. Assuming both countries had the same growth before the liberalization, the country with the lower SHARE value would have higher average growth (because of the liberalization). Therefore, the SHARE value would have a negative relationship with growth. In other words, the regression would predict the longer a country has been open, the lower the average economic growth.

Figure 1 demonstrates that the level of the average annual growth of GDP per capita is higher after liberalization. The top figure is taken directly from Henry (2007) while the bottom figure is my replication, which yields similar results. Formal estimates show that the average growth rate of output jumped from 1.72% in the pre-liberalization period (years -3 to -1) to 3.12% in the post-liberalization period (years 0 to 3).

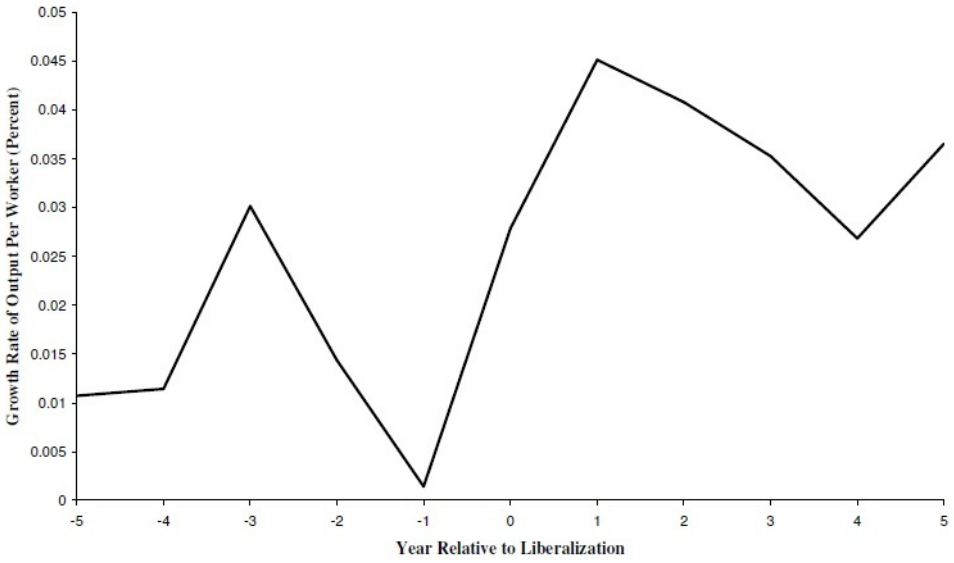


Figure The Growth Rate of Output Per Worker Increases When Countries Liberalize.

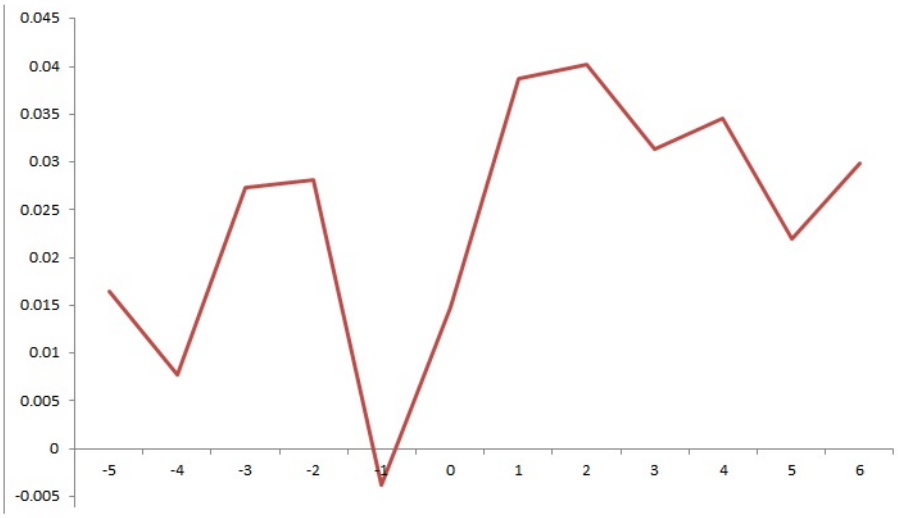
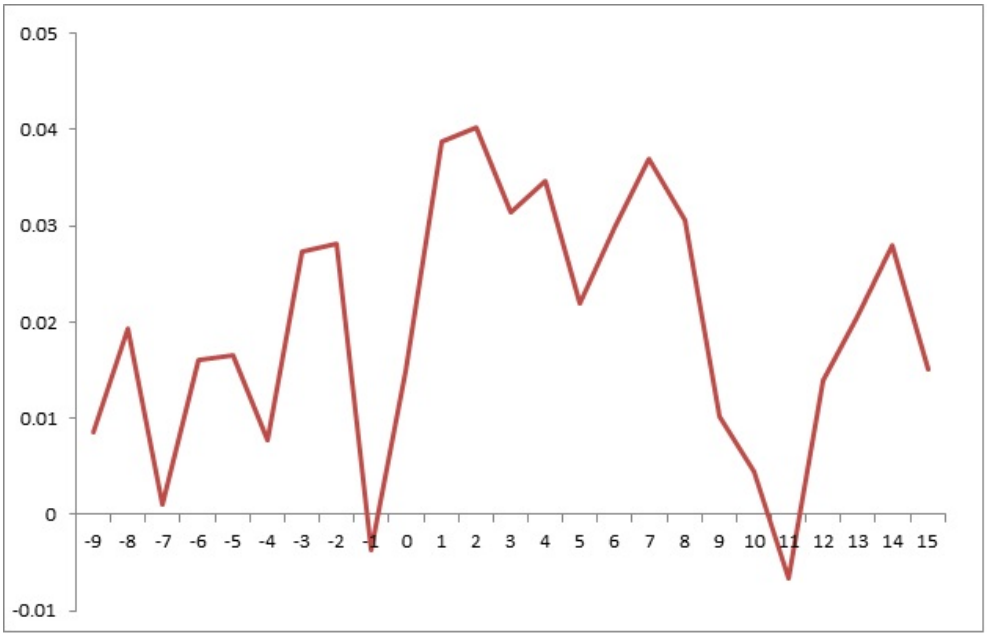


Figure 2 is an extension of Henry (2007), to include ten years before and fifteen years after. To my knowledge, no one has focused on the data from years five to fifteen after a liberalization. It is a plot of the average growth rate of GDP per capita in event time for the 25 countries in the study. Note the significant drop at years ten and eleven. This was not reflected by Henry(2007) because he only captured the five years before and after a liberalization. What in the data explains this drop in years ten and eleven?



One could argue it is outliers. Korea 1998, Indonesia 1998, Malaysia 1998, Thailand 1998, Zimbabwe 2003 and 2004 all experienced drops in annual GDP per capita of greater than ten percent during years ten or eleven. However, to not include these outliers in the data while looking at the effects of capital liberalization is akin to disregarding the negative consequences of financial crises.

Rodrik (1998) argues that these financial crises are caused by large shifts in net private capital flow, which is made possible by the capital account liberalization. Despite the negative effects of these crises, countries like Thailand and South Korea that experienced the worst of these events still have higher mean growths post liberalization than pre liberalization. Given this fact, it is still important to be aware of these effects found in later time periods, as these are unexplained by Chari et al (2009) and Henry (2007).

One could potentially argue that while capital account liberalization leads to a temporary increase in growth and a permanent increase in the standard of living, a financial crisis that occurs ten years later would likewise result in a temporary decrease in growth and a permanent decrease in the standard of living. However, of the 35 instances in which a country in this study incurred negative growth of greater than ten percent over the past 50 years, only ten of these instances occurred at some time after a capital account liberalization. Of these ten instances, half of them can be attributed to Zimbabwe. Thus, more than two-thirds of the countries in the study suffered no large drops in growth in any of the years that followed the liberalization of the capital account. While this reasoning in no way discounts

the likelihood of a financial crisis upon liberalizing the capital account, it does show that countries that do suffer this fate make up a small minority.

Figures 1 and 2 represent simple averages during the course of an opening. A major concern about both of the figures are coinciding macroeconomic reforms such as trade liberalization, inflation stabilization, privatization, and the Brady Plan debt relief programs. I attempt to control for the effects these may have on growth by creating a dummy for the year of the event and the following four years. Therefore, reforms and liberalizations are treated identically. Dates for these events are provided by Chari et al 2009.

Another important concern about both of the figures is that an exogenous worldwide shock is impacting the growth rates in both liberalizing and non-liberalizing countries. Using year-fixed effects should help capture this exogenous worldwide shock. I also include country-fixed effects to control for time invariant unobserved heterogeneity across countries that may explain variation in growth of GDP per capita.

Upon controlling for the above economic reforms while using fixed effects, I find that the impact of liberalization on real GDP per capita growth is temporary and declining over time. Prior to this decline, the impact of liberalization on real GDP per capita growth is economically large. The window that has maximum significance (years [0] to [8]) exhibits an average increase in growth of GDP per capita of 2.05% above the long run mean. Thus, for the typical country, the effect of capital account liberalization after controlling for other economic reforms is calculated as an increase of 1,568 PPP-adjusted dollars in real GDP per capita. This calculation is based on a point estimate, and if one takes the lower bound of the 95% confidence interval based on this point estimate, there still exists a 502 PPP-adjusted dollar increase in real GDP per capita. These calculated increases are in comparison to a typical country that does not liberalize, assuming it continues at its preliberalization mean growth rate.

What happens after year 8? During the window of 9 years to 12 years after liberalization, I find a 99% significant negative effect in which average GDP per capita growth is 2% lower than the long run mean. Just as I argued that the above temporary increase in growth resulted in a permanent level increase, the temporary decrease in growth in years 9 to 12 also results in a permanent decrease in the standard of living. After taking this time period into account, one can no longer be 95% confident that the average country is empirically

better off twelve years after a capital account liberalization. To my knowledge, this result (using an extension of Chari et al 2009 & Henry 2003,2007's methodology) is new.

The theory says the effect on liberalization should drop by about one percentage point from year one to year 11, but the data reflects a drop of almost four percentage points. Even after controlling for the Asian financial crisis by removing the affected countries, a reversal is taking place that is not explained by neoclassical theory. In other words, unlike Henry (2007), I am skeptical that neoclassical theory adequately explains why an effect is found in the short run that is not found in the long run.

Section 2 explains the theory, all of which is completely standard. Section 3 shows the Solow model's predicted effects. Section 4 explains the methodology and empirical results along with the economic interpretation. Section 5 concludes.

2 Theory

The Solow neoclassical open economy growth model will be used for the remainder of the paper to determine the effects of a policy reform on economic growth. The discussion that follows will focus on the temporary effects on growth, as predicted by the theory. The following exposition is completely standard.

2.0.1 Demographics

Consumers are endowed with a unit of labor which is devoted to labor. Prices and salaries are fully flexible, so the economy is always in full employment. Hence, population $N_t = N_0 e^{nt} = L_t = L_0 e^{nt}$, which is labor.

2.0.2 Preferences

Aggregate savings are a constant proportion of income each period so that $S_t = sY_t$. The savings rate s is exogenous.

2.0.3 Technology

Assume at the aggregate level, available technology can be represented by a first degree homogenous Cobb Douglas production function with exogenous technology growth, in the

form of productivity factor $A_t = A_0 e^{gt}$, L_t is labor, Y_t is output, K_t is capital,

$$Y_t = F(K_t, AL_t) = K_t^{\alpha}(AL_t)^{1-\alpha} \tag{1}$$

with $F_K,\ F_{A,L} > 0$ and F is concave. Also, $F(K_t, 0) = F(0, AL_t) = 0$, so we must have positive amounts of each input. Inada conditions also apply,

$$\lim_{K_t \to 0} F_{K_t} = \lim_{AL_t \to 0} F_{AL_t} = \infty, \lim_{K_t \to \infty} F_{K_t} = \lim_{AL_t \to \infty} F_{AL_t} = 0$$

Define AL as effective labor, and most importantly, assume aggregate constant returns to scale and decreasing returns to scale in each input, which removes the possibility of positive steady-state growth. The aggregate constant returns to scale allows

$$Y_t = F(K_t, AL_t) = AL_t F(\frac{K}{AL}, 1) = ALf(k_t)$$

where $k_t = \frac{K_t}{AL_t}$ denotes the stock of capital per unit of effective labor.
Output per unit of effective labor is

$$y_t = \frac{Y_t}{AL_t} = f(k_t) = k_t^{\alpha}$$

$$0 < \alpha < 1$$

Output is either consumed or invested,

$$Y_t = C_t + I_t = C_t + \dot{K}_t + \delta K_t \tag{2}$$

$$\dot{K}_t = F(K_t, AL_t) - C_t - \delta K_t \tag{3}$$

Dividing by the effective units of labor

$$\frac{\dot{K}_t}{AL_t} = \frac{F(K_t, AL_t) - C_t - \delta K_t}{AL_t} = f(k_t) - c - \delta k \tag{4}$$

and since $k_t = \frac{K_t}{AL_t}$

$$\dot{k_t} = \frac{\dot{K}_t}{AL_t} - \frac{A\dot{L}_t}{AL_t}k - \frac{\dot{A}L_t}{AL_t}k \tag{5}$$

$$\dot{k_t} = \frac{\dot{K}_t}{AL_t} - (n+g)k \tag{6}$$

And plugging in (4), provides us the law of motion of the economy

$$\dot{k_t} = f(k_t) - c_t - (n + \delta + g)k_t \tag{7}$$

Given an exogenous saving rate s denoting the fraction of national income that is saved and no government, $S_t = I_t$,

$$Y_t = C_t + I_t = C_t + S_t = C_t + sY_t \Rightarrow C_t = (1-s)Y_t \tag{8}$$

Dividing through by AL_t, and plugging in for c_t

$$\dot{k_t} = sf(k_t) - (n + \delta + g)k_t \tag{9}$$

which is the law of motion of the economy. This equation shows how the stock of capital per unit of effective labor increases when per capita savings is greater than total capital depreciation.

The growth of capital per unit of effective labor can be obtained by dividing by k_t,

$$\gamma_k = \frac{\dot{k}}{k} = \frac{sf(k_t)}{k_t} - (n + \delta + g) \tag{10}$$

The steady state of this economy entails $\dot{k_t} = 0$, so that

$$k_{ss} = (\frac{s}{n + \delta + g})^{\frac{1}{1-\alpha}} \tag{11}$$

The ratio of capital to effective labor will be constant at steady state. The level of capital (K_t) will grow at the rate n+g and output per worker (Y/L) will grow at rate g.

Equation (10) is important because the focus of the paper is on the effects of policy reform after it has been implemented. We will be measuring the effects while the economy is transitioning to a new steady state k^*_{ss}, as shown below.

2.1 Capital Account Liberalization in the Solow Model

Assuming firms are maximizing profits, we obtain the equilibrium condition for investment

$$f'(k_{ss}) = r + \delta \tag{12}$$

It is standard to assume that r*, the exogenously given world interest rate, is less than r. This is because the rest of the world has more capital per unit of effective labor than the small (cannot affect world prices) developing country. In the post liberalization steady state, the equation becomes

$$f'(k^*_{ss}) = r^* + \delta \tag{13}$$

with r* $< r$ and k*$_{ss} > k_{ss}$.

The post liberalization equation says the marginal product of capital equals the world interest rate plus the rate of depreciation. The pre-liberalization steady state ratio of capital per unit of effective labor (k_{ss}) is constant and the stock of capital (K) grows at the rate n+g. The post liberalization steady state (k^*_{ss}) is also constant and the capital stock is also n+g. However, because $k^*_{ss} > k_{ss}$, it follows that K exceeds n+g during the transition. Given the growth rate of output per worker:

$$\gamma_{\frac{Y}{L}} = \alpha\gamma_k + g \tag{14}$$

It is clear that the growth rate of output per worker also increases temporarily.

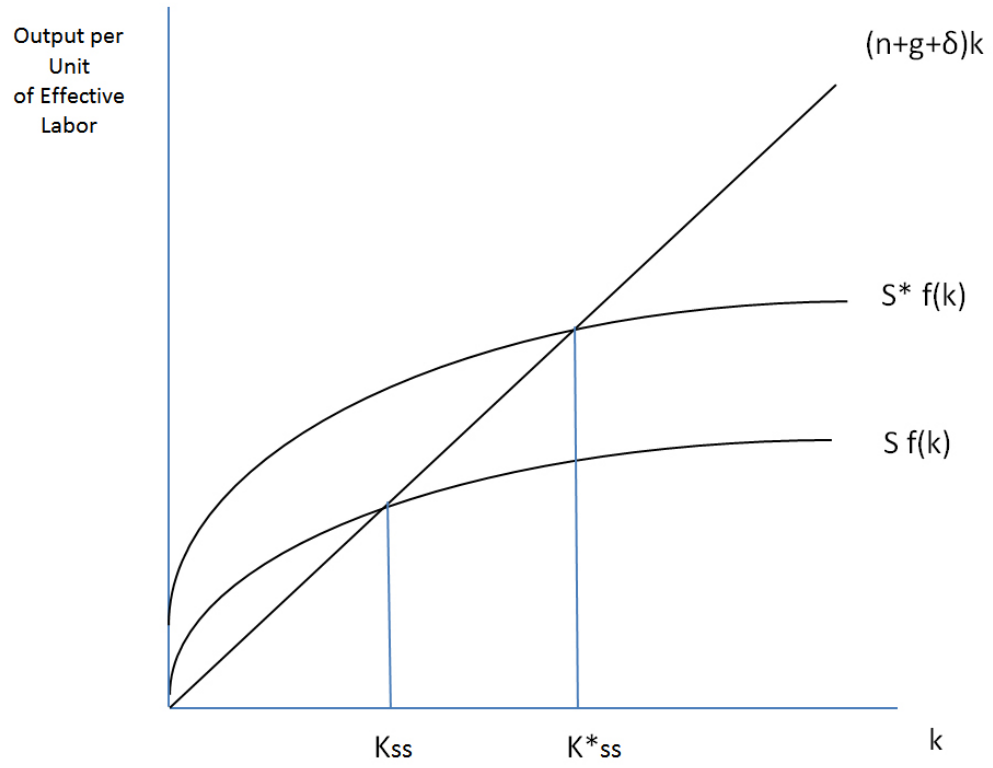
The model predicts instantaneous convergence, but a slower transition would more accurately reflect reality. This can be done by treating the transition from k_{ss} to k^*_{ss} as if it came from a permanent increase in a closed country's saving rate. This is possible because for a given r and r*, there exists a permanent increase in the savings rate such that the country's new steady state ratio of capital per unit of effective labor is identical to the effect of a liberalization. Also, by slowing the speed of convergence, we are increasing the power of cross sectional regressions to detect this effect while understating the importance of testing for a temporary effect. The effect of an increase in savings is shown below.

To determine the effects of a capital account liberalization, we must ask how much does the country's growth exceed the rate that would have occurred without liberalization? Again, the growth rate of output per worker is:

$$\gamma_{\frac{Y}{L}} = \alpha\gamma_k + g \tag{15}$$

Given that in this model, liberalization has no impact on total factor productivity, it follows that deviation of growth from its steady state value (g) is equal to $\alpha\gamma_k$. Therefore, to quantify the temporary change in growth of output per worker, we must calculate k_t during the economy's transition to its new steady state. To do this, we must solve the differential equation for $\dot{k_t}$. First, we must construct a linear approximation of the law of motion for capital around steady state:

$$\begin{aligned}
\dot{k_t} &\simeq [sf(k_{ss}) - (\delta + n + \gamma)k_{ss}] + [sf'(k_{ss}) - (\delta + n + g)](k_t - k_{ss}) \\
&= [\frac{(\delta + n + g)k_{ss}sf'(k_{ss})}{sf(k_{ss})} - (\delta + n + g)](k_t - k_{ss}) \\
&= -(1 - \alpha)(\delta + n + g)(k_t - k_{ss}) \qquad (16)
\end{aligned}$$



where $\alpha = \frac{k_t f'(k_t)}{f(k_t)}$ when $f(k) = k^\alpha$ and $(\delta + n + g)k_{ss} = sf(k_{ss})$ in steady state.

The solution to the differential equation can be written as $k_t = k_n + k_f$ where k_n is the solution to the homogeneous equation:

$$\dot{k_t} + (1 - \alpha)(\delta + n + g)k_t = 0 \tag{17}$$

$$k_n = Ce^{-(1-\alpha)(n+g+\delta)t} \tag{18}$$

and $k_f = k_{ss}$. Using initial condition k_0 and plugging in for t=0,

$$k_0 = C + k_{ss} \tag{19}$$

k_0 represents the preliberalization steady state, we end up with equation (7) from Henry (2007):

$$k_t = (k_0 - k^*_{ss})e^{-(1-\alpha)(n+g+\delta)t} + k^*_{ss} = (k_0 - k^*_{ss})e^{\mu t} + k^*_{ss} \tag{20}$$

with $\mu = (1 - \alpha)(n + g + \delta)$ representing the speed of convergence to steady state.

The preliberalization steady state and postliberalization steady state can be found using the investment equilibrium condition (12),

$$k_{ss} = (\frac{r + \delta}{\alpha})^{(\frac{1}{\alpha - 1})} \tag{21}$$

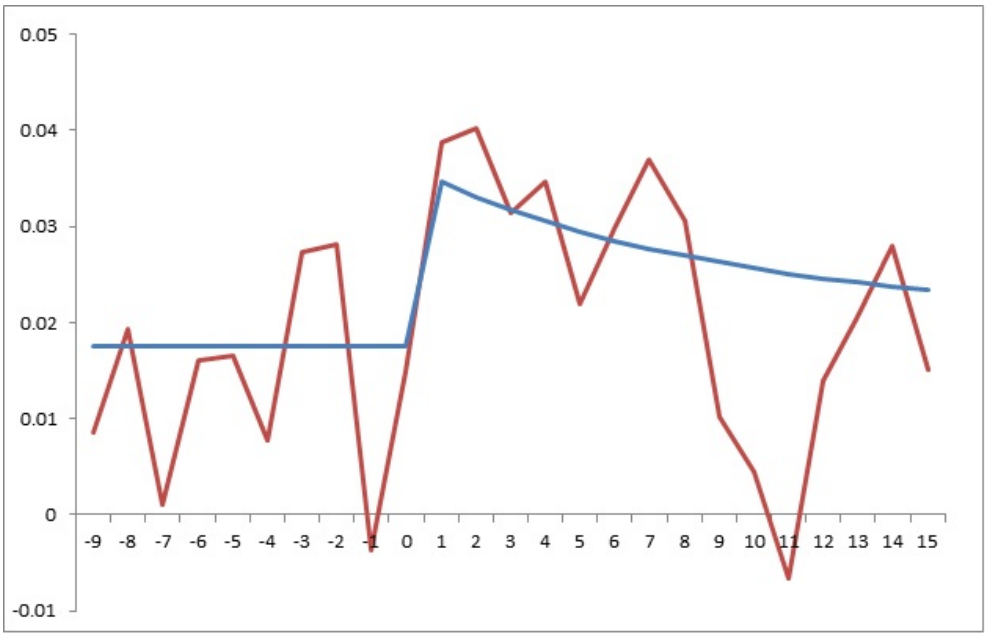
Henry assumes the autarky interest rate in the developing country is twice as high as the world interest rate, with r=0.16 and r*=0.08. Plugging these values in with a capital share $\alpha = 1/3$, δ= 0.04, we obtain $k_0 = 2.1517$ and $k^*_{ss} = 4.6296$. Assuming that TFP growth (g) and population growth (n) is 1 percent, μ=0.04. This is in the middle of the estimated speed of convergence based on cross-country growth regressions which range from 2% (Mankiw, Romer, Weil 1992) to 10% (Caselli, Esquivel, Lefort 1996). I was able to replicate the results of Henry by increasing the national savings rate from 10% to approximately 17%.

3 Solow Model's Predicted Effects

Given the above parameters for k_t, we can estimate its effects on economic growth during the transition. The average growth rate of k_t in the five years following a liberalization is 3.8217, based on a solution by linear approximation. If we do not use the linear approximation but instead the exact solution, the average growth rate is only 3.4423. Based on the growth rate of output per worker in equation (15), multiply the average growth rate of capital per unit of effective labor 3.8217 by elasticity of output with respect to capital (1/3). This gives the average deviation of the growth rate of output per worker from its long run steady state value during the first five years postliberalization, 1.274 percent per year.

Year	Predicted	Actual
0	0.0175	0.0148
1	0.0346	0.0387
2	0.0330	0.0401
3	0.0317	0.0313
4	0.0305	0.0346
5	0.0294	0.0219
6	0.0285	0.0298
7	0.0277	0.0369
8	0.0269	0.0305
9	0.0262	0.0102
10	0.0256	0.0045
11	0.0251	-0.0065
12	0.0246	0.0139
13	0.0241	0.0205
14	0.0237	0.0280
15	0.0233	0.0150

Table 1: Solow Predicted Growth



Assuming that prior to the liberalization, the growth rate of output is equal to the mean pre liberalization growth rate found in the data (0.0175), we obtain the above predictions. Years six to thirty represents the difference between the policy experiment approach of Henry (placing dummies for the five years after the liberalization) and the cross sectional regression approach. From years six through thirty, the average annual growth rate of k_t is 1.6151 percent a year, which is approximately a 0.5384 percent increase in average annual growth of output per worker above its steady-state value.

Is this increase in economic growth able to be distinguished from noise by a cross sectional regression? We can figure that out by looking at the standard error we typically see in cross sectional regressions of growth on an openness variable such as SHARE. This variable represents the average level of openness over a given time period. Its standard errors will give us an idea of the noise typically found. Henry uses the example of Rodrik (1998), which reports a standard error of 0.0055 on the variable SHARE. Dividing 0.008807 by 0.0055 gives a t-statistic of only 1.58, short of the magnitude required for statistical significance. Rodrik (1998) isn't the only paper that uses SHARE:

Paper	Period	# Countries	Error	Theory's Effect	T Stat
Alesina et al (1994)	1950-89	20	0.004	0.005352	1.34
Grilli et al (1995)	1966-89	61	0.00482758	0.007208	1.49
Rodrik (1998)	1975-89	95	0.00558392	0.008807	1.58
Edison et al (2002)	1980-2000	57	0.00689655	0.007682	1.11
Chanda (2005)	1976-95	82	0.00649128	0.007851	1.20

Table 2: SHARE Standard Errors

Table 2 shows that the size of the error is relatively robust across different countries and time periods. The average theoretical effect is calculated for each paper based on the number of years in the study. Clearly, the theory's predictions over these time periods result in effects that are not significant given the noise found in the data, even at the ten percent level. Yet, if we focus on the first five years after a liberalization, the estimated effect is 1.2739 percent per year, which is at least ten percent significant in all of the studies listed in Table 3 based on their reported standard errors.

One could make "quasi" confidence bands for the theoretical prediction by taking the standard error on the effect of openness on growth that is measured in the literature. This results in the figure below with a 95% confidence interval. This is constructed by taking the typical standard error 0.006 and multiplying it by 1.96 to obtain the 95% confidence bands.

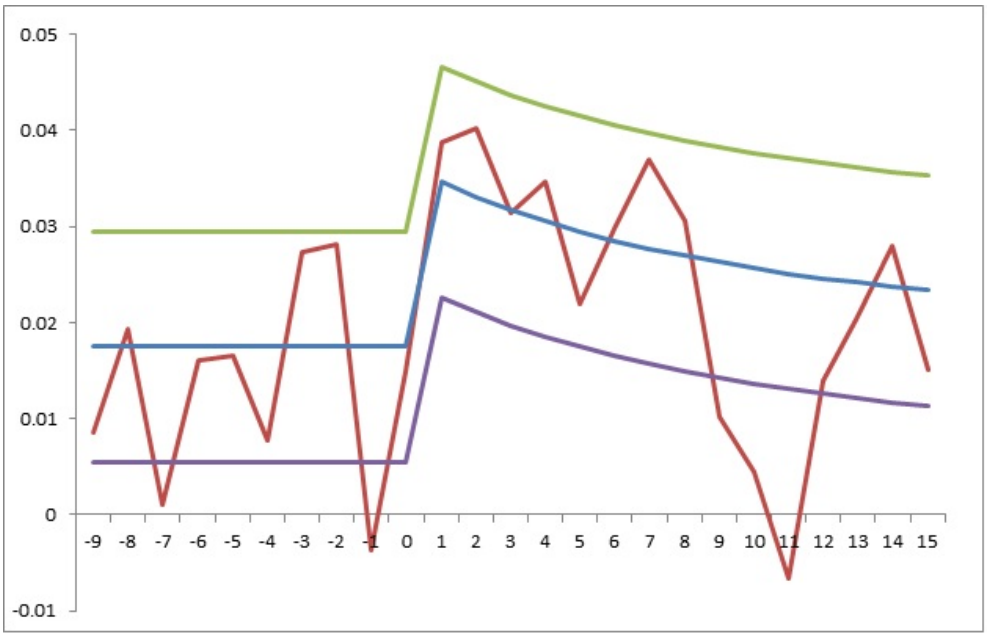


Figure 3 is an extension of Henry (2007), to include ten years before and fifteen years after. I stop at year fifteen because we have no data beyond this point for certain countries (South Africa, Nigeria, Jordan all liberalized in 1995). It is a plot of the average growth rate of GDP per capita in event time for the 25 countries in the study along with the Solow predicted effect and its "quasi" confidence bands. Note the significant drop at years ten and eleven. This was not reflected by Henry(2007) because he only captured the five years before and after a liberalization. What in the data explains this drop in years ten and eleven?

One could argue it is outliers. Korea 1998, Indonesia 1998, Malaysia 1998, Thailand 1998, Zimbabwe 2003 and 2004 all experienced drops in annual GDP per capita of greater than ten percent during years ten and eleven. However, to not include these outliers in the data while looking at the effects of capital liberalization is akin to disregarding the negative consequences of financial crises.

Rodrik (1998) argues that these financial crises are caused by large shifts in net private capital flow, which is made possible by the capital account liberalization. Despite the negative effects of these crises, countries like Thailand and South Korea that experienced the

worst of these events still have higher mean growths post liberalization than pre liberalization. Given this fact, it is still important to be aware of these effects found in later time periods, as these go unexplained in papers such as Chari et al (2009) and Henry (2003, 2007) (Chari et al (2009) focuses on effects up to three years after and Henry (2003, 2007) focuses on effects up to five years after liberalization). Table 3 provides additional descriptive statistics for before and after a liberalization.

Country	(1)	(2)
Argentina	5.69%	1.18%
Brazil	-9.45%	-25.36%
Chile	21.52%	10.50%
Colombia	10.11%	4.17%
Egypt	21.60%	6.18%
Greece	8.87%	9.46%
India	14.09%	1.99%
Indonesia	25.74%	12.19%
Israel	11.84%	-0.38%
Jordan	-6.60%	-31.58%
Korea	37.68%	9.31%
Malaysia	25.86%	28.9%
Mexico	10.71%	21.65%
Morocco	-9.86%	-24.30%
Nigeria	5.87%	14.21%
Pakistan	4.00%	-2.80%
Philippines	9.30%	32.23%
Portugal	6.15%	-6.96%
South Africa	6.41%	7.54%
Spain	5.46%	-3.177%
Taiwan	33.84%	9.88%
Thailand	35.60%	17.35%
Turkey	8.80%	-2.04%
Venezuela	15.08%	27.19%
Zimbabwe	14.30%	23.19%
Mean	12.50%	5.62%

Table 3: Summary Statistics for Real GDP Growth During Capital Account Liberalization

Column 1 gives the change in the natural log of real GDP per capita over the liberalization window (years [0] to [3]). Column 2 gives the change in real GDP per capita (years [0] to [3]) for each country expressed relative to the country's real GDP per capita change over the pre-liberalization window (years [-3] to [-1]). It is clear from the descriptive evidence that on average for the 25 sample countries, the mean growth during the post liberalization window

is higher than the pre liberalization window, which is true for three quarters of the sample countries.

However, the above descriptive evidence only focuses on the immediate before and after of a liberalization. One could potentially argue that while capital account liberalization leads to a temporary increase in growth and a permanent increase in the standard of living, a financial crisis that occurs ten years later would likewise result in a temporary decrease in growth and a permanent decrease in the standard of living. This could erase the short run gains that are found by Henry (2007). However, of the 35 instances in which a country in this study incurred negative growth of greater than ten percent over the past 50 years, only ten of these instances occurred at some time after a capital account liberalization. Of these ten instances, half of them can be attributed to Zimbabwe.

Thus, more than two-thirds of the countries in the study suffered no large drops in growth in any of the years that followed the liberalization of the capital account. While this reasoning in no way discounts the likelihood of a financial crisis upon liberalizing the capital account, it does show that countries that do suffer this fate make up a small minority. It is very possible this small minority may be contributing to the difference between the short run and long run findings.

In addition, concurrent macroeconomic reforms such as trade liberalization, inflation stabilization, privatization of state owned enterprises, and Brady debt relief programs could be impacting the growth of real GDP per capita. By looking at the dates of the reforms, it is very plausible that these reforms are responsible for the apparent increase in growth shown in the above descriptive statistics. The next section, which presents the formal methodology and empirical results, uses the dates in Table 11 (taken from Chari et al 2009) to control directly for the effects of these economic reforms and attempts to control for other important concerns addressed below.

4 Methodology and Empirical Results

I evaluate the statistical significance of a temporary increase in GDP per capita growth by estimating the following panel regression.

$$\Delta lng_{it} = a_0 + COUNTRY_i + YEAR_t + b_1 * LIBERALIZE_{it} + b_2 * TRADE_{it} + b_3 * STABILIZE_{it} + b_4 * PRIVATIZE_{it} + b_5 * BRADY_{it} + \epsilon_{it} \quad (22)$$

The left hand side variable, Δlng_{it}, is the natural log of the annual change in real GDP per capita for country i. On the right-hand side of the equation, the variable $COUNTRY_i$ represents the country-fixed effects and $YEAR_t$ represents the year-fixed effects. The variable $LIBERALIZE_{it}$ is a dummy variable that takes on a value of 1 in the year that country i liberalizes([0]) and each of the subsequent X years, with X=3...13. This means that the coefficient b_1 measures the average annual deviation of the growth rate of real GDP per capita from the typical country's long-run mean.

The right hand side also contains four additional country-specific dummy variables that are designed to prevent country-specific shocks such as other economic reforms from artificially inflating the coefficient on LIBERALIZE. Each of the dummy variables takes on the value 1 in the year a reform program begins and each of the four subsequent years. Changing the number of subsequent years to three or five for the reform variables did not result in any significant changes.

Window	([-3], [-1])	([0],[3])	([0],[4])	([0],[5])	([0],[6])	([0],[7])	([0],[8])	([0],[9])	([0],[10])	([0],[11])	([0],[12])	([0],[13])
Liberalize	-.00280	.00908	**.01072****	**.00944****	**.01263****	**.01751*****	**.02054*****	**.01841*****	**.01366****	.00535	.00429	.00375
	(.00736)	(.00583)	(.00479)	(.00461)	(.00462)	(.0057)	(.00649)	(.00560)	(.00622)	(.00820)	(.00900)	(.00828)
STABLE	-.00460	-.00732	-.00625	-.00577	-.00571	-.00554	-.00544	-.00533	-.00507	-.00486	-.00483	-.00483
	(.0059)	(.00533)	(.00562)	(.00578)	(.00576)	(.00575)	(.00569)	(.00566)	(.00567)	(.00573)	(.00575)	(.00576)
TRADE	.00489	.00296	.00465	.00482	.00478	.00499	.00498	.00495	.00473	.00478	.00475	.00475
	(.00455)	(.00467)	(.00445)	(.00446)	(.00449)	(.00453)	(.00453)	(.00454)	(.00452)	(.00451)	(.00450)	(.00451)
PRIVATE	.00853	.00147	.00546	.00558	.00495	.00436	.00451	.00537	.00660	.00809	.00829	.00838
	(.00657)	(.00652)	(.00645)	(.00604)	(.00590)	(.00570)	(.00564)	(.00593)	(.00615)	(.00667)	(.00667)	(.00656)
BRADY	-.00536	.004223	-.00513	-.0051	-.00539	-.00630	-.00629	-.00557	-.00527	-.00527	-.00527	-.00527
	(.0092)	(.00977)	(.00887)	(.00884)	(.00859)	(.00843)	(.00830)	(.00830)	(.00852)	.00899)	(.00905)	(.00907)
Constant	**.02830***	**.02836***	**.02834***	**.02834***	**.02833***	**.028302***	**.02833***	**.02834***	**.02835***	**.02836***	**.02839***	**.02829***
	(.01551)	(.01552)	(.01551)	(.01552)	(.01551)	(.01551)	(.01552)	(.01551)	(.01551)	(.01551)	(.01551)	(.01551)

Table 4: THE IMPACT OF LIBERALIZATION ON REAL GDP GROWTH IS TEMPORARY AND DECLINES OVER TIME #1

Window	([-3], [-1])	([0],[3])	([0],[4])	([0],[5])	([0],[6])	([0],[7])	([0],[8])	([0],[9])	([0],[10])	([0],[11])	([0],[12])	([0],[13])
Liberalize	.00110	.00362	.00697	.00433	.00706	**.01094***	**.01350***	**.01214****	.0080	.00287	-.00166	-.00267
	(.00841)	(.00624)	(.00493)	(.00465)	(.00447)	(.00580)	(.00689)	(.00521)	(.00615)	(.00885)	(.00953)	(.00880)

Table 5: TABLE 4 WITHOUT THAILAND, MALAYSIA, SOUTH KOREA, AND INDONESIA

One can see that the average estimated effect of liberalization on GDP per capita growth differs based on the size of the window. Consistent with the above theoretical prediction that liberalization will produce a temporary increase in GDP per capita growth, the average effect increases in size and significance from years five to eight. From years 8 to 13, the sign and significance of the coefficients drop to zero. The window with the highest magnitude and significance is that which combines year 0 through year 8. Controlling for the effects of trade liberalization, the Brady Plan, privitization, and inflation stabilization, the coefficient on LIBERALIZE is 0.0205 and is significant at the 99 percent level. This means that during liberalization episodes, the average annual growth rate of the typical country's real GDP per capita exceeds its long-run mean by 2.05 % percent per year.

The coefficient estimates demonstrate that controlling for the other economic reforms that tend to accompany liberalization does not decrease the impact of capital account liberalization on the growth of real GDP per capita. When running the regressions with one reform at a time, the sign and level of the coefficient were nearly identical to results found when including all reforms. This reinforces the relevance of the corresponding dummy variables as controls.

An important concern in a regression using panel data across countries is serial correlation of the residuals, which would bias the OLS standard errors and may overestimate or underestimate the true variability of the coefficient estimates. The Wooldridge Test for serial correlation in panel-data models fails to reject at the 95% confidence level the null hypothesis that there is no first order autocorrelation of the residuals. Another issue is measurement error, which can cause unspecified correlation between observations in the same country. To control for this, I use robust standard errors that are clustered by country, as proposed by Bertand et al (2004).

Another concern is correlation of the residuals across countries within a given time period because liberalizations often occur at the same time for different countries. For example, five of the countries opened their capital accounts in the year 1989. This fact might cause correlation in the growth residuals across countries at a specific point in time. To control for this dimension (cluster by year) along with the previous (cluster by country), one can address both of these concerns using the approach of Petersen(2009). He uses the following estimate of the variance-covariance matrix, which combines the standard errors clustered by

country with the standard errors clustered by year:

$$Var_{Country\&Time} = Var_{Country} + Var_{Time} - Var_{White} \tag{23}$$

The results using this method only slightly increased the standard errors, but this did not change the significance of any of the coefficients in the regressions above. This suggests that the general findings above are robust to concerns about both serial and cross-country correlation in the residuals.

4.1 Economic Interpretation

Consider the magnitude of the growth rate of the real GDP per capita during the liberalization window (years [0] to[8]) relative to the growth rate of the real GDP per capita over the entire sample. To do this, one could use the estimate of the constant and the liberalization dummy from the above regressions that control for the other economic reforms. However, given the above regressions make use of fixed effects, the constant changes depending on the country that is omitted (one country must be omitted for identification purposes). Instead, use the pre-liberalization sample mean of the change in GDP per capita growth, 1.72%. Adding this to the estimate of the coefficient on the liberalization dummy (2.05%) gives the average growth rate of real GDP per capita during liberalization episodes, 3.77% per year. This result means that the average growth rate of real GDP per capita doubles the pre-liberalization growth rate for over eight years.

What does this mean in levels? The average level of annual GDP for the sample 25 countries was 6,630 PPP-adjusted dollars in the year before liberalization. During the eight year liberalization window the real GDP per capita grows at 3.79% per year, so that by the beginning of year 9, the average level of real GDP per capita will be $6,630 * e^{0.0379*9} = 9,308$ PPP-adjusted dollars. Now assume that without the capital account liberalization, the real GDP per capita would have grown at the sample mean of 1.72 percent per year. In this case, the level of real GDP per capita at the beginning of year 9 would be $6,630 * e^{0.0172*9} = 7,741$ PPP-adjusted dollars. Thus, for the average country, the effect of capital account liberalization after controlling for other economic reforms would be an increase of 1,568 in real GDP per capita. If this strikes the reader as unreasonably high, then look to the lower bound. In order to be more conservative, the lower bound of the 95% confidence interval for

the effect is 0.007 (the point estimate was 0.0205). Use this number to calculate the same effects, $6,630 * e^{(0.0172+0.007)*9} = 8,243$ PPP-adjusted dollars. Thus, the lower bound after eight years for real GDP per capita will be 502 PPP-adjusted dollars higher for the average country that liberalizes the capital account.

What does the theory predict? The theory above predicts from years zero to eight an average increase in GDP of 1.282% over the pre liberalization mean. Thus theory predicts that real GDP per capita will be $6,630 * e^{(0.0172+0.0128)*9} = 8,685$ PPP-adjusted dollars. This is 623 dollars less than what the regression predicts, but is within the 95% confidence interval. But what about years 9 to 12? Running the same regressions as above while controlling for other economic reforms but capturing the effects in years 9 to 12 gives the following estimates:

Window	**([9],[12])**	**W/O Crisis**
Liberalize	**-0.020*** **	**-0.019** **
	(0.007)	(0.008)
STABLE	-0.005	-0.009
	(0.006)	(0.006)
TRADE	0.006	0.007
	(0.005)	(0.005)
PRIVATE	0.007	0.007
	(0.007)	(0.006)
BRADY	-0.006	0.002
	(0.008)	(0.009)

Table 6: Estimation Results : Years 9 to 12

One can clearly see a 99% significant negative effect in which average GDP per capita growth is 2% lower than the long run mean. Just as I argued that the above temporary increase in growth resulted in a permanent level increase, the temporary decrease in growth in years 9 to 12 also results in a permanent decrease in the standard of living. After four years, the average level of GDP per capita will be $9,308 * e^{(-0.0203+0.0172)*4} = 9,193$ PPP-adjusted dollars. Without the capital account liberalization, the real GDP per capita would be $6,630 * e^{0.0172*13} = 8,292$ PPP-adjusted dollars, still 901 PPP-adjusted dollars less. Starting at the

lower bound of the 95% confidence interval for the original point estimate above (recall, $6,630 * e^{(0.0172+0.007)*9} = 8,243$), one obtains $8,243 * e^{(-0.0203+0.0172)*4} = 8,141$ PPP-adjusted dollars. This level of GDP per capita is now below the real GDP per capita without the capital account liberalization ($6,630 * e^{0.0172*13} = 8,292$). To summarize, one can no longer be 95% confident that twelve years after a capital account liberalization, the average country is empirically better off.

What happens if Korea, Thailand, Malaysia, and Indonesia are removed from the data? The results are shown in Table 5 and Table 6. Surprisingly, the same pattern occurs as in the above regressions when including each of the four countries. There is a slight decrease from 99% significant to 95% significant for the above regressions but otherwise the same pattern holds (increase in significance and magnitude up to year 9 then decrease in magnitude and significance when including each additional year). This means the estimates in the medium term are not simply capturing the Asian financial crisis, as the results still hold even when controlling for the countries involved. These results even hold when Zimbabwe is removed in addition to the other four countries.

By taking into account the data in the medium run, it is evident that there exists a reversal in the effects of a liberalization on growth of GDP per capita that is not being picked up in the short run. The predicted average growth by the neoclassical Solow model in years 9 to 12 is 2.54% but the actual average growth over this same time window is 0.5%. Thus, these findings should lend skepticism to the critique that cross sectional regressions are not finding effects simply due to not properly testing the theory. When one takes the predictions of neoclassical theory seriously, as Henry (2007) requests, it is clear there is an effect on growth that is decreasing over time. But is this effect decreasing over time strictly because of predictions of the theory, or is there more going on that the theory is not predicting?

The theory says the effect on liberalization should drop by about one percentage point from year 1 to year 11, but the data reflects a drop of almost four percentage points. Clearly, even after controlling for the Asian financial crisis by removing the affected countries, a reversal is taking place that is not explained by neoclassical theory. In other words, unlike Henry (2007), I am skeptical that neoclassical theory adequately explains why a significant effect is found in the short run that is not found in the long run.

5 Conclusion

What are the effects of capital account liberalization on growth? How should we measure these effects? Are the effects only found in the short run, long run, both, or neither? Are these effects economically meaningful? The goal of this paper was to answer these questions by modeling the effects of a capital account liberalization in the Solow economy.

I found that capital account liberalization has a 99% significant positive effect when looking at a time window up to 8 years after a liberalization. This temporary effect leads to atleast (with 95% confidence) a 502 PPP-adjusted dollar increase in the level of the real GDP per capita in comparison to a country that does not liberalize. However, I also found a significant negative effect in the four years after (years 9 to 12). This reversal in sign is found even after removing countries from the sample that were affected by the Asian financial crisis. Based on this negative effect, one can no longer be 95% confident that twelve years after a capital account liberalization, the average country is empirically better off.

The neoclassical theory predicts that the impact of a liberalization is temporary and declining over time. This is confirmed in the data by Table 4 and Table 5. However, the theoretical predictions of the Solow model only predict a 1 percent drop of the effect on growth from year 1 to year 11. The data reflects a drop of almost four percentage points over the same time period. Thus, there is more to the story of a declining effect that is predicted by neoclassical theory, as the drop is much greater than expected. By focusing on the medium run, I have found patterns in the data that explain the short run positive effect while at the same time showing evidence for why there is the lack of significance found in the long run. The reversal in years 9 to 12 is key to the latter finding, and the effect over this time period is not adequately explained by the predictions of neoclassical theory. More research is needed to explain what is driving these negative effects that are found in between the short run and the long run.

Table 11.Capital Account Liberalizations Occur Around the Same Time as Other Major Economic Reforms.

Country	Capital Liberalization	Stabilization Program	Trade Liberalization	Privatization	Brady Plan Debt Relief
Argentina	Nov-89	Nov-89	Apr-91	Feb-88	Apr-92
Brazil	Mar-88	Jan-89	Apr-90	Jul-90	Aug-92
Chile	May-87	Aug-85	1976	1988	NA
Colombia	Dec-91	NA	1986	1991	NA
Egypt	Feb-91	Apr-91	Apr-91	Apr-91	NA
Greece	Jul-94	Jul-89	Apr-53	Nov-90	NA
India	Jun-86	Nov-81	1994	1991	NA
Indonesia	Sep-89	May-73	1970	1991	NA
Israel	Oct-89	Jul-85	Feb-52	Jan-86	NA
Jordan	Dec-95	May-94	1965	Jan-95	Jun-93
Malaysia	May-87	NA	1963	1988	NA
Mexico	May-89	May-89	Jul-86	Nov-88	Sep-89
Morocco	Dec-92	Jan-84	Sep-83	1993	NA
Nigeria	Aug-95	Jan-91	NA	Jul-88	Mar-91
Pakistan	Feb-91	Sep-93	2001	1990	NA
Philippines	May-86	Oct-86	Nov-88	Jun-88	Aug-89
Portugal	Jan-93	Oct-90	Jan-60	Apr-89	NA
South Africa	Mar-95	Mar-86	Apr-94	Apr-94	NA
South Korea	Jun-87	Jul-85	1968	NA	NA
Spain	Jan-93	Jan-78	Jul-59	1985	NA
Taiwan	May-86	NA	1963	NA	NA
Thailand	Sep-87	Jun-85	Always Open	1988	NA
Turkey	Aug-89	Jul-94	1989	1988	NA
Venezuela	Jan-90	Jun-89	May 1989**	Apr-91	Jun-90
Zimbabwe	Jun-93	Sep-92	NA	1994	NA

Notes: The capital account liberalization dates identified in this table are the dates on which the eighteen countries in Column 1 eased restrictions prohibiting foreign ownership of domestic stocks. The liberalization dates in Column 2 are an amalgamation of those in Henry (2000), Levine and Zervos (1998b) and Bekaert and Harvey (2000). Columns 2 through 6 list the dates of major economic reforms that occurred around the same time as the capital account liberalizations. The stabilization program dates in Column 3 come from Henry (2002) and various issues of the IMF Annual Reports. Column 4 lists trade liberalization dates from Sachs and Warner (1995). The privatization dates in Column 5 come from the Privatization Data Base maintained by the World Bank. Finally, Column 6 lists the month and year that each country received debt relief under the Brady Plan. The debt relief dates come from Cline (1995), Lexis Nexis, and various issues of the *Economist Intelligence Unit*. **Venezuela reversed its trade liberalization reforms in 1993.