___Endogeneity in the Wage-Capital equation____

We should be concerned about simultaneous causation in equation #<>. Modeling only one side of the supply-demand relationship is a well-known pitfall in econometrics. However, the relationship between capital stock and the wage premium is indirect: it operates through the complementarity of capital and high-skilled labor. Therefore, it is not appropriate to model the relationship as a full supply-demand simultanous equation system.

We will still take an instrumental variable approach. A straightforward instrument for the level of capital stock is r, the price of capital accumulation. In a closed economy, r is determined endogenously; firms' solutions to their profit maximization problems should ensure that $r = {}^{\partial F}/_{\partial K}$, where $F(\cdot)$ represents the aggregate production function. In an open economy, r can be determined exogenously. The import price of capital goods determines the domestic capital price in the Atolia model. Clearly we want to avoid assuming aspects to the Atolia model while we test it, however. We can rely on other models in which international financial markets can exogenously determine r<citation?>. Thus, r is determined in other countries rather than endogenously. In principle, this could lead to all countries facing the same r, which would present a statistical identification problem. We observe that r is not equalized across countries, though, so we can proceed <make citation of a paper dealing with this. Also, this challenges a bit our assertion that r is exogenously determined>.

According to the firm's optimization problem, if an exogenous shock to r leads to ${}^{\partial F}/_{\partial K} < r$, then capital should be accumulated faster. If ${}^{\partial F}/_{\partial K} > r$, then the capital stock should shrink. This leads to the following functional relationship: ${}^{\partial K}/_{\partial t} = G(r)$, i.e. the change of K over time is a function of r. Our RHS variable in equation #<> is in levels of K, not change, so we must integrate both sides with respect to time: $K = \int_a^b G(r)\,dt$. If $G(r)$ is simply linear, then we can approximate this relationship by simply summing over the value of r in each time period: $K = \sum_{t=a}^{b} r_t + \epsilon$. For an IV strategy, we need the assumption that r affects the wage premium only through its effect on capital accumulation. <TODO: justify a little>. The first stage of the model can then be expressed as

$$\triangle \ln K_{it} = \alpha'' + \beta_r \triangle \ln \left(\sum_{t=a}^{b} r_t\right) + \triangle\, \xi_{it}$$

and the second stage is just the original equation that we wanted to estimate:

$$\triangle \ln \frac{w_{H\,it}}{w_{L\,it}} = \alpha' + \beta_K \triangle \ln K_{it} + \triangle\, v_{it}$$

An estimate of r for each country and year is available from the Penn World Table. We will divide the price of investment by the price of consumption to obtain the real investment price. We choose the years 1975-1990 for the first period measurement of $\sum_{t=a}^{b} r_t$ and 1991-2004 for the second period, which matches the periods of measurement for capital stock growth in the tariff-capital equation.

The fatal flaw in the approach outlined above is that r turns out to be an extremely weak instrument for capital accumulation. The F-statistic for a regression of $\triangle \ln K_{it}$ on $\triangle \ln \left(\sum_{t=a}^{b} r_t\right)$ is 0.20. In light of the rule of thumb that an instrument is weak if the F-stat is less than ten, this instrument appears to be useless. <Staiger and Stock (1997) http://www.econ.brown.edu/fac/Frank_Kleibergen/ec266/staigerstock1997.pdf> Therefore, we have to discard this approach. If we cannot detect an effect of the price of investment on capital accumulation, then it seems no other variable would be powerful enough to act as a strong instrument, so here we abandon our efforts to handle endogeneity in the wage-capital equation. As consolation, the weakness of r as an instrument for capital accumulation provides indirect evidence that the effect of the wage premium upon capital accumulation may be weak. That is to say, if the price of capital accumulation itself does not detectably affect capital accumulation, the price of another factor of production probably does not affect it either. Hence, the problem of endogeneity that spurred this exercise may not be worrisome. In any case, the results

___Results__

<say that throughout, our precision is limited by sample size>

Among developing countries, the correlation between changes in capital and consumption tariffs is 0.89. Thus, regressing capital accumulation against both variables (and their product) would inflate the variance of the estimated coefficients. Any effect may be masked by this variance inflation. Therefore, we will start by presenting a parsimonous specification that only includes the product of the two tariffs, which is our main coefficient of interest. Table 1 displays these results.

Given that many coefficients are not different from zero, the table shows t-statistics rather than standard errors so it is easier to assess the distance from statistical significance. Among developing countries, we detect no effect of the capital and consumption tariff cross term on the rate of capital accumulation, although the sign of the point estimate is consistent with the theory. The level of capital stock, however, does have an effect on the wage premium that is different from zero at the 5% level. We have estimated that a one percent rise in the per capita capital stock leads to a 0.3% rise in the ratio of high-skill wages to low-skill wages.

We also include an estimation of the same model with both developed and developing countries. Interac-

Table 1: First difference SUR without instrument on first equation
(t-statistics in parentheses)

	Sample			
	Developing countries		World	
	Dependent variable			
	1st eqn %Δ of per capita K	2nd eqn $\ln(w_H/w_L)$	1st eqn %Δ of per capita K	2nd eqn $\ln(w_H/w_L)$
(Intercept)	−0.008	−0.085	−0.006	0.144
	(−1.511)	(−1.324)	(−1.389)	(1.127)
$\ln(1+\tau_K/100) \times \ln(1+\tau_C/100)$	−0.042		0.306	
	(−1.414)		(1.115)	
ln(Per capita K stock)		0.318^{**}		−0.311
		(2.536)		(−0.890)
Developing country			−0.002	−0.229
			(−0.303)	(−1.665)
$\ln(1+\tau_K/100) \times \ln(1+\tau_C/100) \times$ Dev cntry			−0.348	
			(−1.264)	
ln(Per capita K stock)× Developing country				0.629^{*}
				(1.733)
R^2	0.081	0.238	0.123	0.224
Adj. R^2	0.045	0.207	0.060	0.161
Num. obs.	27	26	46	41
Residual ρ between equations		0.096		0.060

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

tion terms separate the effects on the two groups. For the Atolia theory to be true, we need the effect to exist for developing countries, but not for developed countries. The results are consistent with the theory. The effect of the product of capital and consumption tariffs for developing countries is not statistically different from zero, but the estimated sign is negative, consistent with theory. Furthermore, the point estimate for developed countries is positive but not statistically significant. If these effects were statistically significant, we might conclude that the Atolia mechanism holds for developing countries but not developed countries. Finally, the results indicate that the positive effect of capital stock on the wage premium holds only for developing countries.

Table 2: First difference 3SLS with GATT membership × 1985 average tariff as instrument on first equation (t-statistics in parentheses)

	Sample			
	Developing countries		World	
	Dependent variable			
	1st eqn %Δ of per capita K	2nd eqn $\ln(w_H/w_L)$	1st eqn %Δ of per capita K	2nd eqn $\ln(w_H/w_L)$
(Intercept)	-0.009	-0.085	-0.023	0.144
	(-1.608)	(-1.324)	(-0.776)	(1.101)
$\ln(1+\tau_K/100)\times\ln(1+\tau_C/100)$	-0.059		-1.669	
	(-1.431)		(-0.474)	
ln(Per capita K stock)		0.318^{**}		-0.311
		(2.536)		(-0.870)
Developing country			0.013	-0.229
			(0.431)	(-1.627)
$\ln(1+\tau_K/100)\times\ln(1+\tau_C/100)\times$ Dev cntry			1.610	
			(0.457)	
ln(Per capita K stock)× Developing country				0.629^{*}
				(1.693)
R^2	0.068	0.238	-1.013	0.224
Adj. R^2	0.031	0.207	-1.164	0.161
Num. obs.	27	26	44	41
F-stat on first stage	25.530		52.638	
Residual ρ between equations		0.118		-0.004

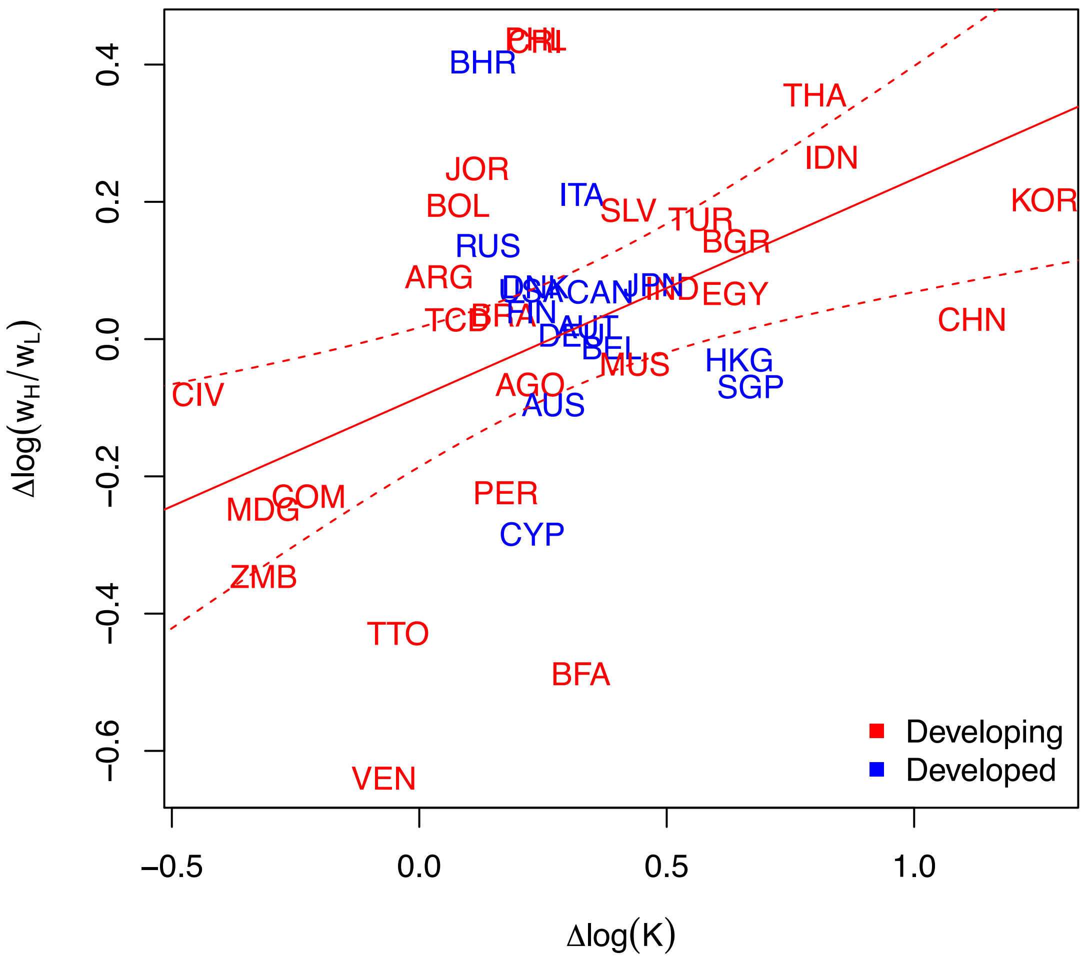
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table 3: First difference saturated SUR without instrument on first equation (t-statistics in parentheses)

	Sample			
	Developing countries		World	
	Dependent variable			
	1st eqn %Δ of per capita K	2nd eqn $\ln(w_H/w_L)$	1st eqn %Δ of per capita K	2nd eqn $\ln(w_H/w_L)$
(Intercept)	-0.007	-0.085	-0.005	0.144
	(-0.943)	(-1.324)	(-0.585)	(1.127)
$\ln(1+\tau_K/100)\times\ln(1+\tau_C/100)$	-0.066		0.196	
	(-0.665)		(0.129)	
$\ln(1+\tau_K/100)$	-0.016		0.108	
	(-0.184)		(0.174)	
$\ln(1+\tau_C/100)$	0.026		-0.053	
	(0.450)		(-0.198)	
ln(Per capita K stock)		0.318^{**}		-0.311
		(2.536)		(-0.890)
Developing country			-0.002	-0.229
			(-0.181)	(-1.665)
$\ln(1+\tau_K/100)\times\ln(1+\tau_C/100)\times$ Dev cntry			-0.262	
			(-0.172)	
$\ln(1+\tau_K/100)\times$ Developing country			-0.124	
			(-0.199)	
$\ln(1+\tau_C/100)\times$ Developing country			0.079	
			(0.291)	
ln(Per capita K stock)$\times$ Developing country				0.629^{*}
				(1.733)
R^2	0.092	0.238	0.133	0.224
Adj. R^2	-0.027	0.207	-0.027	0.161
Num. obs.	27	26	46	41
Residual ρ between equations		0.049		0.020

$^{***}p<0.01$, $^{**}p<0.05$, $^{*}p<0.1$

Figure 1: Capital accumulation raises wage premium for developing countries



<TODO: Look at schooling - like the supply of high skilled labor>

<in our data table, can say that a var coresponds to something in the PWT>