Inequality dynamics under trade in developing countries

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Abstract

This paper tests the theory that trade liberalization leads to asymmetric capital accumulation, thereby increasing wage inequality. We use panel data of developing countries from pre- and post-trade liberalization movement in the 1990's. To deal with the endogeneity problem that potentially impacts the relationship between trade liberalization and capital accumulation, we instrument the liberalization using historical tariff levels and GATT membership status. From the estimation results, we could not detect an effect of trade liberalization on capital accumulation. However, there is some evidence that capital accumulation increases the wage skill premium in developing countries.

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1 Introduction

1.1 Motivation and Literature review

The Heckscher-Ohlin model predicts lower wage inequality under trade in developing countries. Instead, lower tariffs have been associated with higher inequality in the developing world. Atolia (2007) provides a reconciliation to the Hechscher-Ohlin prediction, arguing that the adverse effect of trade on wage inequality is only temporary. We wish to empirically test this theory.

This section investigates the effect of trade on wage inequality by exploration of theoretical models, as well as empirical evidence.

Heckscher-Ohlin model and inconsistency in the data

Let us first go back to the basic Heckscher-Ohlin (HO) trade model with two countries (the North and the South) and two goods (high-skilled and low-skilled-intensive goods). We can think of the North as developed countries and the South as developing counterparts. The North (*the South*) has relatively large supply of high-skill labor (*low-skilled labor*) and thus has a comparative advantage in high-skilled- (*low-skill*ed-) intensive goods. When trade opens, we assume that the cost of producing each good become the same across countries. Assuming zero trade costs (transportation, tariffs, etc.–also known as iceberg costs), the price of goods become the same across countries. Under a comparative advantage framework, the North (*the South*) will export high-skilled- (*low-skill*ed-) intensive goods. The relative price of low-skilled-intensive goods will increase in the South. By the Stolper-Samuelson theorem[1], this will raise the South's demand for low-skilled labor and their relative wage. Therefore, the HO model implies that trade should lead to a lower *wage premium* (the ratio of wages between high-skilled and low-skilled labors) in developing countries.

Nevertheless, this prediction is inconsistent with the experiences of Latin America and some Asian countries. Researchers have proposed varied explanations for this. Some studies such as Hanson & Harrison (1999) and Beyer, Rojas & Vergara (1999)find that trade reforms in Mexico and Chile during mid 1980s have resulted in higher wage premium. Both studies find that trade exposes the low-skill-intensive industry to competition from other countries with large supply of low-skilled labors. This drives down the relative price of low-skilled-intensive goods and hence reducing relative wage for low-skilled workers. Hasan and Jandoc (2010) studies the relationship in the Philippines during the second half of the 1990s. They find that trade induces an employment shift from exposed sectors to more protected sectors–especially service

[1]Stolper and Samuelson theorem states that the return to the intensively-used factor will increase if the relative price of the good increases.

sector, in which wage premium tends to be higher. In conclusion, wage inequality increases under trade in these economies.

Dornbusch, Fisher and Samuelson (1980) provides a formalized model explaining how wage inequality rises with trade. This model is based on the HO trade model with two countries but a continuum of goods which are ranked by level of skill needed in the production technology. On average, the North (*the South*) will export high-skilled- (*low-skill*ed-) intensive goods. Suppose there is a positive shock in the world demand for high-skilled-intensive goods. This decreases the relative wage of low-skilled labor. Suppose instead there is a positive shock to the South's supply of low-skilled labor. This also decreases relative wage of low-skilled labor. In both scenarios, wage inequality increases. If the two countries differ significantly, we can also have the case of complete specialization. In this case, the South exports goods ranged from the lower end of the skill-intensity rank up to a cutoff point. The North exports goods starting from the cutoff point up to the higher end of the skill-intensity rank. This allows us to consider the case of technological catch-up of developing countries. Supposing there is a positive shock to the production technology in the South, the country can export goods in the higher skill-intensity range, raising the cutoff point. Zhu and Trefler (2005) finds empirical evidence supporting the theory that technological catch-up under trade increase wage inequality in the developing countries.

So, is trade liberalization is bad for wage equality after all? The answer might be no, at least for the long run according to Atolia (2007).

Atolia (2007) model: inequality dynamics under trade in developing countries

Atolia (2007) constructed a model to explain the welfare effect of trade liberalization in Latin American countries. We believe that it can be extended to developing countries in general. Assume there are three sectors in the economy: non-traded (e.g. construction), export and import-competing sectors. The export sector produces low-skilled-intensive goods while the import-competing sector produces high-skilled-intensive goods. Inputs[2] in this model are composed of capital stock, imported capital goods (i.e. machineriy) and labor (low-skilled and high-skilled). Capital stock is produced using imported capital goods and non-traded goods. It is mobile but subjected to adjustment costs. Labor is freely mobile across sectors.

In the transition to free trade in the Atolia model, lowered tariffs on capital goods reduce the cost of capital accumulation, while tariff reduction in consumption goods exposes the import-competing sector to

[2]In Atolia's terminology, inputs are composed of capital goods, imported intermediate goods (i.e. machinery), and labor. We change the terminologies in order to be consistent with other parts of the paper. In particular, Atolia's "intermediate goods" become capital goods. His "capital goods" become capital stock. We believe that this modification preserves the intended meaning of these variables in the model.

foreign competition. This implies that export sector will suddenly increase its rate of capital accumulation due to cheaper price of capital. On the other hand, the import-competing sector will contract due to foreign competition, and it will have to decumulate its capital stock. This transition will be slow as capital stock are not freely mobile across sectors. Therefore, trade liberalization will lead to *asymmetric capital accumulation;* Export sector suddenly increases its capital accumulation while import-competing sector gradually decumulate its capital stock. Under the assumption of capital-skill complementarity, the export sector will increase the demand for high-skilled labor. This will increase their relative wage. For the short-run, trade will therefore increase wage inequality through the process of *asymmetric capital accumulation*. Table 1 summarizes the short-run dynamics in this model. In the long run, however, the economy will reach the new steady state. Atolia's numerical simulations indicate worsening inequality for thirty years or more. This defines short-term to be a few decades following the liberalization.

Table 1: Short-run dynamics in the Atolia model

Trade liberalization:	Capital Accumulation:	Wage premium:
Consumption goods	$\Rightarrow \downarrow \triangle K$	$\Rightarrow \downarrow w_H/w_L$
Capital goods×Consumption goods	$\Rightarrow \uparrow \triangle K$	$\Rightarrow \uparrow w_H/w_L$

An important caveat in this model lie in the assumption that developing countries acquire all its intermediate goods from abroad. Even though this is a strong assumption, there are some supporting evidences. Alfaro and Ahmed (2009) take a look into disaggreated trade data and find that many developing countries import large fractions of capital goods from developed countries.

To our knowledge, there has not been any empirical work studying the effect of trade on wage inequality via *capital accumulation*. Therefore, we would like to test this relationship based on Atolia's model using data from developing countries.

1.2 Research question and hypothesis

Our main research question is: Does trade liberalization increase wage inequality in the short run through *asymmetric capital accumulation*[3]?

Specifically, we would like to test:

1. Whether trade liberalization in capital goods increases overall capital accumulation.

[3]As explained in the above section, *asymmetric capital accumulation* is Atolia's term used to explain a sudden increase in rate of capital accumulation in export sector versus the gradual capital decumulation in import-competing sector.

2. Whether trade liberalization in consumption goods decreases overall capital accumulation.

3. Whether the interaction between trade liberalizations in capital and consumption goods increases overall capital accumulation.

4. Whether capital accumulation increases the *wage premium* (the ratio of wage between high-skilled and low-skilled occupations)

2 Empirical model

The Atolia model predicts sector-specific changes in capital accumulation. Ideally, we would like to directly measure these effects. However, there is no extant cross-country data on capital stock by sectors. Atolia nevertheless predicts an overall change in the aggregate capital stock of the country, so we can still hope to test the model with aggregate capital data. The theoretical model suggests two relationships, the first of which can be modeled by the following equation:

$$\ln\left(\frac{K_{it}}{K_{it-1}}\right) = \alpha \; + \; \beta_{\tau K}\, \tau_{it}^{K} \; + \; \beta_{\tau C}\, \tau_{it}^{C} \; + \; \beta_{\tau(K\times C)}\, (\tau_{it}^{K} \times \tau_{it}^{C}) \; + \; u_{it} \tag{1}$$

where

K_{it} is the capital stock per capita in country i in time t,

$\tau_{it}^{K}$is the tariff on capital goods, and

$\tau_{it}^{C}$is the tariff on consumption goods.

This capital-tariff equation captures Atolia's predictions of the effect of trade liberalization on the rate of capital accumulation. Since a cut only to tariffs on consumption goods will cause the capital-intensive import-competing sector to contract, with no corresponding rise in capital in the export-oriented sector, we expect $\beta_{\tau C} > 0$. When both capital and consumption tariffs are cut, the export-oriented sector accumulates capital faster than the import-competing sector decumulates it, so we expect $\beta_{\tau(K\times C)} < 0$. This cross term is interpreted as an interaction effect, i.e. the additional effect when a country is a liberalizer in both capital and consumption goods trade. Atolia is silent on what would happen if only capital tariffs were cut, but the economy-wide lower price in capital should increase the incentive to accumulate capital, so we predict that $\beta_{\tau K} < 0$.

The second equation that the Atolia model suggests is:

$$\ln\left(\frac{w_{H\,it}}{w_{L\,it}}\right) = \alpha' + \beta_K \ln K_{it} + v_{it} \tag{2}$$

where

$\frac{w_{H\,it}}{w_{L\,it}}$ is the ratio of high-skilled wage to low-skilled wage and

K_{it} is the capital stock per capita.

Under the Atolia assumption of complementarity between high-skilled labor and capital, a higher stock of capital should raise the wage premium for high-skilled workers. Hence the prediction of the theory is $\beta_K > 0$.

Since capital appears on the left side of the first equation and the right side of the second equation, the structure of the two equations above may suggest a two-stage least squares approach. However, proceeding in that way would require us to assume that trade liberalization only affects the wage premium through its affect on capital accumulation We are not prepared to make this claim. Moreover, the capital-tariff equation deals with the *growth* of capital, while the wage-capital equation involves the *level* of capital, ruling out a two-stage least squares strategy.

We will use first difference to condition on country-specific effects. Our identification strategy is thus difference-in-differences, where the treatment is continuous (tariff and capital stock levels) rather than discrete. We need the parallel trend assumption for identification. On the capital-tariff relationship, this requires countries with a high tariff would have had the same change in the rate of capital accumulation as those with a low tariff, absent the actual change in trade policy. Similarly, in the wage-capital relationship we need low-capital countries to have had the same change in wage premium as the high-capital countries, absent the actual rise in capital.

Our data on disaggregated tariffs limits us to estimating the above equations with just two periods: roughly the late 1980's to the early 2000's. This time frame is well within the "short-run" period of Atolia.

3 Estimation

Since we are estimating two equations with the same sample, a seemingly unrelated regressions approach permits us to obtain more efficient estimates of the parameters. We have a small number of observations, so any increase in statistical power is welcome. In practice, the residuals of the two regressions are nearly uncorrelated, so there is little advantage to using seemingly unrelated regressions compared with estimating each equation individually.

Endogeneity is a concern in the two equations. To handle this problem, we can use three-stage least squares. This involves simply instrumenting for endogenous variables in each equation individually and then using the seemingly unrelated regressions technique to make use of the correlated residuals of the two equations.

3.1 Endogeneity in the capital-tariff equation

We are worried about possible endogeneity in Equation (1) since factors like institutions may play a role affecting both trade openness and capital accumulation. To deal with this problem, we follow the instrumental variable technique from Estevadeordal & Taylor (2013). The paper studies the effect of trade liberalization on economic growth using two different instruments:

$$Average\,Tariffs_{1985} \times GATT\,membership_{1975}$$
$$Average\,Tariffs_{1985} \times Great\,Depression\,Depth$$

where $Great\,Depression\,Depth = GDP_{1935}/GDP_{1929}$. They believe that these instruments indicate both ability and willingness of countries to engage in trade liberalization movement in the 1980-90s. For $Average\,Tariffs_{1985}$, if a country had high tariff in 1985, it would have ability to have a big tariff cut in the following period. $GATT\,membership_{1975}$ is a binary variable indicating General Agreement of Tariffs and Trade (GATT) membership in 1975. If a country was a member of GATT, then it would be more likely to later join trade liberalization movement. $Great\,Depression\,Depth$ is how much a country suffered from the Great Depression. Estevadeordal & Taylor believe that this determines policy makers' openness to trade. They find that these provide strong instruments for tariff reduction. For us to be able to use these instruments, we need to make sure exclusion restrictions hold. In other words, there is no direct relationship between the two instruments and our dependent variable *capital accumulation.* For *Great Depression Depth,* we believe that factors affecting GDP in the 1930s are not the same factors affecting capital accumulation in the 1980-90s. For *GATT membership,* we also believe that the decision to enter GATT in 1975 should not have any impact on 1980s to 1990s capital accumulation. Therefore, the exclusion restriction should be valid.

3.2 Endogeneity in the wage-capital equation

We should be concerned about simultaneous causation in Equation (2). 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 simultaneous equation system.

We will still take an instrumental variable approach. A straightforward instrument for the level of capital stock is the price of capital accumulation r. 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 (Barro, Mankiw & Sala-I-Martin 1995). 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.

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 (2) 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. The first stage of the model can then be expressed as

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

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

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

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 first differences regression of $\ln K_{it}$ on $\ln\left(\sum_{t=a}^{b} r_t\right)$ 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 & Stock, 1997). 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 variables 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.

4 Data

We used data from three sources: the Penn World Table, Estevadeordal & Taylor (2013), and Occupational Wages of the World. Table 2 summarizes the variables and their sources. Our sample size is limited by the coverage of the tariff data in Estevadeordal & Taylor and the wage data in Occupational Wages of the World.

Table 2: Data sources

Variable	1st Period	2nd Period	Source
Per capita capital stock growth	1975-1990	1990-2004	Penn World Table
Per capita capital stock	1985-1990 mean	1999-2004 mean	Penn World Table
Disaggregated tariffs	1985-1993	2000-2004	Estevadeordal & Taylor (2013)
Disaggregated wages	1985-1991 mean	1999-2008 mean	Occupational Wages of the World
Aggregated 1985 tariffs			Estevadeordal & Taylor (2013)
Great Depression depth			Estevadeordal & Taylor (2013)

We measured the rate of capital stock accumulation as the geometric growth between 1975 and 1990 for the first period and 1990 and 2004 for the second. This corresponds to the GDP growth period that Estevadeordal & Taylor (2013) use to estimate the effect of capital tariffs on GDP growth. For measuring capital stock levels, we take the average of two six-year periods to mitigate the impact of business cycles on the data.

Wages in supervisory and technical occupations were defined as "high-skilled", while everyone else, such as production line workers, were defined as "low-skilled". This is in accordance with Zhu & Trefler (2005). Only

workers in the manufacturing sector were included. Since we did not have measurements of the number of workers in each occupation, we computed the simple average of all occupations in each skill category. Ideally, the periods of time for measurement of capital stock and wages would be the same, but missing occupational wage data was a serious problem. Therefore, we somewhat extended the period of time of measuring wage data to avoid dropping too many countries from the sample.

Estevadeordal & Taylor recorded three different tariff measures: tariffs on consumption goods, intermediate goods, and capital goods. They could not obtain disaggregated tariff data for the same years in each country, so the measured tariff rates are spread over a number of years. In their main regression specification, Estevadeordal & Taylor used the simple average of intermediate and capital goods tariffs to explain GDP growth. Therefore, we will use this average and call it capital goods tariff for the remainder of this paper. The number of countries available in the tariff dataset is limited, but there is no obvious reason that selection bias may be a factor in our analysis.

Summary statistics of the variables, after transformation and taking first differences, are available in Tables 3 and 4. We use the World Bank's classification of developing country as of the 1980's.

Table 3: Summary statistics of developing countries (first differences)

	Mean	Std. dev	Min	Max
$\%\Delta$ of per capita K	-0.002	0.021	-0.043	0.040
$\ln(1+\tau_K/100)$	-0.155	0.121	-0.447	0.040
$\ln(1+\tau_C/100)$	-0.205	0.206	-0.719	0.122
$\ln(1+\tau_K/100)\times\ln(1+\tau_C/100)$	-0.109	0.132	-0.550	0.018
$\ln(w_H/w_L)$	0.007	0.279	-0.640	0.437
ln(Per capita K stock)	0.296	0.376	-0.447	1.263

Table 4: Summary statistics of developed countries (first differences)

	Mean	Std. dev	Min	Max
$\%\Delta$ of per capita K	-0.009	0.008	-0.028	0.010
$\ln(1+\tau_K/100)$	-0.037	0.040	-0.193	0
$\ln(1+\tau_C/100)$	-0.052	0.056	-0.247	0.017
$\ln(1+\tau_K/100)\times\ln(1+\tau_C/100)$	-0.008	0.014	-0.063	0.0001
$\ln(w_H/w_L)$	0.041	0.151	-0.284	0.404
ln(Per capita K stock)	0.320	0.141	0.129	0.670

5 Results and discussion

Among developing countries, the correlation between changes in capital and consumption tariffs is 0.89. Thus, regressing the rate of 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 parsimonious specification that only includes the product of the two tariffs, which is our main coefficient of interest. Table 5 displays these results for the seemingly unrelated regressions model.

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 1% rise in the per capita capital stock leads to a 0.3% rise in the ratio of high-skill wages to low-skill wages.

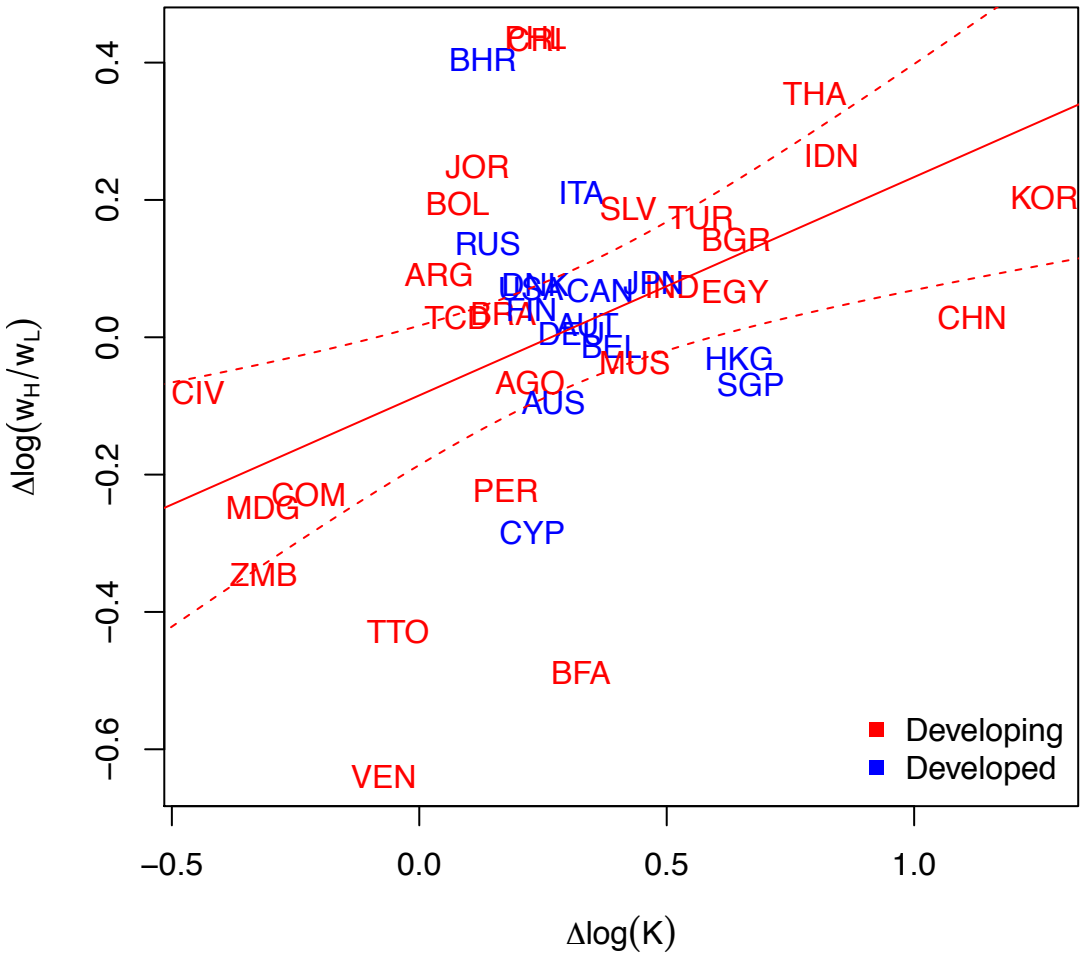
We also include an estimation of the same model with both developed and developing countries. Interaction terms separate the effects on the two groups. For the Atolia theory to be true, we need the effect to exist for developing countries, but not for developed countries. The results are consistent with 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 for the wage-capital equation suggest that the positive effect of capital stock on the wage premium holds only for developing countries. This result is visualized in Figure 1.

Table 5: First difference SUR without instrument on first equation
(t-statistics in parentheses)

	Sample			
	Developing countries		World	
	Dependent variable			
	1st eqn $\%\Delta$ of per capita K	2nd eqn $\ln(w_H/w_L)$	1st eqn $\%\Delta$ 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

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

Figure 1: Capital accumulation raises wage premium for developing countries



When the tariff level is instrumented by $Average\,Tariffs_{1985} \times GATT\,membership_{1975}$ in a three-stage least squares design, the results for the developing country sample, shown in Table 6, are basically unchanged. On the other hand, the signs of the coefficients on the capital-tariff equation for the world sample are the opposite of what they were in the uninstrumented regression. If these coefficients were statistically significant, it would challenge the theory that lower capital tariffs increase the capital stock for developing countries but not developed. However, the very low precision of the estimates here (t-stats around 0.4) means that we cannot conclude that any violation of the Atolia theory really exists. A Wu-Hausman test cannot reject the null hypothesis of no endogeneity, but the test is expected to have low power in this environment of having a small number of observations.

Table 6: First difference 3SLS with $Average\,Tariffs_{1985} \times GATT\,membership_{1975}$ as instrument on first equation
(t-statistics in parentheses)

	Sample			
	Developing countries		World	
	Dependent variable			
	1st eqn $\%\Delta$ of per capita K	2nd eqn $\ln(w_H/w_L)$	1st eqn $\%\Delta$ of per capita K	2nd eqn $\ln(w_H/w_L)$
(Intercept)	−0.009	−0.085	−0.022	0.144
	(−1.608)	(−1.324)	(−0.745)	(1.127)
$\ln(1+\tau_K/100) \times \ln(1+\tau_C/100)$	−0.059		−1.845	
	(−1.431)		(−0.484)	
ln(Per capita K stock)		0.318**		−0.311
		(2.536)		(−0.890)
Developing country			0.013	−0.229
			(0.409)	(−1.665)
$\ln(1+\tau_K/100) \times \ln(1+\tau_C/100)\times$ Dev cntry			1.786	
			(0.469)	
ln(Per capita K stock)× Developing country				0.629*
				(1.733)
R^2	0.068	0.238	−1.244	0.224
Adj. R^2	0.031	0.207	−1.404	0.161
Num. obs.	27	26	46	41
F-stat on first stage	25.530		55.866	
P-value of Wu-Hausman endogeneity test	0.557		0.411	
Residual ρ between equations		0.118		−0.011

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

Table 7: First difference saturated SUR without instrument on first equation (t-statistics in parentheses)

	Sample			
	Developing countries		World	
	Dependent variable			
	1st eqn $\%\Delta$ of per capita K	2nd eqn $\ln(w_H/w_L)$	1st eqn $\%\Delta$ 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)× 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

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

For completeness, we also present the results with the "saturated" seemingly unrelated regressions model of capital tariffs, consumption tariffs, and their product in Table 7. As expected, the high correlation between the two tariffs greatly inflates the variance of the coefficients. The point estimates are consistent with the Atolia theory, however, since the sign of the capital tariff coefficient is negative while the sign of the consumption tariff is positive. We also estimated a three-stage least squares model. To instrument for the consumption tariff, we used $Average\,Tariffs_{1985} \times Great\,Depression\,Depth$ as Estevadoreal & Taylor did, but the variance of the coefficients is so large that we will not present the results here.

6 Conclusion

In light of our empirical test, we cannot reject the Atolia theory. The precision of our estimates suffers badly from a small sample size. As a result, we cannot be sure of the sign of the effect of tariff levels on capital accumulation, or even if it is nonzero. On the other hand, the positive effect of capital accumulation on the wage premium among developing countries offers limited support for the theory. In some sense, this effect is the less important part of the theory since it could, arguably, be unrelated to trade. The estimated elasticity of the wage premium with respect to the level of capital stock in developing countries is 0.3.

Our estimation strategy suffers from a few weaknesses that we hope to address in the future. Our inability to eliminate possible endogeneity in the wage-capital equation softens confidence in our results somewhat. We were not able to obtain sector-specific estimates of capital stock, which prevents us from having a sharp identification of the Atolia model. Finally, in recent years some economists have challenged the robustness of cross-country regressions (Durlauf 2009). Nevertheless, we have moderate confidence in our results. Our analysis suggests that an augmented Hechscher-Ohlin model has a role to play in explaining the impact of trade liberalization on domestic inequality.

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