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Trade Policy and the Household Distribution of Income

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Abstract: We explore the relationship between import protection and the household distribution of income. We first develop a general-equilibrium mapping from tariffs to household inequality measures. This also yields predictions for linkages between tariffs, development level, and observed household inequality. Working with a new dataset, we then examine cross-country variation in inequality with respect to import protection. Results are consistent with predictions of the factor-intensity model of trade. Regression results suggest that import protection makes income distribution worse for countries in labor-intensive diversification cones. This relationship shifts to one of falling inequality as incomes rise and we move to capital-intensive diversification cones.

Keywords: trade, inequality, distribution of income, Atkinson index, Gini coefficient, globalization, tariffs

JEL codes: F13, D31, O15

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NON-TECHNICAL SUMMARY

In the early modern literature on economic development, Kuznets first noted the apparent relationship between income distribution and growth. He stressed that a rising household income inequality seemed to be a normal process –a "stylized fact." Inequality seemed to first grow worse, and then improve with rising per-capita incomes. There followed a sizeable literature on this topic, starting with Kuznets, Champernowne, and Tinbergen in the 1950s. This literature has seen a recent revival. Building on datasets released in the late-1990s, recent research focuses particular attention on the impact of globalization on inequality and poverty in the developing world.

In this paper we analyze the impact of trade and tariffs on the observed cross-country variation in the household distribution of income. We build on results of the literature on production and the functional distribution of income in the 2x2 and higher-dimensional manifestations of the factor-intensity model of international trade to link import protection to variations in the household distribution of income. Working with a new dataset on inequality, we then examine cross-country variation in inequality with respect to import protection. Results are fully consistent with the predictions of the factor-intensity model of trade. Our regression results suggest that import protection makes income distribution worse for countries with labour-intensive production patterns -- technically know as diversification cones. This relationship shifts to one of falling inequality as incomes rise and we move to capital-intensive diversification cones. The crossing-point is for the set of economies with a per-capita income of between $5500 and $8750 (in 1995 dollars). Below this level, increased import protection tends to make gross household income inequality worse at the margin. Above this range, import protection tends to reduce inequality. Results also suggest that OLS-based cross-country inequality regressions might best be viewed with some suspicion, due to quality of data for countries at lower income levels and variability in variables at this income range left out of unconditional Kuznets-U regressions.

Our results also have implications for the welfare consequences of trade policy. If we work with Sen-type social welfare indexes, then increased inequality discounts the welfare benefits of improved incomes through the efficiency gains from trade. It is in higher-income countries that higher import protection appears to improve the gross household distribution of income the most. Yet these are the same countries with well-developed social safety nets (at least vis-à-vis lower income countries), such that the adverse effects of inequality that accompany efficiency gains may be offset. As such, current import protection patterns impose welfare costs related to inequality exactly in those countries least able to offset distribution losses through a well-functioning social safety net.

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INTRODUCTION

In the early modern literature on economic development, Kuznets (1955, 1963) first noted the apparent relationship between the household distribution of income and growth. He stressed that rising income inequality seemed to be a normal process –a "stylized fact." Distributions seemed to first worsen and then improve with rising per-capita incomes. There has since been a sizeable literature in development economics, starting with Kuznets, Champernowne (1953), and Tinbergen (1956).

Taken together with the more recent literature on openness and growth, a logical development in the recent empirical literature has been the search for three-way linkages between openness, growth, and the personal/household distribution of income.[1] This includes general empirical evidence on the impact of international trade on income distribution and poverty in developing countries (McCulloch, Winters and Cirera, 2001;

[1] While the emphasis of this paper is on the personal and household distribution of income, there has also been a large recent literature on the role of trade in the evolution of the functional distribution of income. See Richardson (1995), and Feenstra and Hanson (forthcoming).

Winters 2000). It also includes the growing computational literature on the household impact of policy reform. Along these lines, Devarajan and van der Mensbrugghe (2000) have examined the household impact of trade policy reform in South Africa, Hertel *et al*. (2000) have explored the impact of multilateral trade liberalization on poverty reduction, Ianchovichina *et al.* (2000) have examined reform and distribution in Mexico, Robillard *et al.* (2001) have examined the recent crisis in Indonesia, and Khan has focused on tax reform in Bangladesh (1997).

The recent econometric work in this area draws on data developed by Deininger and Squire (1996). Higgings and Williamson (1999) find evidence that demographical sources are the most important factor for explaining the distribution of income. They also find that, once one controls for demographic structure and openness to trade, there is strong evidence for Kuznets' inverted U-curve. However, the evidence of a link between income distribution and openness is mixed. Dollar and Kraay (2000) conclude that the income of the poor tends to grow at the same rate as economy-wide income. In other words, in contrast to the Kuznets-U reported elsewhere in the literature (like Higgins and Williamson), their results suggest that economic growth does not cause a relative deterioration in the mean income of the poor. In addition, they find that the share of growth following from trade does not significantly affect the income share of the poor either. Barro (2000) finds that inequality in developing countries is negatively correlated with economic growth, while Adams (2003) uses a new dataset to argue that growth is important for poverty reduction.

In this paper we analyze the impact of trade and tariffs on the observed cross-country variation in the household distribution of income. We build on results of the literature on production and the functional distribution of income in the 2x2 and higher-dimensional manifestations of the 2x2 trade model (Kemp 1956, Mussa 1979, Ethier 1982, Deardorff 1979, 1982) to link import protection to variations in the household distribution of income.[2] Working with a new dataset on inequality, we then examine cross-country variation in inequality with respect to import protection. Results are fully consistent with the predictions of the factor-intensity model of trade. Our regression results suggest that import protection makes income distribution worse for countries in labor-intensive diversification cones. This relationship shifts to one of falling inequality as incomes rise and we move to capital-intensive diversification cones. Results also suggest that OLS-based inequality regressions might best be viewed with some suspicion.

The paper is organized as follows. The next section develops a formal representation of inequality in general equilibrium. We then explore linkages between trade policies, the pattern of production, and inequality. This is followed by an econometric assessment of the linkages between trade policy and the observed pattern of inequality. The last section offers a summary and conclusions.

PRODUCTION AND TRADE IN GENERAL EQUILIBRIUM

We start with a dual representation of trade in general equilibrium for a single country. This involves adopting the following set of assumptions:

- Rational behaviour by households and firms;
- Complete and perfectly competitive markets;
- Convex preferences, with neoclassical production functions;
- Convex technology for a composite consumption good;

[2] The theoretical literature closest to the present paper includes Bourguignon and Morrisson (1990) and Spilimbergo *et al.* (1999). Both studies use an ownership matrix to write a general function of the personal income distribution in terms of endowments, tariffs and the ownership structure. A related paper is Galor (1994). He includes tariffs in his general equilibrium Overlapping-Generations model, but centers his analysis on the redistributive effects of the tariff *revenues.* He does not consider the efficiency and distributional effects caused by the tariffs.

- Identical and strictly quasi-concave composite good aggregation technologies across households.

Given these assumptions, we can define the core general equilibrium system for demand and production on the basis of expenditure and revenue functions, with expenditure defined in terms of the composite consumption good. Income distribution indexes (and social welfare) are then developed as a set of side equations from the core general equilibrium system.

The Core General Equilibrium System

We assume that all households consume the composite good *c*. This means we can represent aggregate expenditure *e* as a function of aggregate consumption *c* and prices *p*. This is represented by equation (1).

$$e(p,c) = c \cdot f(p) \tag{1}$$

In equation (1), $f(p)$ is the homothetic price index for the composite good.

On the production side, we assume standard neoclassical production functions with constant returns to scale: $x_i = g_i(v_{ji})$, where $g_i(.)$ is the production function for good *i* and v_{ji} is the use of factor *j* in the production of good *i*. If we define unit input coefficients as a_{ji} then we also have: $1 \le g_i(a_{ji})$. Endowment constraints are then $\sum_i a_{ji} x_i \le \bar{v}_j$. From these, we can then define the economy-wide revenue function with respect to goods prices and endowments, as in equation (2).

$$r(p,v) = \max_{x_i, a_{ji}} \left\{ \sum p_i x_i \,\middle|\, \Sigma_i a_{ji} x_i \le \bar{v}_j \; and \; 1 \le g_i(a_{ji}) \forall i, j \right\} \tag{2}$$

From the envelope theorem and the properties of the revenue function *r*, factor incomes and goods production can be expressed in terms of the value of the partial derivatives of the revenue function, evaluated at the equilibrium set of prices:

$$\frac{\partial r(p,v)}{\partial v_j} = w_j = w(p,v) \qquad \forall j \tag{3}$$

$$\frac{\partial r(p,v)}{\partial p_i} = x_i = x(p,v) \quad \forall i \tag{4}$$

We are ultimately interested in making empirical comparisons across countries. Empirically, this implies taking actual world prices as given by the data, and characterizing individual countries within this set of world prices. Taking equations (3) and (4) above in conjunction with the equations (1) and (2), we can write the open-economy general equilibrium system for production, consumption, and trade for an individual country as follows:

$$c^h f(p) = w(p,v) \cdot v^h + w_t^h t \cdot m \qquad \forall h \tag{5}$$

$$m = \sum_h c^h \cdot f_p(p) - x(p,v) \tag{6}$$

$$e(p,c) = \sum_h \left(w(p,v) \cdot v^h + w_t^h t \cdot m \right) \tag{7}$$

$$p = P^* + t = 1 + t \tag{8}$$

In equations (5)-(8), we have assumed that a tariff of t is imposed on imports from the world, while world prices are normalized to one. The term w_t^h is the household share of tariff revenue, while v^h is the household ownership share of factors and c^h is household consumption. We will generally assume that the household share of tariff income is n^{-1} where n indexes the number of households. Equation (5) sets the value of household consumption equal the household budget, equation (6) defines imports on which import tariff revenue is generated, equation (7) sets economy wide expenditure equal to receipts, and equation (8) defines the wedge between world and domestic prices. Together, equations (5)-(8) define an equally dimensioned set of relationships and unknowns: c^h, c, m, p.

Household Inequality

As noted earlier, both the older and the more recent literature on trade and the distribution of income have been focused on the functional distribution of income. The functional distribution of income is also an important building block here for the representation of the household or personal distribution of income. Starting with factor incomes *s*, they follow directly from the endowment stock and the properties of the revenue function, as represented by equation (9).

$$s_j = w_j v_j = r_{v_j}(p,v) \cdot v_j \tag{9}$$

In reduced form, the functional distribution of income *F(s)* is then an artefact of the equilibrium matching of preferences and the technology set, given our endowment vector.

$$F(s) = F(p,v) \tag{10}$$

The household distribution of income follows from the combination of factor incomes w_j, the vector of endowments, and the household ownership share in factors of production, w_j^h. It will also depend on the distribution of tax revenue (tariffs in the present context), again represented by a household share parameter, this one applied to import tax revenues. This is shown in equation (11), which gives the basic definition of household income in terms of its primary components. By substitution from equation (5), this is also shown as a function of equilibrium prices, the production technology set, and the endowment set.

$$\begin{aligned} y^h &= \left(\sum_j w_j \cdot v_j \cdot w_j^h\right) + w_t^h t \cdot m \\ &= \left(\sum_j r_{v_j}(p,v) \cdot v_j \cdot w_j^h\right) + w_t^h t \cdot m \\ c^h &= \frac{y^h}{f(p)} \\ &\qquad where\ \ 1 \geq w_j^h \geq 0 \\ &\qquad and\ \ \sum_h w_j^h, \sum_h w_t^h = 1. \end{aligned} \tag{11}$$

In reduced form, the household distribution of income *F(y)* is a consequence of endowments, the technology set, preferences, the endowment vector, and the ownership matrix of coefficients w_j^h (Ω). From equation (11) we thus have:

$$F(y) = F(p,v,\Omega) \tag{12}$$

We introduce two inequality indexes to our analytical framework: the Gini coefficient I_G and the Atkinson index I_A. Constant relative risk aversion (CRRA) preferences yield the Atkinson inequality index directly as a natural metric for the income distribution component of social welfare (see Atkinson 1970). In this sense, Atkinson's index maps naturally into a social welfare function and in particular, to Sen's (1974) preferred definition of social welfare. In contrast, the Gini coefficient implied social welfare function is axiomatic, in that we do not have an obvious mapping, through aggregation, from individual preferences to an aggregate social welfare function. This follows because the Gini coefficient (and hence the implied social welfare function) is rank sensitive. The formal definitions of these inequality indexes are provided in equations (13) and (14).

$$I_A \qquad = 1 - \left[\frac{1}{n} \sum_h \left(\frac{y^h}{\bar{y}} \right)^{1-q} \right]^{\frac{1}{1-q}} \tag{13}$$

$$I_G \qquad = 1 + \frac{1}{n} - \frac{2}{n^2 \bar{y}} \left(y^1 + 2y^2 + ... + ny^n \right) \tag{14}$$

In equation (13), q corresponds to the coefficient of relative *inequality* aversion assuming CRRA preferences. In equation (14) the Gini coefficient is defined as twice the area between the Lorenz curve and the 45-degree line, where we have arranged households so that $y^1 \geq y^2 \geq ... \geq y^n$.

We can also write the Atkinson and Gini indexes in terms of system fundamentals. Making a substitution from (9) into (13) and (14), we obtain equations (15) and (16).

$$I_A = 1 - \left[\frac{1}{n} \sum_h \left(\frac{n \left(\sum_j r_{v_j}(p,v) \cdot v_j \cdot w_j^h \right) + n w_t^h t \cdot m}{y} \right)^{1-q} \right]^{\frac{1}{1-q}} \tag{15}$$

$$= 1 - \left(n^{-q} \sum_h \left(n^{-1} + \sum_j b_j \left(w_j^h - n^{-1} \right) \right)^{1-q} \right)^{\frac{1}{1-q}}$$

$$I_G = 1 + \frac{1}{n} - \frac{2}{n} \sum_h h \cdot \left(\frac{\left(\sum_j r_{v_j}(p,v) \cdot v_j \cdot w_j^h \right) + w_t^h t \cdot m}{y} \right) \tag{16}$$

$$= 1 + \frac{1}{n} - \frac{2}{n} \sum_h h \cdot \left(n^{-1} + \sum_j b_j \left(w_j^h - n^{-1} \right) \right)$$

where $b_j = \frac{r_{v_j} \cdot v_j}{y}$, which is the national income share accruing to factor *j*.

TARIFFS AND HOUSEHOLD INEQUALITY

Generalized Effects

From equations (15) and (16) above, inequality is a function of the first two moments of the household distribution of income. This is especially obvious with the Atkinson index.[3] The impact of a tariff on the household income distribution follows from differentiation of equations (15) and (16). This is shown in equations (17) and (18) below.

[3] While the functional form is different, the social welfare functions underlying other income distribution indexes yield a similar result, though with different weights in the variance component of the welfare function. The CRRA function yields a particularly clear and parsimonious reduced form.

$$\frac{\P I_A}{\P t} = -\left(\frac{1}{1-q}\right)\left[n^{-q}\sum_h\left(\left[\sum_j b_j(w_j^h-n^{-1})\right]+n^{-1}\right)^{1-q}\right]^{\frac{q}{1-q}} \tag{17}$$

$$n^{-q}\sum_h\left((1-q)\left(\sum_j b_j(w_j^h-n^{-1})+n^{-1}\right)^{-q}\sum_j\left(\frac{\P b_j}{\P t}\right)\left(w_j^h-n^{-1}\right)\right)$$

$$= -n^{\frac{-q}{1-q}}\left[\sum_h\left(\left[\sum_j b_j(w_j^h-n^{-1})\right]+n^{-1}\right)^{1-q}\right]^{\frac{q}{1-q}}\sum_h\left(\left(\sum_j b_j(w_j^h-n^{-1})+n^{-1}\right)^{-q}\sum_j\left(\frac{\P b_j}{\P t}\right)\left(w_j^h-n^{-1}\right)\right)$$

$$\frac{\P I_G}{\P t} = -\frac{2}{n}\sum_h h\cdot\left(\sum_j\left(\frac{\P b_j}{\P t}\right)(w_j^h-n^{-1})\right) \tag{18}$$

Recall that the term b_j represents the national income share of factor *j*. Note that we also have an inverse income weighting, by a factor of q, in equation (17) applied to induced changes in the deviation from the mean component of household income -- $b_j\left(w_j^h-n^{-1}\right)$. The weighting of induced changes in income for the Gini index depends on the ranking of individual households on the relative income scale. In both cases, the changes in income in turn depend on Stolper-Samuelson derivatives, and induced price changes that follow from tariff changes. This set of induced price changes is expressed in equation (19), where the term db_j/dt depends on system fundamentals and consequent Stolper-Samuelson relationships. The last line of equation (19) expresses this relationship in elasticity terms.

$$\begin{aligned} b_j &= \frac{r_{v_j}\cdot v_j}{y} \\ \Rightarrow \quad \frac{db_j}{dt} &= \frac{\P r_{v_j}}{\P p}\frac{\P p}{\P t}\frac{v_j}{y} - \frac{r_{v_j}\cdot v_j}{y}\frac{\P y}{\P t} \\ e_{b_j,t} &= e_{r_{v_j},p}\,e_{p,t} - e_{y,t} \end{aligned} \tag{19}$$

Tariffs and Household Inequality in the Heckscher-Ohlin Model

Consider the application of equations (17) and (18) to a standard two-factor, two-good Heckscher-Ohlin model. If we apply the additional normalization that all households hold a claim on one unit of labour, then our inequality indexes can be manipulated to yield equations (20) and (21). (We have also assumed a neutral redistribution of the tariff revenue).

$$\partial I_A \big/ \partial t = -n^{\frac{-q}{1-q}} \left[\sum_h \left(\left[b_k (w_k^h - n^{-1}) \right] + n^{-1} \right)^{1-q} \right]^{\frac{q}{1-q}} \sum_h \left(\left(b_k (w_k^h - n^{-1}) + n^{-1} \right)^{-q} \left(\partial b_k \big/ \partial t \right) \left(w_k^h - n^{-1} \right) \right) \tag{20}$$

$$\partial I_G \big/ \partial t = -\frac{2}{n} \sum_h h \cdot \left(\partial b_k \big/ \partial t \right) (w_k^h - n^{-1}) \tag{21}$$

Inequality is purely a function of the allocation of capital in this model. At the same time, the impact of the tariff is then a function of which sector is protected. If protection leads to an increase in wages and a drop in capital income, inequality is reduced. Alternatively, if capital income is protected, we will see a rise in inequality.

On the basis of equation (20) and (21) we can summarize our discussion above with the following observations about import protection and inequality in a 2x2 Heckscher-Ohlin economy.

- <u>Observation 1</u>: In a labour-rich 2x2 Heckscher-Ohlin economy under the assumption that poorer households by definition derive income only or mostly from labour, then observed inequality as measured by the Gini or Atkinson indexes will be greater, as import protection in labour rich countries will help capital owners, who receive relatively low weight in equations (20) and (21).

- Observation 2: In a capital-rich (developed) Heckscher-Ohlin economy, under the assumption that the poor receive only or mostly labour income, import protection within a Heckscher-Ohlin economy means a lower observed inequality as measured by the Gini or Atkinson indexes.
- Observation 3: When making comparisons across 2x2 countries at a given set of world prices (as will be the case for cross-section inequality regressions), Observations 1 and 2 can be reinterpreted as saying that tariffs will be linked to greater observed inequality in capital-poor countries and less inequality in capital-rich countries.

While Observation 3 has empirical appeal, the classic 2x2 model is actually problematic when we confront it with real data. Countries present a range of relative endowments, while we might reasonably expect the global trade matrix to include more than two broad classes of goods. Following Deardorff (1979), if we assume Heckscher-Ohlin technologies and a range of goods, we can then rank goods by their relative factor intensities in production. Countries in turn can be ranked by their location in a chain of product diversification cones. More labor intensive countries will be located in diversification cones characterized by more labor intensive goods. We can then generalize Observation 3 to allow for a continuum of goods and factor intensity rankings.

- Observation 4: Assuming a Deardorff-type continuum of goods, then when making comparisons across countries within a given diversification cone, at a given set of world prices higher tariffs will be linked to greater observed inequality in cones occupied by capital-poor countries and less observed inequality in cones occupied by capital-rich countries.

- Observation 5: Assuming a Deardorff-type continuum of goods, as we move across diversification cones from more labour-intensive to more capital-intensive goods, the marginal impact of a tariff on inequality will fall.

ECONOMETRICS

Data

We turn next to an empirical examination of the linkages between import protection and the household distribution of income. Almost exclusively, the current literature on openness and household inequality is built on the Deininger and Squire (1996) dataset. This dataset mixes inequality indexes drawn from income surveys, expenditure surveys; surveys based on net- and gross- incomes; and household and individual reference units. The same is true of the household distribution data reported by the World Bank (*World Development Indicators*) and the United Nations (*Human Development Report*). The assumption is that different income concepts and reference units are broadly comparable. Actually though, it turns out that they are not, and in many cases they do not even convey the same broad information set[4].

In our data we control for comparability between different sources of household distribution data. To avoid measurement error problems, we therefore work with inequality series that combine comparable definitions. To be consistent with our theoretical framework, we use inequality data that we have either estimated directly from gross income household survey data, or that are reported as coming from gross income household surveys (where the underlying share data was not available)[5]. We have two indexes of inequality,

[4] Atkinson and Brandolini (2001).
[5] We take the inequality data from the World Income Inequality Database (2000).

the Atkinson index[6] and the Gini coefficient. Because the Gini coefficient is commonly reported from household surveys, even when the share data is not supplied, we have a broader sample of countries with estimated Gini coefficients. These data are shown in Table 1. Values are centred on 1994 (though inequality indexes are taken from the nearest available year in a 4-year span before and after 1994). Per-capita income in the sample, in 1995 dollars, ranges from $532 (China) to $40,515 (Japan). The mean per-capita income is $10,774. The trade-weighted tariff for the sample ranges between 0 percent (Hong Kong) and 43.7 percent (Thailand), with a sample average duty of 9.9 percent. The mean Gini coefficient from our gross household data is .40, with a maximum and minimum value of .62 (South Africa) and .22 (Slovakia). The mean Atkinson index from our gross household data is .23, with a maximum and minimum of .53 (South Africa) and .08 (Ukraine).[7]

Regression Model and Results

As a starting point, we specify a reduced-form relationship between income level and inequality, formally known as a Kuznets-type inverted-u relationship. In specifying a reduced form for inequality in this way, we are building on a broad empirical literature.[8] To this, we add an indicator of the trade-weighted import duty. We also include an interaction term between duties and income levels, to reflect the possible role (as reflected in Observations 3 and 5) that relative development levels may play in the interaction between import tariffs and the distribution of income.

[6] We use θ=1

[7] These data are part of a larger project aimed at evaluating the impact of household data comparability problems on the current empirical literature on globalization, distribution of income, and poverty. See Francois and Rojas-Romagosa (2004).

[8] See Kanbur (2000) for a recent survey. Following Higgins and Williamson (1999), we can distinguish two versions of the Kuznets hypothesis in the literature. The original (strong) version presented by Kuznets (1955), states that labor demand steers income inequality during the development process. On the other hand, the weak version stressed in the more recent literature recognizes that other factors can also be involved, and that these can reinforce or offset the basic demand forces at play. Deininger and Squire (1996,1998) do not find support for the unconditional Kuznets curve, while Higgins and Williamson (1999), also using the Deininger and Squire data set, find support for the weak Kuznets hypothesis.

Formally, our estimation equation is as follows:

$$LI_i = a_o + a_{PCI} \cdot y_i + a_{PCI^2} \cdot y_i^{\,2} + g_T \cdot T_i + g_{T*PCI} \cdot [y_i \cdot T_i] + e_i \tag{22}$$

where LI_i is a logistic transformation of the inequality index I for country i, y_i is the log of per-capita income, T_i is the weight-average tariff on merchandise imports, and e_i is the error term.

Table 2 first presents basic OLS results. The signs on coefficients are all as expected. However, coefficient estimates are insignificant for the tariff terms in the Gini coefficient regressions, while the Gini and Atkinson regressions both provide relatively poor fits to the inequality data. In this sense, initial results are consistent with the broad literature in this area. In other words, they are disappointing and offers mixed results. However, there is good reason to be suspicious of OLS results in this context, both in columns A and B in Table 2, and also in the literature in general. It is pretty well recognized that data from low-income countries tend to be of poorer quality that data from the OECD countries. In other words, we should expect that low-income country data tend to be noisier. Columns A and B report Chi-squared test statistics for the hypothesis of homoskedasticity, weighed against the alternative hypothesis of variance inversely related to level of development as proxied by income level. These results point strongly to heteroskedasticity, and hence to the preferability of weighted regressions. It is also worth recalling that the Gini and Atkinson indexes are based on the same set of income survey results. As such, the error structure of the Gini-based observations may tell us something about the error of the error-based regressions. As such, we may improve the accuracy of the our estimates of coefficient variance by estimating the two equations jointly.

The results of weighted SUR regressions are reported in columns C (Gini) and D (Atkinson) of Table 2. These estimates address both the heteroskedasticity issue, and the joint nature of the calculation of the Gini and Atkinson indexes. The results for all coefficients have the expected sign, and are highly significant -- in the .001 to .002 range. The import-protection coefficients suggest import protection makes the distribution of income worse at the margin for countries in labor-intensive diversification cones, while this relationship shifts to one of falling inequality as incomes rise and we move to capital-intensive diversification cones. In other words, relative openness helps to improve inequality for the least developed countries. As such, the basic pattern is consistent with our discussion of a Heckscher-Ohlin world with a continuum of goods. It fits the prediction of factor-intensity based trade theory about the linkage between development level, protection, and the observed household income distribution.

To help interpret these results, Figure 1 plots the estimated marginal impact of a change in the tariff on inequality for the countries in our sample using the Gini coefficient and Atkinson index estimates from columns C and D of Table 2. This involves the combined effects of coefficients g_T and g_{T*PCI}. Technically, as the regressions are in logs, this represents an estimate of the elasticity of the logistic transform of the Gini coefficient or Atkinson index with respect to a change in the power of the tariff *T=(1+t).* The turning point for the index is at a per-capita income of between $5,474 (Gini coefficient) and $8,780 (Atkinson). Recall that the Gini coefficient is more sensitive to redistribution in the middle-income ranges, while the Atkinson index is more sensitive to redistribution at the extremes. The turning points for the different indexes hence relate to inequality more in the middle of the income distribution (Gini) or at the upper vs. lower extremes (Atkinson). For countries below this income range, higher import protection is associated with marginal increases in observed income inequality. For countries above this level, relatively high import protection implies marginal reductions in observed inequality.[9]

SUMMARY AND CONCLUSIONS

In this paper we explore the relationship between import protection and the observed cross-country pattern of the household distribution of income. The theoretical linkages between import protection and the functional distribution of income (i.e. factor rewards) are well developed in the literature. Because the functional distribution of income is the first step in mapping import protection to the household/personal distribution of income, the existing functional distribution literature also provides insight into how import protection, through variations in ownership patterns in conjunction with Stolper-Samuelson effects, ultimately impacts the household distribution of income.

On the theoretical side, our contributions in this paper follow from an explicit general equilibrium formalization of linkages between import protection and standard measures of household income distribution. These inequality derivatives yield predictions for patterns in the observed variation in trade protection, level of development, and the level of inequality across countries. On the empirical side, we then work with a set of comparable inequality indexes (i.e. controlling for income definitions and survey units) to test these predictions. To do this, we add trade policy indicators to a set of standard Kuznets-U type inequality regressions. For the present exercise, which is focused on transmission from functional to household income patterns, gross income survey data has been used. In addition to the basic pattern of results (inequality-tariff linkages), our

[9] Burgess (1976) reaches a similar conclusion for the United States, which is obviously one of the high-income countries in our sample. Working with input-output coefficients and a generalized Leontief structure, Burgess concludes that higher tariffs raise real wages with respect to the United States.

estimates also point to potential estimation problems with OLS-based unconditional Kuznets inequality regressions.

Regression results point to a highly significant pattern in the data fully consistent with the theoretical impact of tariffs on inequality in an *n*-good Heckscher-Ohlin world. While consistent with the predictions of theory, the pattern that emerges is not fully consistent with recent anti-globalization rhetoric. We find that in the lowest-income countries, relatively high import protection is associated with observations of greater inequality. It is in higher-income countries that higher import protection appears to improve the gross household distribution of income the most. As such, current import protection patterns impose welfare costs related to inequality exactly in those countries least able to offset distribution losses through a functioning social safety net. [10]

[10] In addition, if one takes distribution as an important component of social welfare, along the lines of Atkinson and Sen, then the implications for numerical analysis of trade policy appear to be first- rather than second-order in developing countries. Crude calculations by the authors not presented here, working with the estimated coefficients from the inequality regressions, suggest that in some cases adjusting trade policy assessments for distribution impacts may yield welfare effects on a par with those linked to efficiency currently stressed in the computational literature on trade policy.

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TABLE 1, COUNTRY DATA

country		Gini coefficient	Atkinson index	per-capita income 1994, in U.S. dollars	trade weighted import tariff
AUS	Australia	0.440	0.317	20,190	9.7
BEL	Belgium	0.318	0.171	26,705	7.0
BLR	Belarus	0.284	0.128	2,172	10.5
BRA	Brazil	0.595		4,299	17.0
CAN	Canada	0.350	0.213	19,366	8.0
CHL	Chile	0.556	0.390	4,212	10.9
CHN	China	0.368	0.213	532	40.6
COL	Columbia	0.580	0.367	2,326	12.4
CRI	Costa Rica	0.455		3,408	8.0
DEU	Germany	0.349	0.197	29,645	7.0
DNK	Denmark	0.289	0.162	33,701	7.0
DOM	Dominican Republic	0.490		1,482	17.7
ECU	Ecuador	0.530		1,563	8.5
ESP	Spain	0.330	0.169	14,528	7.0
EST	Estonia	0.378		3,063	0.5
FIN	Finland	0.295	0.161	24,473	5.0
GBR	Great Britain	0.404	0.298	18,772	7.0
HKG	Hong Kong	0.520	0.288	22,345	0.0
HND	Honduras	0.540		693	7.5
JPN	Japan	0.350		40,515	1.5
LTU	Lithuania	0.248		1,677	1.7
LVA	Latvia	0.240		1,940	2.6
MDA	Moldova	0.267		721	2.7
MEX	Mexico	0.477		3,406	12.2
NLD	Netherlands	0.316	0.172	26,372	7.0
NOR	Norway	0.302	0.120	32,553	4.9
NZL	New Zealand	0.401	0.270	16,056	9.4
PAN	Panama	0.560		3,006	11.0
PER	Peru	0.483		2,132	16.1
PHL	Philippines	0.462	0.302	1,061	20.4
POL	Poland	0.301	0.150	2,684	10.1
PRY	Paraguay	0.590		1,827	8.9
ROM	Romania	0.287		1,310	15.2
RUS	Russia	0.272	0.112	2,376	7.4
SGP	Singapore	0.422	0.260	23,017	0.0
SVK	Slovakia	0.215		3,220	6.2
SVL	El Salvador	0.530		1,612	8.7
SVN	Slovenia	0.281	0.119	9,053	12.1
SWE	Sweden	0.309	0.177	26,380	5.0
THA	Thailand	0.535	0.401	2,647	43.7
TWN	Taiwan	0.327	0.163	12,070	6.5
UKR	Ukraine	0.233	0.079	1,076	6.3
USA	United States	0.424	0.296	27,343	4.4
VEN	Venezuela	0.470		3,482	13.4
ZAF	South Africa	0.620	0.538	3,828	16.9

Tariff data and income data are from the *World Development Report* (various issues). Income distribution data are from Francois and Rojas-Romagosa (2004).

TABLE 2, REGRESSION RESULTS FOR KUZNETS' CURVE WITH TARIFFS

		OLS estimates		SUR estimates, weighted†	
		A	B	C	D
	Coefficients	Logistic Gini	Logistic Atkinson Logistic	Gini	Logistic Atkinson
a_0	Intercept	-8.7939	-27.7185	-16.0398	-28.6190
		(-1.60)	(-2.58)**	(-3.18)***	(-3.27)***
a_{PCI}	per-capita income	1.9179	5.7372	3.4302	6.0795
		(1.53)	(2.39)**	(3.07)***	(2.95)***
a_{PCI^2}	squared per-capita income	-0.1100	-0.3088	-0.1855	-0.3229
		(-1.58)	(-2.35)**	(-3.06)***	(-2.78)***
g_T	Tariffs: T=(1+t)	5.5330	24.8864	28.9728	33.5697
		(0.61)	(1.78)*	(3.80)***	(3.95)***
g_{T*PCI}	T*(per-capita income)	-0.4243	-2.6333	-3.3658	-3.6970
		(-0.35)	(-1.47)	(-3.64)***	(-3.55)***
Heteroskedasticity tests					
Breusch-Pagan/Cook-Weisberg ‡		4.77, .029	3.92, .048		
Szroeter's test ‡		4.43, .035	2.68, .100		
‡ *Chi2, Prob>Chi2 w.r.t. income*					
Regression statistics					
Observations for each index		45	27	45	27
F, Pr>F		2.31, .075	2.78, .052	-57.07, 0.000	
R-squared for joint estimate		.1873	.3359	0.9092	
Total observations		45	27	72	
Degrees of freedom		40	22	62	

† Regressions are weighted, on the assumption that variance is inversely related to per-capita income. This is supported by heteroskedasticity tests shown in columns A an B. This simply means that data are noisier in lower-income countries, due to a mix of measurement error and more variability at lower levels of income in factors reflected in the reduced form Kuznet's curve. According to Szroeter's Chi-squared test statistic for homoskedasticity, the hypothesis of variance monotonic in per-capita income is preferred to homoskedasticity at the .035 level for the Gini-based Kuznets' curve and at the .100 level for the Atkinson-based Kuznets' curve. The Breusch-Pagan/Cook-Weisberg Chi-squared test statistic also supports heteroskedasticity in per-capita income (at the .029 and .048 significance levels) for both regressions.

Regression results shown are for unweighted OLS, and for weighted iterated SUR regressions with robust standard errors, where *t*- and *z*-test statistics are reported in parentheses.

* means significant at the .10 level for a two-tailed test.
** means significant at the .05 level.
*** means significant at the .01 level.

FIGURE 1

ESTIMATED MARGINAL IMPACT OF TARIFFS, ln(1+t), ON LOGISTIC INEQUALITY INDEXES