Trade Policy and the
Household Distribution of Income

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Abstract: We explore the theoretical relationship between import protection and the household distribution of income in general equilibrium. Based on CRRA preferences, the social welfare system implicit in Atkinson indexes, we decompose the welfare effect of protection into a real income level and variance component. These explicit inequality derivatives map import protection to inequality-adjusted welfare. They also yield empirical predictions for the linkages between trade protection, country size, level of development, and the level of inequality in a Heckscher-Ohlin and Ricardo-Viner world. Our decomposition of welfare and inequality may also prove parsimonious in applied general equilibrium applications focused on inequality.

Keywords: trade policy and inequality, household distribution of income, Atkinson index

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1. **Introduction**

In the early modern literature on economic development, Kuznets (1955, 1963) noted an apparent relationship between income distribution and development. He stressed that a rising income inequality seemed to be a normal process (a "stylized fact") characterizing economic development. 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, Champerowne (1953), and Tinbergen (1956).

Taken together with the more recent literature on openness and development, a logical development in the empirical literature has been the search for three-way linkages between openness, growth, and income distribution. This includes the general empirical evidence on the impact of international trade on income distribution and poverty in developing countries (Winters 2001a,b). It also includes the growing computational literature on the household impact of policy reform. Along these lines, Devarajan and van der Mensbrugghe (2000) examine the household impact of trade policy reform in South Africa, Hertel et al (2000) explore the impact of multilateral trade liberalization on poverty reduction, Ianchovina et al (2000) examine reform and distribution in Mexico, (Robillard et al 2001) focus attention on the recent crisis in Indonesia, and Khan focuses on tax reform in Bangladesh (1997).

Econometric work in this area has drawn both on data developed by Deininger and Squire (1996, 1998) and on the World Income Inequality Database (1999). Higgins 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 weak. Working with the Deininger and Squire database, 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, the share of growth following from trade does not significantly affect the income share
of the poor either. Barro (1999) actually finds that inequality in developing countries is negatively correlated with economic growth, with the opposite holding for developed countries.

The theoretical literature closest to the present paper includes Janeba (2000), Spilimbergo et al (1997), and Galor (1994). Janeba works with a model of a small open economy, without tariffs, to explore whether an income tax is better than education subsidies. Galor does include tariffs in his general equilibrium model, analyzing the redistributive effects of tariff revenue in an Overlapping-Generations economy. He does not work with social welfare or inequality indexes. Spilimbergo et al use the ownership matrix to write a very general function for the Gini coefficient in terms of endowments, tariffs and the endowment matrix.

In this paper we analyze the impact of trade and tariffs on the household distribution of income. This involves developing a formal link between social welfare and the distribution of income. We embed CRRA preferences into a two-country dual general equilibrium trade model. We then decompose the welfare effect of import protection into a real income level and variance component. These explicit inequality derivatives map import protection to inequality-adjusted welfare, while also yield predictions for linkages between protection, country size, development, and inequality. In conjunction with the Atkinson inequality index, the general form of the decomposition of welfare and inequality we develop here may also be useful in applied general equilibrium applications focused on inequality.

This paper is organized as follows. Section 2 develops a formal representation of social welfare inclusive of income inequality. In Section 3, we embed this social welfare function into a dual, two-country general equilibrium trade model. Section 4 develops the equilibrium representation of inequality, based on the general equilibrium system fundamentals. Section 5 then explores linkages between trade policy, inequality, and welfare. It also examines linkages between country size, development, policy, and inequality implicit in the results of Section 4. We conclude in Section 6.
2. Defining the Social Welfare Index with Respect to Inequality

Our goal in this section is to develop a functional linkage between inequality and aggregate (social) welfare. This will then be integrated in the next section into a dual general equilibrium trade model. A critical condition for inequality to have a meaningful link to aggregate (social) welfare is that the utility function be strictly concave with respect to income. Additionally, for tractability we choose to work with a social welfare function that is symmetric and additively separable in individual incomes.

The existence of social welfare functions depends crucially on the possibility to compare interpersonal utility levels. One such possibility is offered by the ‘veil of ignorance’ approach, where we rank different individual situations no knowing which would be the actual situation. As stated by Sen (1997) this interpersonal comparison can be defined as those situations where we make judgements of the type: ‘I would prefer to be person \(A\) rather than person \(B\) in this situation’ and ‘while we do not really have the opportunity (or perhaps the misfortune, as the case may be) of in fact becoming \(A\) or \(B\), we can think quite systematically about such a choice, and indeed we seem to make such comparisons frequently.’

Because GDP per capita is the most common indicator of social welfare, the ‘veil of ignorance’ approach supports the use of an inequality measure to complement GDP per capita comparisons. If we do not know which individual household we are in a specific country, then the expected utility becomes a function of mean income and the personal distribution of income. How we evaluate the probability of receiving any given income is then determined by the functional representation of the utility function and more specifically on the degree of concavity of this function. In this context, a natural extension of cross-country welfare comparisons is to complement GDP per capita levels with some measure of inequality.

Under the social welfare approach to income distribution measurement, inequality is associated with variance in the distribution of income. This raises two measurement problems. The first is that we cannot generally rely on first moment-based indicators. The second is that even though the concepts of Lorenz-dominance and General Lorenz-dominance are accepted as ways to impartially
rank two different distributions (Lambert 1993), in many cases the Lorenz-curves intersects at least once, so that we obtain incomplete ranking of distributions. To solve both these problems, inequality indexes are usually used to rank distributions in indeterminate cases and to provide a summary variable that can be used in empirical models. While the most commonly used is the Gini coefficient, any inequality measure is implicitly based on a social welfare function (Dalton 1920, Kolm 1969, Atkinson 1970). As such, there is no perfect index, and any index has built in social preferences. In this paper, we employ a representation of household utility and social welfare based on CRRA preferences. This yields the well-known Atkinson inequality index as a natural metric for a mapping from income distribution to social welfare.

Formally, we define a composite consumer good $c$ over the range of all consumption goods, which follows from a linear homothetic aggregation function. As such, cost minimization yields a composite consumer price index $p_c$. This is defined over all consumer prices $p$.

$$p_c = f(p) \quad (1)$$

Household utility $u^h$ is defined as a function of household consumption of the composite consumer good $c^h$:

$$u^h = \square(c^h) \quad (2)$$

Aggregate welfare $\square$ is defined as the sum of household utility,

$$\square = \sum_h u^h \quad (3)$$

while aggregate consumption $\epsilon$ is the sum of household consumption.
We will assume that the function $\xi$ is CRRA.

\[
\xi(c^h) = \begin{cases} 
\frac{(c^h)^\eta}{\ln c^h} & \text{if } \eta \neq 1 \\
\ln c^h & \text{if } \eta = 1 
\end{cases}
\]

In general, we assume that $\eta > 0$, and focus on the case where $\eta \neq 1$.\(^1\) We employ a simple linear transformation, and define a social welfare index in per-capita terms.

\[
SW = \frac{\xi}{n(1-E)} = \frac{1}{n} \xi(\frac{c^h}{c_n})^{\eta}
\]

Simple manipulation then yields social welfare as a function of per-capita income, consume prices, and income equality.

\[
SW = \frac{\Psi}{\hat{p}_c} E
\]

The equality measure $E$ can be mapped directly to the Atkinson index of income inequality. In particular, taking the definition of the Atkinson index (Atkinson 1970), we have the following relationships between the Atkinson index $I_A$, $E$, and social welfare.

\(^1\) We get the same basic results here with log preferences. Note that our inequality index is then simply: $I = \frac{n}{n-1} \prod \ln(c^h) \prod \ln(c)$, while qualitatively subsequent results hold. Estimates in the macro literature are that $\eta$ is less than 1.
Note that as $\bar{q} \to 0$ then only average income matters, rather than the distribution. For a given distribution (measured as shares of total income) we have declining marginal utility of income.

2. Production, Trade, and Inequality in General Equilibrium

To explore the interaction between production, trade and trade policy, and inequality, we work with a modified dual representation of trade in general equilibrium (Dixit and Norman 1980). To do so, we first adopt the following additional set of assumptions:

- Rational behaviour by households and firms;
- Complete and perfectly competitive market;
- Convex technologies, with neoclassical production functions;
- Identical and strictly quasi-concave composite good aggregation technologies across households;
- Two countries that engage in balanced trade.

Given these assumptions, we are able to define the core general equilibrium system for demand and production in terms of expenditure and revenue functions, with expenditure defined in terms of the composite consumption good. Social welfare then follows as a set of side equations from the core general equilibrium system.
3.1 the core general equilibrium system

Because all households have the same consumption technology, we can drop the household index from consumption and represent aggregate expenditure as a function of aggregate consumption and prices. This is represented by equation (10).

\[ e(p,c) = c \cdot f(p) \]  

(10)

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: \( 1 \prod g_i(a_{ji}) \).

Endowment constraints are then \( \prod a_{ji} x_i \prod v_j \). From these identifies, we then define the economy-wide revenue function with respect to goods prices and endowments, as in equation (11).

\[ r(p,v) = \max_{x_i,a_{ji}} \prod p_i x_i \prod a_{ji} x_i \prod v_j \text{ and } 1 \prod g_i(a_{ji}) \prod i, j \]  

(11)

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:

\[ \frac{\partial r(p,v)}{\partial v_j} = w_j = w(p,v) \]  

(12)

\[ \frac{\partial r(p,v)}{\partial p_i} = x_i = x(p,v) \]  

(13)
Taking equations (12) and (13) above in conjunction with the equations (1) and (10), we can write the two-country general equilibrium system for production, consumption, and trade as follows:

\[ c^h f(p) = w(p,v) \cdot v^h + H^h \cdot m \]  \hspace{1cm} (14)

\[ C^H F(P) = W(P,V) \cdot V^H \]  \hspace{1cm} (15)

\[ \sum h c^h f_{p^h}(p) + \sum H C^H f_{p^H}(P) = x_i(p,v) + X_i(P,V) \]  \hspace{1cm} (16)

\[ m = \sum h c^h f_p(p) \cdot x(p,v) \]  \hspace{1cm} (17)

\[ M = \sum h C^h f_p(P) \cdot X(P,V) \]  \hspace{1cm} (18)

\[ p = P + \sum \]  \hspace{1cm} (19)

In equations (14)-(19), we have indicated home and foreign country values by small and capital letters. Note that we have assumed the home country imposes a tariff of \( t \) on imports from the foreign country. Together, equations (14)-(19) define 6 sets of equations and an equally dimensioned set of unknowns: \( c^h, C^H, m, M, p, P \).

3. **The distribution of income**

The recent literature on trade and the distribution of income has 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 (20).

\[ s_j = w_j v_j = r_j(p,v) \cdot v_j \]  \hspace{1cm} (20)
In reduced form, the functional distribution income $F(s)$ is then an artefact of the equilibrium matching of preference and the technology set, given out endowment vector.

$$F(s) = F(p,v)$$  \hfill (21)

The personal 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, $\tilde{O}_j^h$. They will also depend on the distribution of tax revenue (tariffs on the present context), again represented by a household share parameter, this one applied to import tax revenues. This is shown in equation (22), which gives the basic definition of household income in terms of its primary components. By substitution from equation (20), this is also shown as a function of equilibrium prices, the production technology set, and the endowment set.

$$y^h = w_j \cdot v_j \cdot \tilde{O}_j^h + \tilde{O}_i^h \cdot m$$  \hfill (22)

$$c^h = \frac{y^h}{p_e}$$

where $1 \geq \tilde{O}_j^h \geq 0$

and $\tilde{O}_h^h, \tilde{O}_O^h = 1$.

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 $\tilde{O}$. From equation (22) we have:

$$F(y) = F(p,v,\tilde{O})$$  \hfill (23)
Note that social welfare will ultimately be a function of the ownership matrix in the economy, while the impact of trade policy will then depend on the interaction of the underlying economic structure and the ownership matrix.

We can write our social metric of the distribution of income, the Atkinson index, in terms of system fundamentals as well. Making a substitution from (22) into (8), we can derive equation (24).

From equation (24), we can make a substitution back into equation (9), yielding social welfare itself as a function of system fundamentals as well.


5.1 **Generalized Effects**

From equation (25) above, social welfare is a function of the first two moments of the household distribution of income. It is actually the weighted variance of income, with inverse income weights, that provides the variance component of the social welfare function. Because the mean and variance components are

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2 While the functional form is different, the social welfare function underlying other income distribution indexes yields a similar result, though with different weights in the variance
separable, this means we can decompose the impact of trade policy as well into its impact on per-capita income, and its impact on the variance of income. Together, these then determine the overall social welfare impact. Formally, differentiating equation (22), we obtain equation (26).

\[ \frac{\partial SW}{\partial t} = (1 - q)(1 - l) \frac{\partial y}{\partial t} - \frac{y}{p_c} \left( \frac{dp_c}{dt} \right) \left( 1 - q \right) \frac{\partial I}{\partial t} \]

or

\[ \mathcal{A}_{W,G} = (1 - q)(1 - l) \left[ \frac{\partial y}{\partial t} - \frac{y}{p_c} \left( \frac{dp_c}{dt} \right) \left( 1 - q \right) \frac{\partial I}{\partial t} \right] \]

How do we interpret equation (26)? The income component is well known (see for example Dixit and Norman), and is shown here in equation (27). Basically, the impact of the tariff \( l \) on per-capita income will depend on the combination of terms-of-trade and allocation effects (the first set of terms in square brackets in equation (27), and tariff revenue (the second set of terms).

\[ \frac{\delta y}{\delta t} = \frac{1}{n} \sum_{h} \frac{\delta y^h}{\delta t} \]

For a small country, negative allocation effects outweigh the terms-of-trade effects, so that the impact of the tariff on mean income is strictly negative. Also, for the small country, the impact on the cost of living will be to raise prices. As such, the real mean-income effect will be strictly negative for a small country. With a large country, the combined income and cost-of-living effect, or in other words the real income effect of the tariff change as represented by the term in square brackets in

component of the welfare function. The CRRA function yields a particularly clear and parsimonious reduced form.
the first line of equation (26) and by the value of \( (\mathcal{Q}_k - \mathcal{Q}_{k,0}) \) may be positive or negative depending on the magnitude of terms-of-trade effects.

The impact on household income distribution, the other part of equation (26), follows from differentiation of equation (24). This is shown, both in change and elasticity form, in equation (28) below.

\[
\frac{\partial \lambda}{\partial \mathcal{I}} = \frac{\partial \lambda}{\partial \mathcal{I}} \left( \mathcal{Q}_j, \mathcal{Q}_{j,0} \right) + \frac{\partial \lambda}{\partial \mathcal{I}} \left( \mathcal{Q}_k, \mathcal{Q}_{k,0} \right) + \frac{\partial \lambda}{\partial \mathcal{I}} \left( \mathcal{Q}_t, \mathcal{Q}_{t,0} \right)
\]

or

\[
\mathcal{I} = \mathcal{I} \left( \mathcal{Q}_j, \mathcal{Q}_{j,0} \right) + \mathcal{I} \left( \mathcal{Q}_k, \mathcal{Q}_{k,0} \right) + \mathcal{I} \left( \mathcal{Q}_t, \mathcal{Q}_{t,0} \right)
\]

In equation (28), the term \( \mathcal{I}_j \) represents the national income share of factor \( j \).

Note that we also have an inverse income weighting, by a factor of \( \mathcal{I} \), applied to induced changes in income. This in turn depends on Stolper-Samuelson derivatives, and induced price changes that follow from tariff changes. This is expressed in equation (29), where the terms \( \frac{d\mathcal{I}_j}{d\mathcal{I}} \) and \( \mathcal{I}_{j,0} \) depend on system fundamentals and Stolper-Samuelson relationships.
Consider the Heckscher-Ohlin model. To simplify things, we assume everyone has an equal share of tariff revenue and labour income, with capital ownership being the determinant of variations in personal incomes. We then have the following:

5.2 Heckscher-Ohlin Inequality Effects

Consider the application of equation (24) to a 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 index can be manipulated to yield equation (30). (We have also assumed an equitable distribution of tariff revenue). The impact of changes in the tariff on inequality is shown in equation (31), while equation (32) is then the resulting elasticity of inequality with respect to import protection. Inequality is purely a function of the allocation of capital in a 2x2 Heckscher-Ohlin 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 inequality. The social welfare effect, however, will depend on the trade-off between real income effects following from import protection, and the impact on inequality. From equation (32), this is ultimately a function of the degree of inequality aversion, combined with the structural features of the economy and its market power on world markets. For a small country, real income effects will be strictly negative, while inequality effects may be positive or negative, depending on the relative endowment structure of the economy. For a large country, it is possible for both effects to work in the same direction.
However, in this case, note that positive terms-of-trade gains will slow any rise (or slow any fall) in capital income shares, from equation (29). This in turn means that terms of trade effects will tend to mitigate the inequality effects of protection. It will tend to accelerate these effects in capital-intensive countries.

On the basis of equation (33), we can summarize our discussion above with the following observations about import protection and inequality in the 2x2 Heckscher-Ohlin model.

- **Observation 1**: In a small country, where any mean real-income effects from import protection will be negative, import protection may still be welfare improving if the induced change in inequality is large enough. This is ultimately a theoretical possibility and an empirical question.

- **Observation 2**: If, in small developing countries, poor households by definition derive income only or mostly from labour, then in a 2x2 Heckscher-Ohlin world inequality will be made worse, as import protection
in a labour rich country will help capital owners, who receive relatively low weight in equation (30).

- **Observation 3**: In small developed countries, under the assumption that the poor receive only or mostly labour income, import protection within a Heckscher-Ohlin economy means a drop in inequality. Again, the net welfare effect is ambiguous however. It depends on the value of $\phi$, and hence the inequality factor applied against mean income.

- **Observation 4**: The impact of protection on inequality will be weaker, in a Heckscher-Ohlin economy, for large countries. This is because of terms of trade effects from equation (29), which will dampen the goods-price to factor-price transmission mechanisms at play.

### 5.3 Inequality Effects in the 2x3 Ricardo-Viner Model

Next, consider the specific factors model. We can make a similar manipulation of equation (24), like that yielding equations (30)-(32), for the standard 2-good, 3-factor model. This yields equations (33), (34), and (35). Again, if we assume that inequality follows from the ownership pattern of (specific) capital, then in this case a shift in income shares through protection from more to less concentrated factors (in terms of the concentration of factor ownership) yields a reduction in inequality. The same points then follow, as before, with regard to country size and inequality effects in the H-O model. Otherwise, the impact of protection on inequality depends on the pattern of relative wage and ownership effects.
We can summarize our results with respect to the Ricardo-Viner model as follows:

- **Observation 5**: In a small Ricardo-Viner country, where any income effects from tariffs will be negative, protection may still be welfare improving if the induced change in inequality is large enough. This requires that the sign be right, and is ultimately a theoretical possibility.

- **Observation 6**: Unlike the Heckscher-Ohlin model, the impact of protection on inequality is ambiguous when capital ownership patterns are the source of inequality. This is because the degree of concentration of specific-factor ownership may vary.

Observation 6 relates the impact of protection on inequality to differences in ownership patterns for specific factors. Consider that if the ownership of the import-competing specific factor is sufficiently less concentrated than that for the export-sector, import protection will reduce inequality. However, if capital in the
import-competing sector has relatively concentrated ownership, it will make the situation worse. For example, in a developing country where the poor have labour and land, and the rich labour and capital, protection will make the concentration of income worse, assuming the sector using capital is an import-competing sector. On the other hand, if ownership of land is very highly concentrated relative to capital, import protection may improve the distribution of income.

5. **Summary and Conclusions**

In this paper we explore the theoretical relationship between import protection and the household distribution of income in general equilibrium. The theoretical linkages between import protection and the functional distribution of income (i.e. factor incomes) are well developed in the literature. Because the functional distribution is the first step in mapping import protection to the household/personal distribution of income, the existing 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.

Our contributions in this paper follow from an explicit formalization of these linkages, based on the use of CRRA preferences, which are the social welfare system implicitly behind the Atkinson inequality index. By taking this approach, we are able to extract a formal decomposition of the national welfare effect of import protection, in general equilibrium, into a real income level and variance component. These explicit inequality derivatives allow us to map import protection to inequality-adjusted welfare. They also yield empirical predictions for the linkages between trade protection, country size, level of development, and the level of inequality in a Heckscher-Ohlin and Ricardo-Viner world. Our Atkinson-based decomposition of welfare and inequality may also prove parsimonious in applied general equilibrium applications focused on inequality.
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