Informality, tariffs, and welfare

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Abstract

We analyze the effects on aggregate welfare, inequality and the specialization pattern of increasing trade integration in the case of a small country characterized by the presence of informality. We being presenting some new empirical evidence on informality based on Latin American countries. In particular, we document the existence of an inverted U-shape relation between informality and openness and a positive relation between openness and the formal/informal wage ratio. Then we present a simple model able to account for this empirical evidence. Three are the main features of the model: 1) workers’ consume both formal and informal goods; 2) informality is (partly) a voluntary phenomenon as suggested by the empirical evidence presented in Maloney (2004) and Bosh et al.(2007); 3) the government uses tariff revenues to purchase formal goods. We show under which conditions tariff reduction may increase informality and that the maximization of income requires a positive level of tariff protection.

1 Introduction

Informality is an empirically relevant phenomenon in most of the developing countries. For this reason, do not considering this element when modeling the impact of trade liberalization on the labour market and the economy at large may indeed imply missing an important part of the story (Kar and Marjit, 2001; Emran and Stiglitz, 2005). Recently the literature has provided a number of possible explanations for the existence of informality (Gerxhani, 2004; Kar and Marjit, 2009). Yet no theoretical model has jointly analyzed how, on the one hand, the process of increasing trade integration impact on informality

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and, on the other hand, how the standard effects of reducing tariff protection are modified by the presence of informality.

This is where the present paper tries to contribute to the literature. We present a simple model which describes how trade liberalization, in the form of tariff reduction, impacts on the number of informal workers. We also study how increasing trade integration affects aggregate income, inequality and the specialization pattern when a part of the economy is characterized by informality. Three are the main assumptions of our model. First, informality exists because workers-consumers demand both formal and informal goods. Second, following the empirical evidence presented in Maloney (2004) and Bosch et al. (2007), we consider a labour market which in equilibrium is characterized by a wage gap between formal and informal wage because workers enjoy some benefit from being informal. Indeed workers do not equate wages but instead utilities, i.e. the total "package" of benefits attached to a specific status. In the following we will refer to this wage gap using the term informality benefit. Third, all tariff revenues are used by the Government to purchase (only) formal goods.

In our model all the results concerning the effects of increasing trade integration on the variables of interest are triggered by how tariff reduction affects informality. Actually two opposite forces are at work in determining the impact of tariff reduction on the level of informality. On the one hand, since the Government uses tariff revenues to purchases only formal goods changes in the tariff level modifies the composition of consumption demand. Indeed, since tariff revenues are a concave function of tariffs, starting from a high level of protection, a tariff reduction increases demand for the formal goods. Thus reducing high tariff protection tends to reduce informality. On the other hand, tariff reduction increases trade flows: in this case tariff reduction affects informality through changes in relative prices and the induced adjustment taking place in the labour market. As in the standard Dornbusch et al. (1977) model, a reduction in tariffs enhances world production efficiency, reduces the prices of (formal) imported goods and increases domestic export. Thus, trade integration tends to reduce informality because of the substitution between formal and informal goods and of the increase in the foreign demand for formal domestic goods. But the increase in the import of (now cheaper) foreign (formal) goods also tends to decrease the formal domestic wage shifting labor supply toward the informal sector. In order to maintain the equilibrium in the labour market, the informal wage decreases and so will do the price of the informal good. Since the informal price decreases proportionally more than the formal one, informality tends to increase. Interestingly our model shows that these two opposite forces result in a non-linear relationship between tariff protection and informality that depends upon the consumption parameters and on the level of government efficiency.

Our model also predicts that the presence of informality deeply modifies the standard (positive) effect of a reduction of tariffs on aggregate income. Again there are two opposite forces at work here. On the one hand, aggregate income moves with tariff revenues because the latter - which is a concave function of the tariff level - is a component of the former. Thus a reduction in the tariff tends to first increase and
then decrease aggregate income. On the other hand, as we mentioned above, reducing tariff protection increases informality. Thus, since the informal wage is lower than the formal one, aggregate income tends to decrease. Which effect prevails depends on the initial level of tariff protection. Our model predicts that reducing tariff protection always increases wage inequality and, differently from standard trade theory, welfare is maximized by a positive level of the tariff. Finally, the present model allows the derivation of some testable relationships between preferences for informal goods and the country’s level of specialization.

To the best of our knowledge this is the first paper that, built in accordance with the view on informality put forward by the influencing paper by Maloney (2004) offers a simple and tractable theoretical framework to determine the effect of reducing tariff protection on a set of important economic variables when the economy is characterized by informality. Moreover the model’s predictions turn out to fit well a number of stylized facts concerning developing - in particular Latin American - countries.

The paper is structured as follows. In the next section we briefly review the empirical and theoretical literature on informality and trade integration. In section 3 we present some new stylized facts concerning trade and informality in Latin American countries. In section 4 we describe the model. In section 5 the main results of the model are derived and compared with the empirical evidence. Section 6 concludes.

2 Informality and trade: related literature

The term informality may indicate different things. In its original meaning, informality included illicit or illegal activities by individuals operating outside the formal sphere for the purpose of evading taxation or regulatory burden (ILO, 1972). In more recent analysis, the informal sector is usually defined as the sector of the economy that does not comply with labor market regulation such as minimum wage laws, hiring/firing regulations, or minimum age laws. In other cases, it is defined as the group of ‘very small enterprises that use low-technology models and do not refer to legal status’ (Webster and Fidler, 1996; ECLAC, 2006). A broader definition of the informal sector may also include temporary workers in formal establishments. Maloney (2004), after acknowledging the high heterogeneity present in the informal sector, suggests to identify informality with its larger component: males who are self-employed or owners of unregistered micro-enterprises with less than five employees.

Despite figures may vary depending on the definition used, it is a fact that the informal sector actually accounts for a large share of the labor force in most developing countries. The economic importance of the informal sector is also confirmed by the fact that its activities are numerous and that most of them also produces import substitutes (Kar and Marjit, 2001).

Reducing informality ranks top in the agenda of policy makes in developing countries. The reason is that informality is said to be associated with low quality and poorly paid jobs. But from an empirical point

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1For a discussion of the different interpretations of the concept of informality see Portes and Schauffler (1993).
of view this view is controversial. Indeed, the existing evidence that workers with the same observable characteristics earn less in the informal than in the formal sector is not sufficient to identify causality: this evidence is indeed consistent also with people self-selecting into the informal sector based on some unobservable characteristics. Maloney (2004) argues that the same type of critique applies to the claim that informal jobs are less desirable. In fact given the available evidence it is not possible to exclude the possibility that some individual may value informal work arrangements superior to formal ones. To support his view, he presents empirical evidence on Latin American countries showing that this may be indeed the case.\(^2\)

The belief that informality is a negative phenomenon has fueled a number of studies in search for its causes and its remedies.\(^3\) In particular a very popular fear is that globalization would increase informality.\(^4\) Nonetheless, up to now, empirical studies examining the relationship between trade liberalization and informal employment are few and their results are mixed (Currie and Harrison, 1997; Goldberg and Pavicnik, 2003; Ghosh and Paul, 2008). Goldberg and Pavicnik (2004), after reviewing a number of country studies, conclude that the informal sector expands following a trade liberalization but that the country’s structural characteristics may play an important role in determining the relations between the two variables.\(^5\)

In general, existing results should be interpreted with several caveats because, while the definition of the informal sector used in these studies captures the broad idea of non-compliance with the labor market regulation, the exact source of non-compliance may differ across countries. One should thus be cautious about comparison of results from cross-country studies when the definition of informality concerns labour market legislation. The influential contribution of Maloney (2004) does not suffer from this shortcoming. Indeed his definition of informality allows for cross-country and across time comparison between different country experiences. Using unique data from Latin American countries, he shows that the informal sector is not a residual of the formal one but the result of a (partly) voluntary choice made by workers (see also Gunther and Launo, 2006). According to this view, workers trade formal protection off for another dimension of job quality.\(^6\) In fact there are a number of reasons for which a worker

\(^2\)Boch et al. (2007) draw a similar conclusion considering the Brazilian case. Opposite evidence on this point based on Colombian data is instead reported in Goldberg and Pavicnik (2003).

\(^3\)For a review see Gerxhani (2004).

\(^4\)There are, obviously, other important factors that influence the level of informality in a country (see for instance Loyaza, 1994). Early empirical studies focused on the relationship between the tax rate (and the level of government intervention in the economy) and informality founding a positive correlation between the two. More recent and detailed studies show that this relationship is far from robust (Goldberg and Pavicnik (2004)).

\(^5\)For instance, Ghosh and Paul (2008) find robust empirical evidence trade liberalization or openness significantly increases the informal share of GDP in 18 Central Eastern European and Former Soviet Union countries.

\(^6\)As Maloney (2004) remarks,

"Arguing that workers are voluntarily informal does not, of course, imply that they are not living in poverty, only that they would not obviously be better off in the formal jobs for which they are qualified." [Maloney(2004), p.1160].
may want to become ‘unprotected’ or informal. The most important one is that in developing countries, government provided services to the formal sector are frequently of poor quality. Since workers pay for these implicitly or explicitly, to the degree that perceived benefits fall short of taxes there is an incentive to become informal.

3 Some stylized facts: informality in Latin American countries

Informality is a relevant phenomenon in several Latin American countries. In this section we report some new stylized facts concerning informality and its relation with some important economic variables for the largest countries in the region. Table 1 presents UN-ECLAC’s estimates of the evolution of informality during the period 1990-2005. Two facts emerge from these data. First, informality is a quantitatively important phenomenon in Latin American countries. Second, informality has increased during the period under consideration, with the average share of informality increasing from 46.9% to 49.2%.

Table 1: Informality in Latin America - selected years
(Percentage of total urban employed population)

<table>
<thead>
<tr>
<th>Country</th>
<th>1990</th>
<th>2000</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>44.4</td>
<td>42.2</td>
<td>39.8</td>
</tr>
<tr>
<td>Bolivia</td>
<td>58.5</td>
<td>63.1</td>
<td>70.9</td>
</tr>
<tr>
<td>Brazil</td>
<td>49.2</td>
<td>46.2</td>
<td>43.6</td>
</tr>
<tr>
<td>Chile</td>
<td>38.8</td>
<td>32.5</td>
<td>31.8</td>
</tr>
<tr>
<td>Costa Rica</td>
<td>36.9</td>
<td>39.1</td>
<td>39.9</td>
</tr>
<tr>
<td>Ecuador</td>
<td>54.5</td>
<td>56.5</td>
<td>57.9</td>
</tr>
<tr>
<td>El Salvador</td>
<td>55.6</td>
<td>53.8</td>
<td>54.6</td>
</tr>
<tr>
<td>Honduras</td>
<td>53.3</td>
<td>55.2</td>
<td>59.4</td>
</tr>
<tr>
<td>Paraguay</td>
<td>55.5</td>
<td>54.5</td>
<td>56.0</td>
</tr>
<tr>
<td>Uruguay</td>
<td>39.2</td>
<td>42.6</td>
<td>44.3</td>
</tr>
<tr>
<td>Venezuela (Bol. Rep. of )</td>
<td>39.2</td>
<td>54.6</td>
<td>52.0</td>
</tr>
<tr>
<td><strong>Latin America</strong></td>
<td>46.9</td>
<td>48.1</td>
<td>49.2</td>
</tr>
</tbody>
</table>

Source: Economic Commission for Latin America and the Caribbean (ECLAC) - Social Panorama 2006.

Notes: Informality defined as in ECLAC (2006): urban population employed in low-productivity sectors of the labour market. We have included all countries for which there are at least three observations. aGreater Buenos Aires; bAsuncion; cData correspond to 1989; dData correspond to 2001; eData correspond to 1999; fData correspond to 2001; gData correspond to 2004; hData correspond to 2003; iData correspond to 2004; jData correspond to 2003; lSimple average.

In the last two decades, Latin American countries have undergone deep structural changes. In particular trade liberalization episodes took place in most of the countries. To explore the possible existence

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7The ECLAC’s definition of informality is an extended version of Maloney (2004)’s one since also domestic services are included into the informal sector. Since this definition of informality is not subjected to the discrepancies cause by in the regulatory frameworks of each country, it can be safely used to comparison across countries.
of a relationship between increasing trade openness and informality, we run a series of regressions using different specifications. The results are reported in Table 2. We first regress the level of informality on openness. The result show that the openness coefficient is not significant (regression (1)). When we control for for country heterogeneity, the coefficient changes sign but remains not significant (regression (2)). On the contrary, when we include the openness quadratic term both openness and squared openness turn out to be significant controlling or not for heterogeneity (regressions (3) and (4)) with the former coefficient being positive and the latter negative. Then we include as an additional control variable GDP per capita. When we regress informality on openness (regression 5), the coefficient becomes significant and negative but its significance disappears when we control for country heterogeneity (regression 6). Finally we include in the regression also the openness squared term (regression 7 and 8). When we control for heterogeneity, the openness coefficient changes sign and becomes positive and the squared term turns out to be significantly negative. The GDP-per capita coefficient remains significant and negative.

In conclusion, the results suggest the existence of a quadratic relationship between informality and openness. The following model will try to account for this inverted U-shape relationship.

Table 2: Informality and Openness 1990-2005: Regression results

<table>
<thead>
<tr>
<th>Dependent variable: Informality</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Openness</td>
<td>-3.13</td>
<td>2.37</td>
<td>12.03*</td>
<td>11.42**</td>
<td>-9.29***</td>
<td>2.80</td>
<td>-10.92**</td>
<td>22.93***</td>
</tr>
<tr>
<td></td>
<td>(2.41)</td>
<td>(2.17)</td>
<td>(6.47)</td>
<td>(5.42)</td>
<td>(1.61)</td>
<td>(2.17)</td>
<td>(4.67)</td>
<td>(6.30)</td>
</tr>
<tr>
<td>Openness^2</td>
<td>-8.33**</td>
<td>-3.38*</td>
<td>.86</td>
<td>-7.28***</td>
<td>.86</td>
<td>-7.28***</td>
<td>.86</td>
<td>-7.28***</td>
</tr>
<tr>
<td></td>
<td>(3.31)</td>
<td>(1.86)</td>
<td>(2.32)</td>
<td>(2.15)</td>
<td>(2.32)</td>
<td>(2.15)</td>
<td>(2.32)</td>
<td>(2.15)</td>
</tr>
<tr>
<td>GDP per capita</td>
<td>- .003***</td>
<td>-.001</td>
<td>-.003***</td>
<td>-.002***</td>
<td>-.003***</td>
<td>-.003***</td>
<td>-.002***</td>
<td>-.003***</td>
</tr>
<tr>
<td></td>
<td>(.0003)</td>
<td>(.0007)</td>
<td>(.0003)</td>
<td>(.0008)</td>
<td>(.0003)</td>
<td>(.0008)</td>
<td>(.0003)</td>
<td>(.0008)</td>
</tr>
<tr>
<td>Country dummies</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>Number of observations</td>
<td>109</td>
<td>109</td>
<td>109</td>
<td>109</td>
<td>109</td>
<td>109</td>
<td>109</td>
<td>109</td>
</tr>
<tr>
<td>R^2</td>
<td>0.016</td>
<td>0.02</td>
<td>0.07</td>
<td>0.92</td>
<td>0.60</td>
<td>0.92</td>
<td>0.60</td>
<td>0.93</td>
</tr>
<tr>
<td>AdjR^2 - squared</td>
<td>0.006</td>
<td>0.905</td>
<td>0.907</td>
<td>0.907</td>
<td>0.906</td>
<td>0.906</td>
<td>0.906</td>
<td>0.916</td>
</tr>
</tbody>
</table>

Source: ECLAC database - Social Panorama (2006) and Statistical Yearbook (2006). Countries included: Argentina, Bolivia, Brazil, Chile, Costa Rica, Dominican Rep., Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay, Venezuela. Data on Real GDP-per capita and Openness (constant price) are from the PWT 6.2. For the list of countries and data used see the Appendix.

Note: *,**,*** denote significance at 10, 5 and 1% respectively. All regressions are estimated by OLS. The values in parenthesis are standard errors.

The basic intuition for the result that there is a non-linear relation between informality and openness is as follows. Trade integration is expected to bring about deep structural changes in the economy. One of the possible mechanisms through which this happens is changes in the relative prices - due to tariff reduction. But when the economy is characterized by informality, these changes do not only affect the domestic and foreign relative prices - as it happens in standard models of trade - but also the formal and informal ones. Thus the presence of informality creates an additional effect of trade integration absent in the standard models of trade: the reduction of tariff protection impacts the domestic labour market through a modification of the distribution of workers across the formal and informal sectors. We expect these effects to depend on the level of trade integration.
Table 3 reports correlation coefficients between the main variables we will consider in the following model. Results suggest the existence of a positive association (correlation coefficient 0.29) between openness and the relative formal/informal wage. In also results that informality and the relative formal/informal wage are positively correlated. The positive coefficient (0.44) indicates that in countries where informality is larger wage inequality - as measured by the ratio formal/informal wage - is higher. The table also shows that the dimension of the formal market is negatively correlated with inequality and informality while it is positively correlated with the level of openness. We conclude this list of stylized facts reporting that our measure of the informal benefit\(^9\) is negatively correlated (−0.26) with the level of trade openness.

Table 3: Informality, trade openness and formal/informal wage

<table>
<thead>
<tr>
<th></th>
<th>number informal workers</th>
<th>trade openness</th>
<th>formal/informal wage</th>
</tr>
</thead>
<tbody>
<tr>
<td>formal/total market</td>
<td>-0.78</td>
<td>0.31</td>
<td>0.21</td>
</tr>
<tr>
<td>formal/informal wage</td>
<td>0.44</td>
<td>0.29</td>
<td></td>
</tr>
</tbody>
</table>

Source: Authors' calculation based on ECLAC (2006). For details on variables' definition see the Appendix C. All correlation coefficients are significant at 5%.

In the following we present a variant of the classical Ricadian model with a continuum of goods that incorporates as basic features these stylized facts and it is also in accordance with the empirical evidence reported in Maloney (2004). The intent is to offer an empirically based model able to account for the effect of reducing tariff protection on informality and to analyze how the presence of informality modifies, with respect to the standard case, the impact of increasing trade openness on the main economic variables.

4 The model

The theoretical literature on informality is highly idiosyncratic both concerning modeling choices and results obtained (see Loyaza, 1994; Marjit, 2003; Gibson, 2005, Marjit et al. (2007)). Two are the main assumptions of our model. First, the cause for the existence and persistence of informality is workers’ demand for informal goods. Thus the explicit consideration of demand in determining the effects of increasing trade integration on informality becomes crucial. Second, we model a labour market in a way which is coherent with the empirical evidence presented in Maloney (2004). As we have seen, the empirical evidence suggests that, even if their wage is lower, informal workers are not necessarily worse-off with respect to formal ones. An implication of this is that formal wage paid by firms should be higher than

\(^9\)The empirical measure of the informal benefit is the difference between the formal and the informal wage.
informal one to dissuade workers from leaving the formal sector and become informal self-employed.\textsuperscript{10}

In this section we present a variant of the classical Ricardian continuum of goods model (Dornbusch et al. (1977)) in which we have introduced informality.\textsuperscript{11} There are two countries: North and South. Each country can produce a continuum of manufacturing goods. In North all the sectors are formal. On the contrary, in South there is also an informal sector.

4.1 Production and specialization

The formal sector Both countries produce manufacturing goods: these are modeled as a continuum over the interval $z \in [0, 1]$. The production of these goods uses workers as only input; one unit of good $z$ requires $a(z)$ units of labor in South and $a^*(z)$ in North, with $a(z) < 1$ and $a(z)^* < 1$. We assume $a(z) \neq a^*(z)$ for all $z$. Define

$$A(z) = \frac{a^*(z)}{a(z)}$$

We rank goods such that $A'(z) < 0$. Thus South has a relative productivity advantage in low-index goods and the North in high-index ones.

The informal sector The South economy is characterized by the presence of an informal sector. Following the empirical evidence (Perez Sainz (1998), ECLAC (2006), Sindzingre (2006)), we assume that the informal sector: 1) produces a cheaper good than the (bundle of) goods produced in the formal sectors; 2) has a lower labour productivity than the formal ones\textsuperscript{12}; 3) pays a lower wage than the formal ones; 4) is non-tradeable. In addition, we assume the good produced in the informal sector to be a substitute for the formal goods, either domestically produced or imported from North.\textsuperscript{13} Also the production of informal good uses workers as only input with one unit of good $i$ requiring one unit of labor, i.e. $a_i = 1$.

Specialization pattern Suppose now that South imposes an uniform ad valorem tariff $t$ on imports from North, and that North imposes a tariff $t^*$ on imports from South. Denote $w_f$ and $w^*$ the formal (nominal) wages in South and North, respectively. With perfect competition, the price of formal good $z$ is $p(z) = a(z)w_f$ if domestically produced and $p(z) = (1 + t)a(z)^*w^*$ if imported. Thus, South imports good $z$ if and only if $p(z) = a(z)w_f > (1 + t)a(z)^*w^*$. The equality defines Souths borderline import good $z_m$, whose value satisfies

$$A(z_m) = \frac{w_f}{(1 + t)w^*}$$

\textsuperscript{10}Note that this provides a possible novel interpretation for the existing difference between formal and informal wage.

\textsuperscript{11}We developed our model starting from the version of the Dornbusch et al. (1977) model elaborated in Xu (2003).

\textsuperscript{12}Recent ECLAC estimates show that the relative informal/formal productivity ranges between 10\% and 40\% (Cimoli et al., 2006).

\textsuperscript{13}While it would also be possible to model a continuum of informal sectors, the simplified framework here adopted is able to highlight the basic idea of the model and the mechanism behind our results.
Using the same reasoning, the South exports good \( z \) if and only if \((1 + t^*)a(z)w_f < a(z)^*w^* = p^*(z)\). The equality defines the South’s borderline export good \( z \), whose value satisfies

\[
A(z_x) = (1 + t^*) \frac{w_f}{w^*}
\]

Note that \( z^m = z^x \) iff \( t = t^* = 0 \). If either tariff is positive we always have \( z^m > z^x \). Since South produces goods in the range \([0, z^m]\) and North produces goods in the range \([z^x, 1]\), the goods in the range \([z^x, z^m]\) are tariff-driven non-traded goods. Figure 1 describes the international pattern of specialization.

### 4.2 Consumption

South is populated by \( H \) workers-consumers. Each worker inelastically supplies a unit of labour and demand a bundle of informal and formal goods.\(^{14}\) While the informal good can be produced only domestically, formal ones can be acquired from either domestic or foreign producers. On the demand side of the model, we adopt the representative consumer framework as in Dixit and Stiglitz (1977). The behavior of the representative consumer is described as the outcome of a two stage utility maximization procedure. In the first stage, the consumer optimally allocates expenditure between formal and informal goods. In the second stage consumption decisions are made over the differentiated formal goods.

**First stage** Workers have identical Cobb-Douglas utility functions and they are thus assumed to spend an equal share of income in buying formal goods. Denoting with \( p_i \) the price of the informal good and with \( p_f \) the price index of formal ones (defined below, equation (5)), we have that individual \( h \)'s consumption of informal and formal goods, respectively, are given by\(^{15}\)

\[
c_{ih} = \frac{[1 - \lambda]I_h}{p_i}, \quad c_{fh} = \frac{\lambda I_h}{p_f}
\]

\(^{14}\)Marcouiller and Young (1995) rationalize the existence of an informal sector by assuming that goods produced in the formal sector are imperfect substitutes for essential goods produced in the informal sector. Their idea is very different from our in that we do not attach any ’necessary’ characteristics to the informally produced goods.

\(^{15}\)Worker’s \( h \)'s preferences in the first stage are described by a Cobb-Douglas utility function

\[
U_h = c_{ih}^{1-\lambda} c_{fh}^\lambda
\]

where \( 0 < \lambda < 1 \) is the share of individual income spent in formal goods, \( c_{ih} \) is the quantity of the informal good consumed by individual \( h \) and \( c_{fh} \) is the aggregate or industry quantity index of the differentiated formal good (to be defined below).
with \( h = \{i, f\} \), where \( h = i \) if the agent is an informal worker and \( h = f \) if she is formal. \( I_h \) is agent’s income and \( \lambda \) is the income share spent on formal goods. Normalizing \( H = 1 \), aggregate South’s private demand for formal goods is:

\[
c_f i (1 - L) + c_f f L = \frac{\lambda w_i}{p_f} (1 - L) + \frac{\lambda w_f}{p_f} L = \lambda \left[ \frac{w_i (1 - L) + w_f L}{p_f} \right]
\]

where \( L \) and \( (1 - L) \) are formal and informal workers, respectively and \( c_f i \) and \( c_f f \) are individual demand of formal goods by informal and formal workers, respectively. The government uses tariff revenues \( G \) to purchase only formal goods.\(^{16}\) Thus total expenditure on formal goods is:

\[
\Theta = p_f [c_f i (1 - L) + c_f f L] + G = \lambda [w_i (1 - L) + w_f L] + \alpha t \left[ \frac{1 - z_m \Theta}{1 + t} \right]
\]

where \( G \) is total import tariff revenue. The parameter \( 0 < \alpha < 1 \) represents the share of tariff revenues that become formal demand. The remaining \( (1 - \alpha) \) is a pure waste. We interpret \( \alpha \) as the efficiency level of the Government.

The derivation of total expenditure on informal good is identical and we have:

\[
\Delta = (1 - \lambda) [w_i (1 - L) + w_f L]
\]

Finally, total expenditure in South is given by:

\[
E = \Theta + \Delta = w_i (1 - L) + w_f L + \alpha t \left[ \frac{1 - z_m \Theta}{1 + t} \right]
\]

For the moment, we will assume that there are no government inefficiencies and thus all tariff revenues are spent by the government to purchase formal goods, i.e. \( \alpha = 1 \). We will discuss the effect of different levels of government inefficiency in Section 5.2.

**Second stage** Equation (1) gives total expenditure on formal goods by South workers. The following step is to determine how much each formal good \( z \) receives. The consumption bundle of formal goods of worker \( h = \{i, f\} \), \( c_{fh} \), is defined as follows:

\[
c_{fh} = \left( \int_0^1 \frac{\theta z}{c_{fhz} \, dz} \right)^\frac{\theta}{\theta - 1}
\]

where \( c_{fhz} \) is the quantity of good \( z \) demanded by individual \( h \), and with \( \theta > 1 \) that measures the elasticity of substitution between the different goods. The formal goods price index is given by

\[
p_f = \left( \int_0^1 p(z)^{1-\theta} \, dz \right)^\frac{1}{1-\theta}
\]

\(^{16}\)Government spending is assumed to be financed only through tariff revenues. The presence of a taxation scheme would not modify our results as long as the (net) formal wage is superior to the informal one, condition which is consistent with the evidence discussed in Section 2.
where \( p(z) \) is the price of good \( z \). International trade implies that:

\[
p(z) = \begin{cases} 
  a(z)w_f & \text{if } z < z_m \\
  a^*(z)(1 + t)w^* & \text{if } z > z_m
\end{cases}
\]  

(6)

The worker of type \( h \) in the second stage maximises equation (4) subject to the budget constraint:

\[
\lambda w_h = p_f c_{fh} = \int_0^1 p(z)c_{fh}dz
\]

Since formal goods are a continuum \([0, 1]\), each variety receives a constant share of the income. This yields the following demand function for good \( z \) by individual \( h \):

\[
c_{fh} = \left( \frac{p(z)}{p_f} \right)^{-\theta} \frac{\lambda w_h}{p_f} \quad h = \{i, f\}
\]

Summing up for all workers and adding government expenditure we obtain total South demand for each formal good (recall eq.(1)):

\[
C_{fz} = \left[ \frac{p(z)}{p_f} \right]^{-\theta} \frac{\Theta w_i}{p_f} (1 - L) + \left[ \frac{p(z)}{p_f} \right]^{-\theta} \frac{\lambda w_h}{p_f} L + \left[ \frac{p(z)}{p_f} \right]^{-\theta} \frac{G}{p_f} = \left[ \frac{p(z)}{p_f} \right]^{-\theta} \frac{\Theta}{p_f}
\]

(7)

Finally, assuming that varieties are perfect complements (i.e. \( \theta \to 1 \)), we have that

\[
C_{fz} = \frac{\Theta}{p(z)}
\]

where \( C_{fz} \) is total demand for good \( z \).

### 4.3 Factor market equilibrium

**Labour demand** As we have seen South workers spend \( \Theta \) on the continuum of formal goods \([0; 1]\). Since all formal goods receive an equal share in expenditure and the price of domestically produced ones is \( p(z) = a(z)w_f \), workers demand \( \frac{\Theta}{p(z)} = \frac{\Theta}{a(z)w_f} \) units of each formal good domestically produced. Given that the unit labour requirement is \( a(z) \), it follows that the labour demand for each formal good in South is given by \( \frac{\Theta}{w_f} \). Since the range of formal good produced in South and consumed by South workers is \([0, z_m]\), domestic consumption generates a total demand for formal labor in South equal to \( z_m \frac{\Theta}{w_f} \).

Let \( E^* \) denote total North nominal expenditure. North workers spend \( E^* \) on goods \( z \) exported by South at the price \((1 + t^*)p(z)\), which implies a formal demand equal to \( \frac{E^*}{(1 + t^*)w_f} \). Since the range of Southern goods exported to the North is \([0, z_x]\), North’s consumption generates a total demand for South formal labor equal to \( \frac{z_x E^*}{(1 + t^*)w_f} \). Adding the domestic and foreign components of formal labour demand, we obtain

\[
L = \frac{1}{w_f} \left[ z_m \Theta + \frac{z_x E^*}{(1 + t^*)} \right]
\]

(8)

where \( L \) is the demand for formal workers in South.

The demand for informal labor is generated only by South’s workers consumption decisions. Denote \( w_i \) the South informal wage and \( p_i \) the price of the informal good. Southern workers spend \( \Delta \) buying the
informal good. Employment in the informal sector is determined by the equality between the number of demanded and supplied goods. Formally:

\[ \frac{\Delta}{p_i} = \frac{(1 - L)}{a_i} \]

This implies a demand for informal labour equal to

\[ (1 - L) = \frac{\Delta}{w_i} \]

(9)

Full employment in South is obtained summing up (8) and (9) yielding

\[ H = \frac{1}{w_f} \left[ z_m \Theta + \frac{z_x E^*}{(1 + t^*)} \right] + \frac{1}{w_i} \Delta = 1 \]

Following the same procedure, we obtain North’s full employment condition. South workers demand \( \frac{\Theta}{a^*(1+t^*)} \) units of the foreign produced formal goods. This implies a labour demand for formal workers in North equal to \( \frac{\Theta}{(1+t^*)w^*} \). The full employment condition in North reads:

\[ H^* w^* = (1 - z_m) \frac{\Theta}{(1 + t)} + (1 - z_x) E^* \]

**Labour supply** We model the supply side of the labour market in accordance with the empirical evidence reported in Maloney (2004). His empirical analysis suggests that workers attach some positive value to the fact of being informal. Thus, some worker may prefer working in the lower-wage informal sector instead of working in the higher-wage formal one because she values positively the fact of being informal.\(^{17}\) In this sense, informality is interpreted as a voluntary choice.

We formalize this empirical evidence in the following way. Since the formal wage is larger than the informal one, we write:

\[ w_f > w_i = w_f - g \]

(10)

where \( g > 0 \). Define \( b \) the benefit workers attach to the fact of being informal, i.e. the *informality benefit*. It follows that the equilibrium condition in the labour market is given by:\(^{18}\)

\[ U(w_f) = U(w_i + b) \]

\(^{17}\)If this were not the case, since formal wage is higher than the informal one, all workers would prefer staying in the formal sector. Note that if there were no benefits attached to being informal, the only possible explanation for the existence of an informal sector with a lower wage than the formal one is a segmented labour market either due to the existence of efficiency wages (Cimoli et al. (2006)) or to the presence of institutional rigidities that do not allow the labour market to clear (Loyaza (1996)). In this paper we do not consider these alternatives.

\(^{18}\)According to Maloney (2004):

“[I]t follows that] if much of the sector is voluntary, in the sense of workers preferring their present job to one in the formal sector, then the informal job must be at least of equal quality measured along broader set of relevant job characteristics.” [Maloney (2004), p.1159].
In equilibrium must obviously hold that \( g = b \), i.e. the wage difference \( g \) is equal to the benefit \( b \) the workers attach to the fact of being informal. This is the necessary condition for the workers to be indifferent as where to be employed.

4.4 Trade balance

World commodity market equilibrium implies balanced trade. Measured at world prices, South imports manufactures of value \( \frac{(1-z_m)\Theta}{(1+t)} \). North imports manufactures of value \( z_x E^* \). Trade balance thus reads:

\[
\frac{(1-z_m)\Theta}{(1+t)} = \frac{z_x E^*}{1+t^*}
\]

5 Results

We now present the model’s results. We begin studying the impact of increasing trade integration on wage inequality, on the level of informality and on aggregate welfare. Then we describe the results of a number of static comparative exercises concerning workers’ preference for buying formal goods, the level of Government efficiency and the value workers attach to being informal. To focus on the effects that increasing trade integration has on South, we assume that North has no tariff protection, i.e. \( t^* = 0 \).

We begin deriving the model’s results assuming that there are no inefficiency associated to Government spending, i.e. \( \alpha = 1 \); we postpone the analysis of changes in this parameter to Section 5.2.

5.1 Trade integration

We describe the process of increasing trade integration as a decrease in the level of the tariff \( t \). We begin our analysis describing the effect of tariff reduction on wage inequality. This effect is mediated by the trade integration-induced change in relative prices. A reduction in tariff protection decreases the price (index) for the formal goods bundle, which includes both domestic and imported goods.\(^{19}\) Since the only factor of production is labor, any movement in relative prices also induces a movement in wages in the same direction. Given eq.\((10)\), the equilibrium condition in the labour market requires the informal wage to decrease as much as the formal one. But this implies that, since the informal wage decreases relatively more than the formal one, the formal/informal wage ratio increases. This result is summarized in the following:

**Proposition 1** Reducing tariff protection increases the relative formal/informal wage

**Proof.** See Appendix B

\(^{19}\)From eq.\((6)\) it follows that as \( t \) decreases eq.\((5)\) decreases.
This result is shown in Figure 2.\textsuperscript{20} Note that the model’s prediction is in accordance with the stylized fact reported in Table 3 that there is a positive correlation between the level of openness and the formal/informal wage ratio.

The change in the tariff level also affects the distribution of workers between the informal and the formal sectors. Indeed, as we have seen, a tariff reduction reduces the relative wage and thus induces workers to move from the formal to the informal sector. At the same time, the reduction in the tariff increases the total demand for formal goods due to the increase in the foreign demand for the (formal) domestic production. Finally, another effect adds to the previous ones. Tariff reduction affects domestic formal demand also through Government spending. The latter is given by the tariff revenues which are a concave function of the tariff.\textsuperscript{21} While the complexity of the model does not allow us to analytically derive the effect of tariff reduction on informality, numerical results indicate that:

\textbf{Proposition 2} \textit{Reducing tariff protection increases informality.}

\textbf{Proof.} See Appendix B \hfill \blacksquare

This means that, under our chosen parametrization, the trade-induced increase in informality induced by the reduction in the relative formal/informal wage is always larger than the decrease in informality due to the increasing demand for formal domestic goods from both North and the Government. The

\textsuperscript{20}All Figures show the numerical solution of the model obtained using an ad-hoc FORTRAN77 program. If not otherwise stated, results are obtained (and Figure drawn) using the following parameters: $g = 0.5$, $A(z) = 1 - 0.5z$, $\lambda = 0.8$, $\alpha = 1$. The program codes are available upon request.

\textsuperscript{21}See the Appendix for a Proof.
result that trade liberalization increases informality is in accordance with Kar and Marijt (2009). In the next Section, we show how this result changes depending on the degree of government efficiency.\textsuperscript{22}

Our model is also suitable to analyze the impact of increasing trade integration on aggregate income. The relationship between the level of tariff protection and aggregate income is shown in Figure 3 and it indicates that:

**Proposition 3** \textit{The level of the tariff that maximizes aggregate income is positive.}

**Proof.** See Appendix B ■

This result is important because it shows that in the presence of informality, even when this is a voluntary phenomenon, decreasing tariff protection may not be always welfare increasing.\textsuperscript{23} In our model the existence of an optimal level of tariff $\hat{t}$ depends on the fact that reducing tariff protection has two effects on income. The first goes through tariff revenues and the second through informality. On one side, tariff revenues are a concave function of the tariff level. On the other side, as we have seen, reducing tariff protection increases informality and thus reduces the average wage and aggregate income. Starting from a sufficiently high tariff level, reducing tariff protection has a positive impact on aggregate income because it increases tariff revenues. But reducing tariff protection also tends to reduce aggregate income through an increase in the level of informality. For the range of tariff values for which the first effect is larger than the second, income increases with trade integration. Yet, given the concavity of the revenue

\begin{itemize}
\item \textsuperscript{22}To anticipate the result, in the presence of government inefficiencies, the relationship between the tariff level and informality becomes convex, in accordance with the estimation results reported in Table 2.
\item \textsuperscript{23}Emran and Stiglitz (2005) show that, in the presence of an informal sector, price-neutral reforms (i.e. reducing trade taxes and increasing consumption tax like VAT) do not necessarily enhance welfare.
\end{itemize}
function, when the level of tariff becomes lower than its optimal level $\hat{t}$, both effects have a negative impact on income and a further increase in trade integration inevitably reduces aggregate income.

5.2 Comparative statics

In the following we present a number of comparative statics exercises. We begin studying how differences in workers’ preferences for the informal good modify the impact of trade liberalization on inequality, on aggregate income and on the specialization pattern. Then we consider how changes in the degree of government efficiency and in the informal benefit, i.e. the value workers’ attribute to being informal, affect the main results of the model.

5.2.1 Preference for the informal good

One of the basic assumption of the model is that South workers demand (in fixed shares) both formal and informal goods. We now describe the relationship between workers’ preferences for formal goods ($\lambda$) and wage inequality, i.e. the formal/informal wage ratio. This is stated in the following:

**Proposition 4** For any given level of tariff protection, the higher the income share spent in buying formal goods the higher wage inequality

**Proof.** See Appendix B

Interestingly, this prediction is in accordance with the empirical evidence reported in Table 3, which reports a positive correlation between the share of formal demand with respect to total demand and the formal/informal wage ratio. The model thus predicts that in countries where informality is larger the informality wage gap should be lower. The level second result concerns the relationship between the preference for formal goods and aggregate income. This is stated in the following:

**Proposition 5** Ceteris paribus, the higher the income share spent in buying formal goods the higher aggregate income

**Proof.** See Appendix B

Finally, different levels of $\lambda$ also have an effect on the pattern of specialization. Figure 4 and 5 show that, for each level of tariff protection, a higher $\lambda$ is associate with a larger export range and smaller import range. The reason is that for any given specialization pattern, the higher $\lambda$ the higher aggregate income (see Proposition 5). Ceteris paribus, the higher the aggregate income the higher the total amount of imports and the higher the trade deficit. The equilibrium can re-established only through an increase in the export range $[0; z_x]$ and a reduction of the import range $[z_m; 1]$. 
5.2.2 Government efficiency

In our model the Government plays a crucial role since it is assumed to use tariff revenues to only buy formal goods. As we said, the $\alpha$ parameter measures the Government’s efficiency in collecting tariffs or in using them (see eq.1). When $\alpha < 1$, a share $(1 - \alpha)$ of the tariff revenues does not accrue to the government. This missing resources are assumed to be a pure waste. Since by assumption government demand only formal goods it follows that, for any given level of tariff protection, the lower $\alpha$ the lower formal (aggregate) demand and thus the lower aggregate income. The effects of different levels of government efficiency on the relationship between tariff protection and aggregate income are shown in Figure 6. The graphs clearly show that the optimal level of informality (the one associate with maximum income) is positive. This result is consistent with the view of Maloney (2004). Our results also indicate that in the presence of informality increasing trade integration may be welfare reducing independently from the level of government efficiency. Yet the negative (positive) effect of reducing tariff protection when $t < t^* \ (t > t^*)$, is smaller (larger) the smaller (larger) the level of government inefficiency. Thus when the government is highly inefficient, the benefit from increasing trade integration is larger. This result is important because it shows that, in the presence of informality, decreasing tariffs may not always be welfare increasing. The model suggests that there is an optimal level of tariff which maximizes total expenditure, depending on two simultaneous effects on income - the first through tariff revenues and the second through private expenditure. On one side, the tariff revenue is a concave function of the tariff level. On the other side, as it was shown previously, growing trade integration increases informality and reduces average wage.

The level of government efficiency has also an effect on the relationship between trade integration and the level of informality. As shown in Figure 7, the lower $\alpha$ the higher informality for any given level of tariff protection. To explain the concave form of the relation between informality and the tariff level
when $\alpha < 1$, consider:

\[
\frac{\partial(1 - L)}{\partial t} = \frac{1}{w_i^2} \left( w_i \frac{\partial k(\cdot)}{\partial t} - k(\cdot) \frac{\partial w_i}{\partial t} \right)
\]

where $k(\cdot) = E - w_f L - \alpha t \left[ \frac{(1 - z_m)\Theta}{1+t} \right]$. *Ceteris paribus*, a lower $\alpha$ implies that the Government demand for formal goods is lower and $k$ is higher. Interestingly, the increase in $k$ is a concave function of the tariff and this implies that also the relation between informality and the tariff level becomes concave.\(^24\) Thus when $\alpha < 1$ the model’s prediction is in line with the empirical evidence presented in Table 2. As the tariff decreases, first informality increases then, for lower levels of the tariffs, it begins to decrease. This result is interesting in that it makes explicit how the characteristics and the behavior of the Government may have an important effect on the way increasing trade integration modifies the level of informality in the economy. Yet note that for zero tariff level, informality is higher than for the no-trade case.\(^25\)

Finally the $\alpha$ parameter also affects the volume of trade. Indeed, the lower $\alpha$, the lower the tariff revenues collected, and hence, the lower domestic demand for formal goods (see eq.(1)). Thus, the higher government inefficiency the lower imports and, through the balance of payment equilibrium condition, exports. This implies that in our model trade is negatively correlated to government efficiency.

\(^24\)More in detail the mechanism is the following. A reduction of the tariff decreases informality on the declining portion of the tariff revenues function. Starting from that point, a lower tariff reduces tariff revenues and thus aggregate income. This implies that both formal and informal demand decreases. But since the informal market is only domestic, income reduction mostly affect the demand for informal good. Instead, the formal market (relatively) increases as an effect of the reduction of the tariff which has enlarged the opportunity for international trade.

\(^25\)Recall that for $\alpha = 1$, numerical results show that informality increases when the tariff decreases (Proposition 2).
5.2.3 Informality benefit

As a last exercise, we consider how the model’s results depend on the value workers give to the fact of being informal, what we called the *informality benefit*. *Ceteris paribus*, if workers give more value to the benefit of being informal, the ratio between formal and informal wage (wage inequality) has to be larger. This is stated in the following:

**Proposition 6** *Wage inequality is increasing in the value workers attach to being informal*

**Proof.** See Appendix B ■

The intuition of this result is very simple. When the benefit of being informal increases, in order to maintain the equalization of workers’ utility, informal workers will accept a lower wage for staying in the informal sector or, equivalently, they will ask a higher wage for becoming formal. In both cases the results is an increase in the formal/informal wage ratio. The increase of $b$ has three additional effects, summarized in the following:

**Proposition 7** *An increase in workers’ preference for being informal increases informality and reduces both the range of exported goods and aggregate income.*

**Proof.** See Appendix B ■

These results highlight the central role played by worker’s evaluation of the benefit of being informal as a determinant of the effects the reduction of tariff protection may have on the economy. These results should thus not be overlooked when design policies aiming at reducing informality and its negative effects.
6 Concluding remarks

Informality is an important feature of the labour market of many developing countries. In this paper we proposed a model aiming at offering a novel view on the link between increasing trade integration and informality. Two are the main features of our model. The first one is the assumption that consumers' demand is one possible cause of the existence and persistence of informality. The second one, in accordance with recent empirical evidence for developing countries, is a labour market characterized by an informal benefit. This implies that in equilibrium both formal and informal workers co-exist even if the labour market is not segmented. The presence of both these elements in a trade model is, at the best of our knowledge, new to the literature.

Three are the main results of our analysis. First, we described a simple mechanism through which increasing trade integration may increase informality. Second, we show that aggregate income is maximized for a positive level of both tariff protection and informality. Third we emphasized a possible positive role for the Government in a context of endemic informality: to the extent to tariffs revenues become Government consumption, Government intervention would contribute to reduce the dimension of the informal sector. But, an obvious corollary of this result is that, for any positive level of Government spending informality increases in the inefficiency of the Government.

While able to produce predictions which are in accordance with a number of stylized facts, the present model is obviously not exempted from shortcomings. An important one is how we have modeled the the way competition takes place in the domestic market: the next step should be to consider the possibility that the informal sector competes with both domestic and foreign production.

References


A Appendix

A.1 Data

In the following we describe how each variable used in Section 3 was calculated.

Total average income and the proportion of informal workers were taken from ECLAC (Social Panorama 2006, pp.343-344) on the basis of special tabulations of data from household surveys. The other variables are calculated using the data in ECLAC (2006) in the following way. Trade openness: Exports plus Imports divided by GDP - Millions of dollars at constant 2000 prices. Informal wage: weighted average of: 1) average income in establishments employing up to 5 persons; 2) average income in domestic employment and average income for non-professional; 3) non-technical self-employed. Formal wage: is calculated from total income assuming that the total average income is a weighted average of the informal wage and formal wage. Formal workers is one minus the (proportion of) informal workers. Formal market is calculated as the number of formal workers multiplied by their wage. Informal market is calculated as number of informal workers multiplied by their wage. Total market is the sum of informal and formal markets. Formal propensity ($\lambda$) is the ratio formal/total market. Informality benefit: the difference between the formal and the informal wage.
## Table 4: Openness and Informality: 1990-2005

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Source: UN-ECLAC Social Panorama (2006) and Statistical Yearbook (2006). Note: Informality includes micro-enterprises and unskilled self-employment. Microenterprises refers to establishments employing up to five persons. In the cases of Bolivarian Republic of Venezuela, Bolivia (1999 and 2002), Chile (1996), Dominican Republic, El Salvador, Panama (up to 2002) and Uruguay (1990), includes establishments employing up to four persons. Unskilled self-employed includes own-account workers and unpaid family workers without professional or technical skills. It also includes persons employed in agriculture, forestry, hunting and fishing. Until 1990 the “micro-enterprises” category includes wage earners lacking an employment contract. In 1997 from 1996 to 1999, this category includes wage earners in establishments employing up to five persons, so that the figures for these years are not comparable with those for previous years. Information from national socioeconomic surveys (CASEN). Information from national household income and expenditure surveys (ENIGH). In the 1994 survey no information was given on the size of establishments employing wage or salary earners. The sample design used in the surveys conducted since 1997 does not distinguish between urban and rural areas, and the figures therefore refer to the nationwide total. Openness is measured as export plus import divided by GDP, all at constant dollars of 2000.
B Appendix

While the complexity of the model does not allow us to analytically prove all our results, in this appendix we describe the different mechanisms at work in the model to give a flavor of the reason behind each proposition.

Proof of Proposition 1 Given equation (10) it immediately follows that:

$$\frac{\partial(w_f/w_i)}{\partial t} = -\frac{\partial w_i}{\partial t} \frac{g}{w_i^2} < 0$$

(13)

if \( \frac{\partial w_i}{\partial t} > 0 \). Now note that \( \text{sign} \left\{ \frac{\partial w_i}{\partial t} \right\} = \text{sign} \left\{ \frac{\partial(w_f-g)}{\partial t} \right\} = \text{sign} \left\{ \frac{\partial w_f}{\partial t} \right\} > 0 \), where the last relationship is a standard result in the Ricardian continuum of good model.

Concavity of the tariff revenue function We show that the tariff revenues are a concave function of the tariff level. From (1), under the assumption \( \alpha = 1 \), we have that

$$TR = t \left[ (1 - z_m)\Theta \right]$$

(14)

which can be rewritten as

$$TR = tz_x$$

Differentiating (14) we have that,

$$\frac{\partial TR}{\partial t} = z_x + t \frac{\partial z_x}{\partial t}$$

(15)

where \( \frac{\partial z_x}{\partial t} < 0 \). When \( t = 0 \), equation (15) is positive because \( z_x \) is positive. Since (14) is a continuous function, as \( t \) increases its derivative has to remain positive for an interval. Thus, starting from a low level of tariff protection, equation (15) is positive, i.e. tariff revenues grow as \( t \) increases. Equation (14) is maximized for

$$t^* = -z_x \left( \frac{\partial z_x}{\partial t} \right)^{-1} > 0$$

which is positive. For \( t \to \infty \) the second term on the right-hand side goes to \(-\infty\). This means that starting from high levels of protection, a reduction in \( t \) increases tariff revenues. For a high level of \( t \), the economy is relatively closed and the tariff revenues are low because the range of imported goods \([1 - z_m]\) is small. In this situation, a tariff reduction has a strong impact on the specialization pattern: reducing the tariff quickly increase the import range. In this case, the increase in the tariff revenues induced by tariff reduction is larger than the loss due to the lower tariff and tariff revenues increase with trade integration. But there is a level of the tariff, call it \( t < t^* \), for which a further decrease in the tariff reduces tariff revenues. In this case the increase of the import range cannot compensate for the decrease in the tariff level: tariff revenues decrease with trade integration.
Proof of Proposition 2 Using eq.(3) and assuming $\alpha = 1$, informality can be written as

$$(1 - L) = \frac{1}{w_i} \left\{ E - w_f L - t \left[ \frac{(1 - zm) \Theta}{1 + t} \right] \right\}$$

Taking the derivatives with respect to the tariff $t$, we have:

$$\frac{\partial(1 - L)}{\partial t} = \frac{\partial}{\partial t} \left\{ \frac{E - w_f L - t \left[ \frac{(1 - zm) \Theta}{1 + t} \right]}{w_i} \right\} = \frac{1}{w_i^2} \left( w_i \frac{\partial k(\cdot)}{\partial t} - k(\cdot) \frac{\partial w_i}{\partial t} \right)$$

(16)

where $k(\cdot) = E - w_f L - t \left[ \frac{(1 - zm) \Theta}{1 + t} \right]$ is informal workers’ total expenditure. The sign of equation (16) thus depends on the sign and magnitude of the two terms $w_i \frac{\partial k(\cdot)}{\partial t}$ and $k(\cdot) \frac{\partial w_i}{\partial t}$. From Proposition 1 we know that the second term is positive. The sign of $\frac{\partial k(\cdot)}{\partial t}$ is instead ambiguous and it cannot be determined analytically. Numerical results show that, under the assumption $\alpha = 1$, the second terms is always larger than the first and thus $\frac{\partial(1 - L)}{\partial t} < 0$, meaning that informality increases with trade integration.

Proof of Proposition 3 Consider a change in the level of tariff on aggregate income. Recalling eq.(3) and taking its derivate respect to tariff, we have:

$$\frac{\partial E}{\partial t} = \frac{\partial}{\partial t} \left\{ w_i (1 - L) + w_f L \right\} + \frac{\partial}{\partial t} \left( t \left[ \frac{(1 - zm) \Theta}{1 + t} \right] \right)$$

The first term of the RHS is private expenditure and the second one is tariff revenues. To analyze the effect of increasing trade integration on aggregate income we have to consider the effect of tariff reduction on both components.

As it was shown, the effect of increasing trade integration on tariff revenues depends on the current level of the tariff since the tariff function is concave in the tariff. Total private expenditure depends on: the formal and informal wages and the distribution of the labour force between the formal and informal sectors. From Proposition 1, we know that the lower the tariff the lower the wages. From Proposition 2 we have that the lower the tariff the higher informality. Hence, the final effect of a tariff reduction on private expenditure is always negative. Summarizing, on one side, the tariff revenues are a concave function of the tariff level. On the other side increasing trade integration increases informality and reduces the average wage.

The combination of two effects has interesting consequences. Numerical results show that aggregate income turns out to be a concave function of the tariff, meaning that our model is characterized by an optimal tariff $\hat{t}$ which maximizes total income.

Proof of Proposition 4 If the (fixed) share of expenditure on formal goods increases, the ratio formal/informal wage increases for any level of protection. Using eq.(10) we have:

$$\frac{\partial (w_f/w_i)}{\partial \lambda} = - \frac{g}{w_i^2} \frac{\partial w_i}{\partial \lambda} > 0$$
since \( \frac{\partial \lambda}{\partial \Lambda} < 0 \). Note that the relation between \( \lambda \) and the informal wage is always negative because, *ceteris paribus*, the change in the preference in favor of formal goods decreases the demand for the informal one and reduces the informal wage (see eq. (9)).

**Proof of Proposition 5** The proof that a higher \( \lambda \) implies a higher aggregate income immediately follows from the observation that a higher preference for formal goods implies a larger share of workers employed in the formal sector and thus a higher average wage.

**Proof of Proposition 6** In equilibrium:

\[
w_f = w_i + b = w_f - g + b \iff b = g
\]

where \( g \) is the wage gap and \( b \) is the benefit of being informal, i.e. the utility gain of being informal. Thus we have

\[
w_f = w_i + b
\]

\[
\frac{w_f}{w_i} = 1 + \frac{b}{w_i}
\]

Differentiating:

\[
\frac{\partial (w_f/w_i)}{\partial b} = \frac{1}{w_i} + b \frac{\partial (1/w_i)}{\partial b} > 0
\]

where

\[
\frac{\partial (1/w_i)}{\partial b} = \frac{\partial (\frac{1}{w_f - g})}{\partial b} = (-1)(-1) \left( \frac{1}{w_f - g} \right)^2 > 0
\]

(17)

**Proof of Proposition 7** Since there is a positive relationship between \( b \) and \( g \) (see Proposition 6), let consider the effect of changes of \( g \) on the level of informality. As \( g \) increases, the informal good becomes relatively less expensive. This makes the relative demand for formal goods to decrease inducing an increase in the informal/formal employment ratio \( \Gamma \). This can be easily shown rearranging eqs. (2) and (9) yielding \( \Gamma = \frac{1 - \lambda}{\lambda} w_f/w_i \). Differentiating it with respect to \( g \):

\[
\frac{\partial \Gamma}{\partial g} = \frac{1 - \lambda}{\lambda} \left[ \frac{1}{w_i} + g \frac{\partial (1/w_i)}{\partial g} \right] > 0
\]

(18)

We now consider the effect of different levels of \( g \) on aggregate income. Using (1) and (2) we obtain

\[
E = \frac{\Delta}{1 - \lambda} + tz_x
\]

Differentiating with respect to \( g \) we obtain

\[
\frac{\partial E}{\partial g} = \frac{1 - \lambda}{1 - \lambda} \frac{\partial \Delta}{\partial g} + \lambda \frac{\partial z_x}{\partial g} < 0
\]

where

\[
\frac{\partial \Delta}{\partial g} < 0
\]
The sign of the first derivative immediately follows from equation (9), i.e. equilibrium condition in the informal sector: $\Delta$ must decrease because if $g$ increases $w_i$ decreases (see eq. 17). The second derivative describes the effect of the *informality benefit* on the range of exported goods. As we have seen, a reduction in the informal wage makes aggregate income to decrease. This implies a reduction in the import and, through the balance of payment condition, a reduction in the range of exported goods.

C Appendix

C.1 The equation system

\[
H = \frac{1}{w_f} \left[ z_m \Theta + \frac{z_x E^*}{(1 + t^*)} \right] + \frac{1}{w_i} \Delta \\
H^* w^* = \frac{(1 - z_m) \Theta}{(1 + t)} + (1 - z_x) E^* \\
\frac{(1 - z_m) \Theta}{(1 + t)} = \frac{z_x E^*}{1 + t^*} \\
v = \frac{w_f}{w^*} \\
A(z_m) = \frac{v}{(1 + t)} \\
A(z_x) = v(1 + t^*) \\
w_i(H - L) = \Delta \\
\Theta = \lambda [w_i(1 - L) + w_f L] + \alpha t \left[ \frac{(1 - z_m) \Theta}{1 + t} \right] \\
w_i = w_f - g
\]

The system has 9 variables ($\Delta$, $\Theta$, $L$, $w_f$, $w^*$, $v$, $w_i$, $z_m$, $z_x$) and 9 equations. Thus it is a solvable system with an unique solution. We have 7 parameters ($g$, $t$, $\lambda$, $\alpha$, $H$, $H^*$ and $t^*$). In the numerical solution of the model we have assumed $A(z) = 1 - 0.5z$. 

27
C.2 Program code

This is the FORTRAN77 program code used to numerically solve the model.

```
PROGRAM main
IMPLICIT REAL*8(a-h,o-z)
PARAMETER (n=8)
PARAMETER (tolx=1.e-7)
PARAMETER (tolf=1.e-7)
INTEGER ntrial
DIMENSION x(n)
ntrial = 10.
c Parameters
c L
  x(1)=0.8312
c wf
  x(2)=0.6494
c u*
  x(3)=1
c wf/u*
  x(4)=0.6494
c zm
  x(5)=0.3505
c xx
  x(6)=0.3505
c theta
  x(7)= 0.6
c delta
  x(8)=0.4
t=0
DO 13
  IF(t.gt.4) exit
  call mnewt(ntrial,x,n,tolx,tolf,t,c)
c=0.5
  alpha=1
  IF (x(5).gt.1) EXIT
  IF (x(6).lt.0) EXIT
  E=x(7)+x(8)
z=t+alpha*(1-x(5))*x(7)/(1+t)
ininformal/formal=(1-x(1))/(x(1))
  wage inequality=x(2)/(x(2)-c)
OPEN(10,FILE='output1.dat',STATUS='unknown')
WRITE(10,'('t,1-x(1))
t=t+0.01
13 CONTINUE
STOP
END

SUBROUTINE lubksb(a,n,np,indx,b)
IMPLICIT REAL*8(a-h,o-z)
DIMENSION indx(n)
DIMENSION a(np,np),b(n)
i=0
do 12 i=1,n
  li=indx(i)
  sum=b(li)
12 CONTINUE
```
b(i)=b(i)
if (ii.ne.0) then
   do 11 j=ii,i-1
      sum=sum-a(i,j)*b(j)
   11 continue
else if (sum.ne.0.) then
   ii=i
endif
b(i)=sum
12 continue
do 14 i=n,1,-1
   sum=b(i)
do 13 j=i+1,n
      sum=sum-a(i,j)*b(j)
   13 continue
b(i)=sum/a(i,i)
14 continue
return
END
SUBROUTINE ludcmp(a,n,np,indx,d)
IMPLICIT REAL*8(a-h,o-z)
PARAMETER (NMAX=500,TINY=1.0e-20)
DIMENSION indx(n), a(np,np),vv(NMAX)
d=1.
do 12 i=1,n
   aamax=0.
do 11 j=1,n
      if (abs(a(i,j)).gt.aamax) aamax=abs(a(i,j))
   11 continue
if (aamax.eq.0.) pause 'singular matrix in ludcmp'
vv(i)=1./aamax
12 continue
do 19 j=1,n
   do 14 i=1,j-1
      sum=a(i,j)
do 13 k=1,i-1
         sum=sum-a(i,k)*a(k,j)
      13 continue
   a(i,j)=sum
14 continue
aamax=0.
do 16 i=j,n
   sum=a(i,j)
do 15 k=i,j-1
      sum=sum-a(i,k)*a(k,j)
   15 continue
   a(i,j)=sum
dum=vv(i)*abs(sum)
   if (dum.ge.aamax) then
      imax=i
      aamax=dum
   endif
16 continue
if (.ne.imax) then
do 17 k=1,n
dum=a(imax,k)
a(imax,k)=a(j,k)
a(j,k)=dum
17 continue
d=-d
vv(imax)=vv(j)
endif
indx(j)=imax
if(a(j,j).eq.0.)a(j,j)=TINY
endif
indx(j)=imax
if(a(j,j).eq.0.)a(j,j)=TINY
if(j.ne.n)then
  dum=1./a(j,j)
do 18 i=j+1,n
    a(i,j)=a(i,j)*dum
18 continue
endif
19 continue
return
END
SUBROUTINE usrfun(x,n,NP,fvec,fjac,t,c)
IMPLICIT REAL*8(a-h,o-z)
DIMENSION fjac(NP,NP),fvec(NP),x(n)
c Paramters
t*
g=0
H
b=1
H*
k=1
E*
d=1
lambda
c=0.8
alpha=1
phi=0.5
c Model equations
fvec(1)=h-(1/x(2))*(x(5)*x(7)+x(6)*d)-(x(8)/(x(2)-c))
fvec(2)=x(3)-((1-x(5))*x(7))/(1+t)-(1-x(6))*d
fvec(3)=(1-x(5))*x(7)/(1+t)-x(6)*d
fvec(4)=(x(4)-(x(2)/x(3))
fvec(5)=1-phi*x(6)**2-x(4)/(1+t)
fvec(6)=1-phi*x(6)**2-x(4)*x(1)**g
fvec(7)=(x(2)-c)*(b-x(1))-x(8)
fvec(8)=x(7)-o*(x(2)-c)*(1-x(1))*x(2)*x(1)-alpha
& *t*((1-x(5))*x(7)/(1+t))
DO i=1,NP
  DO j=1,NP
    fjac(i,j)=0.
  END DO
END DO
fjac(1,2)=(x(5)*x(7)+x(6)*d)*(1/x(2)**2)
fjac(1,5)=-(1/x(2))*x(7)
fjac(1,6)=-(1/x(2))*d
fjac(1,7)=-(1/x(2))*x(5)
30
SUBROUTINE mnewt(ntrial,x,n,tolx,tolf,t,c)
IMPLICIT REAL*8(a-h,o-z)
PARAMETER (NP=15)
DIMENSION x(n)
USES lubksb,ludcmp,usrfun
DIMENSION indx(NP),fjac(NP,NP),fvec(NP),p(NP)
do 14 k=1,ntrial
  call usrfun(x,n,NP,fvec,fjac,t,c)
  errf=0.
do 11 i=1,n
    errf=errf+abs(fvec(i))
 11 continue
if(errf.le.tolf)return
do 12 i=1,n
  p(i)=fvec(i)
 12 continue
  call ludcmp(fjac,n,NP,indx,d)
  call lubksb(fjac,n,NP,indx,p)
  errx=0.
do 13 i=1,n
    errx=errx+abs(p(i))
    x(i)=x(i)+p(i)
 13 continue
if(errx.le.tolx)return
14 continue
return
END