On the Distributional Effects of Trade Policy:

A Macroeconomic Perspective*

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Abstract

This paper develops a theoretical model to explore the relationship between openness to trade and long-term income inequality. Empirical evidence on the issue is mixed, though greater inequality is often cited as a possible cost of trade liberalization. To quantify the effect of liberalization on inequality I calibrate a two-sector (agriculture and non-agriculture) open-economy macroeconomic model to the Mexican economy. Agents in the model are subject to idiosyncratic, uninsurable labor income risk, and precautionary saving generates endogenous distributions of wealth and income. When preferences are characterized by subsistence floor for food consumption, trade liberalization implies large welfare gains for low wealth agents. At the same time, liberalization increases long-run wealth and income inequality. After liberalization land-owners are worse off since the price of land falls along with the relative price of the agricultural commodity. When tariff revenue must be replaced by an alternative instrument, higher labor taxes are preferred to higher taxes on consumption or capital.

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1 Introduction

Who gains and who loses from trade liberalization? Empirical studies suggest that liberalization is linked to increases in per capita income, implying that the country as whole gains. But are there bigger winners among the winners or does anybody lose? From an empirical standpoint the distributional effects from liberalization are uncertain. There is conflicting evidence from different liberalization episodes as inequality increased, decreased or did not change.[1]

Theoretical models also predict that countries gain from opening to trade, although they are limited in their ability to predict the impact of liberalization for distributional concerns. Most of these models are silent about the economy-wide distribution of income and wealth, or the fraction of the population that would support freer international trade. Hence the relation between openness to trade and inequality remains an open matter in international economics.[2]

This paper links the literature on international trade with the macroeconomic literature on inequality to develop a theoretical framework that provides new insights into the trade-

[1] The study of the link between openness to trade, economic growth and income inequality a has been mostly empirical. Berg and Krueger (2003), Bhagwati and Srinivasan (2002), Dollar and Kraay (2001), and Edwards (1997) find that in cross-country regressions openness to trade promotes economic growth and growth itself reduces *absolute* poverty; although no systematic effect on inequality is found—though Rodrik and Rodriguez (2001) question the connection between openness to trade and economic growth based on measurement and methodological flaws. For country specific cases, Dollar and Kraay (2001) report that over the last 20 years inequality has increased in China and Mexico, did not change in Costa Rica and in the Philippines, and decreased in Malaysia and in Thailand. For the case of Argentina, Porto (2003) finds a decline on inequality upon entrance to MERCOSUR.

[2] Goldberg and Pavcnik (2004) conduct an extensive survey of the literature on trade, inequality and poverty. Bannister and Thugge (2001), and Winters, McCulloch and McKay (2002) provide thorough descriptions of the channels through which trade policy affects poverty. These are: 1) by changing the relative price of goods and factors of production, 2) by affecting government revenue, 3) by changing incentives for investment and innovation, and 4) by modifying the risk exposure to domestic and foreign shocks.

inequality relation. The framework generates economy-wide distributions of wealth and income for different levels of trade protection and quantitatively assesses long term changes in inequality. It also determines the households' stance on free trade as they might be differently affected depending on their specific characteristics, say poor or rich.

One end of the model is to explore whether higher protection on agricultural goods relative to non-agricultural commodities observed in international trade has long term effects on capital accumulation and on inequality. "Artificially" high food prices can potentially affect households' saving behavior.[3]

The model is a two-sector small open economy calibrated for Mexico. On the household side I use a Huggett-Aiyagari style heterogeneous-agent, incomplete-markets environment, where households' precautionary saving generates endogenous distributions of wealth and of income. Household heterogeneity arises due to different labor income histories as they are hit by an idiosyncratic shock to earnings every period. A key element of the analysis is that households need to satisfy a subsistence floor associated to the consumption of agricultural goods.[4] Within the model subsistence implies that the share of food in household spending is larger in low income households than in wealthier ones.[5]

The production side of the model consists of an agricultural sector and a non-agricultural

[3] Consider the following situation. In the year 2000 in Mexico, the tortilla share of expenditure in the lowest income quartile was three times that of the highest quartile (McKenzie 2002). In the same year, the most-favored nation (MFN) tariff on corn (basis of tortillas) in was 198%, and corn accounted for more than half of Mexico's imports of grain (Jank, Fuchsloch and Kutas 2001).

[4] Obiols-Homs and Urrutia (2005) study the distribution of wealth overtime in a deterministic one-sector growth model where agents need to satisfy a minimum consumption requirement. They show that if the consumption requirement is not too big inequality monotonically decreases in transition to the steady state from below. In a similar study Alvarez-Peláez and Díaz (2005) numerically explore the evolution of wealth inequality in transition from below for a broader family of CRRA utility functions. They find that in economies with low subsistence levels or high intertemporal elasticity of substitution inequality decreases overtime.

[5] McKenzie (2003) and Nicita (2004) document such pattern in Mexican households.

sector; both goods can be traded in international markets. In the model land is a specific factor in the production of the agricultural good. Agricultural production requires land, labor and capital; while non-agricultural production only utilizes labor and capital. Labor and capital are mobile across sectors and capital is internationally mobile.[6]

In the model the government levies taxes on consumption, labor income and capital income; imposes *ad valorem* tariffs on imports; and can borrow domestically to finance its expenditures.

In contrast to the specific factors model, the Heckscher-Ohlin model, or the imperfect competition-economies of scale model, in this economy households' intertemporal decisions drive international trade. That is, the country's net foreign asset position determines the trade balance. For example, if positive, interest payments from abroad finance the country's trade deficit.

One of the main findings is that in the presence of subsistence trade liberalization leads to an increase on income inequality—consistent with observations for Mexico—and to welfare gains for the majority of the population. In the model low income households experience the larger welfare gains, while wealthier households experience negative welfare changes. A household with 'zero' wealth and low productivity experiences a gain equivalent to a permanent 4.8% increase in non-agriculture consumption. Wealthier households are worse off due to capital losses associated with the fall in the price of land as the agriculture sector contracts. A household in the 99th. wealth percentile and low productivity would experience a capital loss equivalent to a 0.7% permanent fall in non-agriculture consumption.

[6]Models with traded and nontraded goods usually define the traded good as a composite of imports and exports. Hence, commercial policy is defined as a common tax on all international trade. In such framework neither differential protection nor the distinction between tariffs and export taxes can be studied separately.

From a population-wide perspective the model suggests that in the no subsistence economy approximately 70% of the population would vote for free trade, provided that the government does not make up for the lost revenue by raising other taxes. The model suggests that if the government has to maintain a constant path of expenditures raising the tax rate on labor income is the best instrument to offset the fall in tariff revenue. In the absence of subsistence, a special case of the benchmark model, liberalization leads to welfare gains for the majority of the population (61%) and has no impact on long-term inequality.[7]

The apparent contradiction between higher inequality and positive welfare changes can be reconciled as follows. Inequality is a relative (cross-sectional) measure of household heterogeneity in the new steady state, while welfare gains represent (absolute) dynamic improvements in household well-being, incorporating mobility within the distribution of wealth overtime.[8]

The intuition for these results is that after liberalization domestic prices converge to international prices and the relative price of food falls. This triggers households' buffer

[7] In a similar project Krebs, Krishna and Maloney (2004) use a model with incomplete markets and idiosyncratic risk to study the impact of trade reform on income risk in Mexico. To work with closed form solutions their model abstracts from capital accumulation and the agents' endowment follows an i.i.d. process, so it is silent about distributional issues. Under their benchmark parametrization they find that the average welfare gain of cutting tariffs (regardless of the level) is 0.98% of lifetime consumption. Their findings are in the same order of magnitude as those from the model with no subsistence when agents have 'zero' wealth.

Other authors have studied the welfare implications of liberalizing world agricultural trade. Anderson (1998), Ingco (1997) and Tokarick (2003) analyze the effects of liberalization within a representative agent framework. Their approach distinguishes a *terms of trade effect* and a *distortionary* effect associated with a tariff. The estimated welfare cost for developing countries from worldwide liberalization in agricultural products is approximately 1% of GDP. Such effect is attributed to the rise of international prices currently depressed by overproduction from developed countries resulting from export subsidies and other support measures.

[8] In a similar spirit, Flinn (2002) finds that even though the distribution of wages in the U.S. is more disperse than in Italy; the long term distribution of welfare in the U.S. has a higher mean and smaller dispersion than that in Italy. This primarily explained by the higher mobility in the more flexible U.S. labor market.

savings to decline as they are less likely to hit the subsistence bound; less resources are needed to buy a unit of food. Inequality increases because the bulk of the effect occurs in low wealth households since precautionary savings are used to smooth consumption in times where the subsistence floor is likely to bind. From a macroeconomic perspective this effect leads to a 1% decline in aggregate asset holdings.

The paper is organized as follows. Section II describes the model and calibration exercise, section III presents the results, and section IV concludes.

2 The Model

The model environment consists of households, a representative firm, the government and the external sector. The economy is characterized as a small-open economy that takes the good prices and the interest rate as given from international markets. In the model full tariff pass-through imply that domestic prices may be different from international prices so long the country is a net importer of either or both goods. Hence trade policy might change the relative price of the goods and distort the allocation of resources within the economy.[9]

Throughout the model, the non-agriculture good is taken as the numeraire. For this purpose let $\rho^* \equiv \frac{p^*_{\mathsf{A}}}{p^*_{\mathsf{O}}}$ be the international relative price of the agricultural good in terms of the non-agriculture good. If the country were a net importer of both goods, tariff pass-through implies that the internal relative price would be given by $\rho = \frac{1+\tau^{\mathsf{A}}}{1+\tau^{\mathsf{O}}}\rho^*$; where τ^A is the tariff rate on the agriculture good and τ^O is the tariff rate on the non-agriculture good.[10]

[9] The model assumes long-run pass-through of tariffs into internal prices. Feenstra (1989) reports some evidence on full pass through in Japanese imports of motorcycles into the U.S. market. Nicita (2004) reports full pass through in imported food products and other manufacturing products in Mexico.

[10] To facilitate interpretation, notice that by using the internal price (after tariff) of a unit of non-agriculture good as the numeraire, implies that if the household works one unit of time, the wage rate tells how many units of the non-agriculture good can be bought.

In the model households can accumulate wealth in the form of any of the following assets:

- Physical capital (K) : can be rented out for the production of either good at rate r and depreciates at rate δ.
- Land (L) : can be bought at price p_L and may be rented out for the production of the agriculture good at rate r_L.
- Government bonds (B) : by no arbitrage yield a rate of return equal to the international interest rate r^*.
- Foreign bonds (B^*) : whose return is the international interest rate r^*.

In equilibrium all assets yield the same risk free return so the households' portfolio does not need to be specified. At a given point in time household wealth is represented by $a_t \equiv [K_t + p_{L,t}L_t + B_t + B_t^*]$.

2.1 Households

There is a continuum of infinitely-lived households, taken to be of measure one, who are *ex ante* identical but *ex post* heterogeneous due to different histories of labor income. Their preferences are defined over agriculture goods (c_A) and non-agriculture goods (c_O) , and need to satisfy a subsistence level in the consumption of the agriculture good (s_A) . Households supply labor inelastically and are assumed to be potentially credit constrained and cannot borrow. Subject to their initial wealth, their objective is to maximize the expected discounted utility from consumption.[11]

To introduce agent heterogeneity, every period t each household is assumed to face an uninsurable productivity shock $\varepsilon_t \in \mathbb{E}$, which evolves according to a $p-$state first order

[11] See Ríos-Rull (1995) for a review of the literature on heterogeneous agents models.

Markov process with a $p \times p$ transition matrix Π. Let $E \equiv [\varepsilon_1\ \varepsilon_2\ ...\ \varepsilon_p]$ be a $1 \times p$ vector that represents the set $\mathbb{E}$; then each row of Π represents the probability distribution over E such that for any state j, $\pi_{ij} = P(\varepsilon_i|\varepsilon_j) \geq 0$ for $i = 1, ..., p$; and $\sum_{i=1}^{p} \pi_{ij} = 1$. Normalizing the working hours to one, at time t a household's labor income is given by $w\varepsilon_t$, where w is the wage rate. This implies that from an economy-wide perspective the aggregate labor supply is given by $N = \pi_\infty E'$, where π_∞ is the invariant distribution implied by Π.

Let $\mathbb{A} \subset \Re_+$ be the set of possible values for household wealth; then at time t a household's state is given by (ε_t, a_t), where $\varepsilon_t \in \mathbb{E}$ and $a_t \in \mathbb{A}$.

Taking as given taxes on labor income (τ^n), taxes on capital income $\left\{\tau^k\right\}$, taxes on consumption (τ^c), tariffs on agricultural goods $\left\{\tau^A\right\}$ and non-agriculture goods $\left\{\tau^O\right\}$; prices $(r, r^*, r_L, p_L, w, \rho^*)$, their initial wealth (a_0) and productivity $(\varepsilon_{i,0})$ the households' problem is:

$$\max_{\{c_{A,t}, c_{O,t}\}} \quad E_0 \sum_{t=0}^{\infty} \beta^t u(c_{A,t}, c_{O,t}) \quad \text{where} \quad u(\cdot) = \frac{[(c_{A,t} - s_A)^\chi c_{O,t}^{1-\chi}]^{1-\sigma}}{1-\sigma} \qquad \sigma > 0,$$

subject to

$$(1 + \tau^c)(\rho c_{A,t} + c_{O,t}) + a_{t+1} \leq [1 + (1 - \tau^k)r^*]a_t + (1 - \tau^n)w\varepsilon_t, \quad \forall t.$$

Where $\beta \in (0, 1)$ is the discount factor and $a_{t+1} \geq 0$.

In addition to satisfying the budget constraint and the Euler equation, every household must satisfy the following intra-temporal condition :

$$\frac{\chi}{(1-\chi)}\frac{c_{O,t}}{(c_{A,t}-s_A)} = \frac{(1+\tau^A)}{(1+\tau^O)}\rho^*.$$

This equation represents the equilibrium condition that the marginal rate of substitution should equal the marginal rate of transformation. More importantly it shows how trade policy distorts households' choices. Note that as τ^A increases the consumption of agricultural products is expected to fall due to substitution towards the relatively cheaper good; although the subsistence level binds the magnitude of the reallocation.

2.2 Firms

The production side of the model consists of one competitive firm that takes as given domestic prices and can produce any combination of agriculture and non-agriculture goods by renting capital (K) and hiring labor (N). Capital and labor are mobile across sectors and are paid a rental rate r and a wage rate w. It In addition to capital and labor agricultural production also requires land. The rental rate of land (L) is r_L.

Let $f_A(K_{A,t}, N_{A,t}, L_t)$ and $f_O(K_{O,t}, N_{O,t})$ represent the production functions for the agricultural good and non-agricultural good, respectively. Each sector's production function is assumed to exhibit constant returns to scale, to satisfy the Inada conditions and that each input's marginal product is increasing in the other arguments; that is $\frac{\partial^2 f_{\mathsf{i}}}{\partial K_{\mathsf{i}} \partial N_{\mathsf{i}}}$, $\frac{\partial^2 f_{\mathsf{i}}}{\partial N_{\mathsf{i}} \partial K_{\mathsf{i}}}$, $\frac{\partial^2 f_{\mathsf{A}}}{\partial K_{\mathsf{A}} \partial L}$, $\frac{\partial^2 f_{\mathsf{A}}}{\partial N_{\mathsf{A}} \partial L}$, $\frac{\partial^2 f_{\mathsf{A}}}{\partial L \partial K_{\mathsf{A}}}$, $\frac{\partial^2 f_{\mathsf{A}}}{\partial L \partial N_{\mathsf{A}}} > 0$ for $i = A, O$.[12]

[12] If there were more than one firm, because of constant returns to scale the firms would only be scaled versions of each other. Therefore, assuming only one firm is without loss of generality.

The firm's problem at time t is:

$$\max_{\{K_{A,t};K_{O,t};N_{A,t};N_{O,t};L_t\}} \rho f_A(K_{A,t}, N_{A,t}, L_t) + f_O(K_{O,t}, N_{O,t}) - w(N_{A,t} + N_{O,t}) - r(K_{A,t} + K_{O,t}) - r_L L_t$$

subject to $K_A, K_O, N_A, N_O, L \geq 0$ for every period t.

To solve the model numerically I assume the following functional forms for the production functions:

Agriculture: $Y_A \equiv f_A(K_{A,t}, N_{A,t}, L_t) = L^{\lambda} N_A^{\nu} K_A^{1-\lambda-\nu}$

Non-Agriculture: $Y_O \equiv f_O(K_{O,t}, N_{O,t}) = K_O^{\alpha} N_O^{1-\alpha}$

One feature of the economy is that since in equilibrium the rental rate of capital only depends on the international interest rate and the depreciation rate ($r = r^* + \delta$), the capital-labor ratio in the non-agriculture sector and thus the wage rate are pinned down by the world interest rate (r^*). This means that any change in trade policy reflected in ρ does not affect the wage rate nor the return on capital; although it would reallocate resources between sectors and change the price and rental rate of land to equalize returns across all assets.

2.3 Aggregation

As stated before, from an economy-wide perspective, aggregate labor is given by $N = \pi_\infty E'$. Aggregate capital (K) is determined by the firm's demand for capital. The supply of land $\bar{L}$ is fixed and exogenous. However, on a given date, the state of the economy is characterized by how agents are positioned across levels of asset holdings and individual shocks. For this

purpose, let $\mathcal{A}$ denote the Borel sets that are subsets of $\mathbb{A}$ (asset space) and let $\mathcal{E}$ be the set of all subsets of $\mathbb{E}$ (productivity space). Then letting $(X, \mathcal{X}) = (\mathbb{A} \times \mathbb{E}, \mathcal{A} \times \mathcal{E})$ be the product space, we can define a probability measure on $(X, \mathcal{X})$ such that $\mu : \mathcal{X} \to [0, 1]$ represents the distribution of households in the state space.

Such distribution is the basis for computing economy-wide variables such as aggregate asset holdings A_t and total consumption of each good $(C_{A,t}, C_{O,t})$ at any point in time.

2.4 Government

The government is assumed to consume a constant amount of the non-agricultural good (G) every period and makes no transfers. To finance its consumption the government levies taxes and can borrow domestically. Indirect taxes from international trade are collected as long as there are imports of either commodity. Let $M_{A,t} \equiv (C_{A,t} - Y_{A,t})$ denote agricultural imports and $M_{O,t} \equiv [C_{O,t} + K_{t+1} - (1-\delta)K_t + G - Y_{O,t}]$ denote non-agriculture imports.

Whenever the country is a net importer of both goods the government's debt evolves according to the following equation:

$$B_{t+1} + \tau^k r^* A_t + \tau^n w N + \tau^c \left[\rho C_{A,t} + C_{O,t}\right] + \frac{\tau^A p_A^*}{p_O} M_{A,t} + \frac{\tau^O p_O^*}{p_O} M_{O,t} = (1 + r^*) B_t + G.$$

Where the initial amount of debt, B_0, is given.[13]

[13] If there are no agricultural imports then $\frac{\tau^A p_A^*}{p_O} M_{A,t} = 0$. Similarly, if there are no imports of the non-agricultural commodity, $\frac{\tau^O p_O^*}{p_O} M_{O,t} = 0$.

2.5 Equilibrium

A *stationary equilibrium* for this economy is a set of taxes $(\tau^k, \tau^n, \tau^c, \tau^A, \tau^O)$, a set of decision rules $\{c_A(\varepsilon, a), c_O(\varepsilon, a), a'(\varepsilon, a)\}$, a set of prices $(w, r^*, r, r_L, p_L, \rho^*)$, aggregate level of asset holdings (A), government debt (B), net foreign assets (B^*), and effective labor (N), and a probability measure μ such that:

1. The decision rules solve the households' problem.

2. The firm's problem is solved.

3. The market for savings clears:
$$K + B + B^* + p_L L = \int_X a(x)\, d\mu = A.$$

4. The government budget constraint is satisfied and debt remains bounded:
$$\tau^k r^* A + \tau^n w N + \tau^c \left[\rho C_A + C_O\right] + \frac{\tau^A p_A^*}{p_O} M_A + \frac{\tau^O p_O^*}{p_O} M_O = r^* B + G.$$

5. The probability measure μ, is a stationary distribution consistent with the transition probability matrix Π and the savings decision rules:
$$\mu(\varkappa) = \int_X P(x, \varkappa) d\mu, \quad \text{for all} \quad \varkappa \in \mathcal{X}.$$
Where $P(x, \varkappa)$ is the probability that a household with state x next period will have state $\varkappa$ which is an element of $\mathcal{X}$.[14]

6. The goods market clears:
$$\rho \int_X c_A(x) d\mu + \int_X c_O(x) d\mu + \delta K + G = \rho Y_A + Y_O + r^* B^*.$$

[14] The structure of the transition probability matrix Π, along with (the existence of) the solution to the households' problem guarantee that there exists a unique fixed point of μ for any initial distribution μ_0. See Hopenhayn and Prescott (1992) and Huggett (1993).

2.6 Parametrization and Solution Method

In order to find the economy's steady state under the current fiscal regime and the one with liberalized trade I use the standard techniques for solving models with incomplete markets and heterogeneous agents. In Appendix A, I outline the steps of the solution algorithm.[15]

I calibrate the model to the Mexican economy since Mexico applies relatively high tariffs on agriculture and non-agriculture imports, and exhibits differential protection towards agricultural goods. The *ad valorem* average tariff rates in 2001 for agricultural imports was 24.5% and 17.1% for non-agricultural goods (WTO, 2004). Another attribute that makes Mexico a good candidate is that it has been consistently running trade deficits on both types of goods in the last decade (INEGI, 2004).

The model is calibrated such that every model period represents one year. The calibration exercise focused on matching as close as possible the comparable features of the model economy to the Mexican economy based on parameter values estimated for Mexico when available. Table 1 contains the parameter values from the benchmark calibration.

In the absence of specific estimates for Mexico, I use standard values found in the literature for the intertemporal elasticity of substitution $(1/\sigma)$ and the depreciation rate (δ). The discount factor (β) and the international interest rate (r^*) are chosen to match certain moments of the data such as the trade balance.

On the fiscal side I estimated effective (average) tax rates for consumption, labor income and capital income for the 1993-2000 period based on the methodology proposed by Mendoza, Razin and Tesar (1994). Average tariff rates on agricultural and non-agricultural products

[15] See Ríos-Rull (1995) for a summary description of these methods.

are taken from WTO (2004) for the year 2001. The debt to GDP ratio for Mexico was taken from the World Bank's "World Development Indicators" database.

For technology, based on Gollin (2002), I take the capital share of income to be 30% as a conservative estimate for a developing country.[16] Two studies on agricultural technology (Manuelli and Seshadri (2004) and Soloaga (2000) suggest that the land share of income in agriculture is in the order of 20%. Although, they differ in their estimate on the labor share of income as Manuelli and Seshadri estimate it to be 40% in the 1960's in the U.S., while Soloaga estimates it in the order of 25% from a small sample of Mexican farms surveyed in 1995.

The transition between productivity states was parametrized based on Budar-Mejía and García-Verdú (2003). In their study they estimate the transition probabilities between formal employment, informal employment, unemployment and out-of-the-labor force in Mexico for the period between 1994 and 2001. In the model I interpret idiosyncratic shocks as different productivity states which can be matched to formal employment, informal employment, and a joint low productivity state for those unemployed or out of the labor force. The values of the elements of the productivity vector E are such that average productivity is equal to 1 and yield a Gini coefficient of income closest to that observed in Mexico.

In regard to preferences, the weight on agricultural consumption (χ) is such that model's trade balance composition matches that of the Mexican economy in the year 2000. The subsistence level (s_A) was calculated based on the World Bank's (2004) estimates of the *food based* poverty line for Mexico. To do so, I used the value of the basket for the year 2000 and multiplied it by Mexico's population (see INEGI, 2001), and then I expressed it as a proportion of GDP in the same year. This approach would tell how much of Mexico's

[16] Unofficial estimates for Mexico from the Bank of Mexico point to the same order of magnitude.

output was used to satisfy 'subsistence' consumption. For the year 2000, the estimated share of Mexico's GDP used to satisfy subsistence was in the order of 6.5%.

2.7 Welfare

To conduct the welfare analysis I compute the constant percentage increment in non-agricultural consumption under *no reform (NR)* that in expectation renders a given household (with state $x_0 = \{\varepsilon_0, a_0\}$) indifferent between the *status quo* and trade liberalization. Assuming the economy is in the steady state and that there is an unannounced permanent change in trade policy towards liberalization at time 0, the welfare change is the γ_{x_0} that solves:

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_{A,t}^{NR}, c_{O,t}^{NR}; \gamma_{x_0}) = E_0 \sum_{t=0}^{\infty} \beta^t u(c_{A,t}, c_{O,t}).$$

To quantify the welfare effect of liberalization reported in section 3, I simulated forward the 'life' of many households with the same initial level of wealth and productivity, then I averaged their discounted utilities and found the γ_{x_0} that equalized the average discounted utility under both regimes.[17]

To exploit the heterogeneity implied by the model I chose households with 'zero' wealth, median wealth, mean wealth, and those in the 99th. wealth percentile for the three levels of productivity.

From a population-wide perspective, when all households are equally weighted, the average welfare change from liberalization is the γ that satisfies the following equation:

[17] The length of the simulated horizon is 200 periods for 200 agents. In the simulation $u(c_{A,t}^{NR}, c_{O,t}^{NR}; \gamma_{x_0}) = \frac{\{(c_{A,t}^{NR} - s_A)^{\chi}[(1+\gamma_{x_0})c_{O,t}^{NR}]^{1-\chi}\}^{1-\sigma}}{1-\sigma}$.

$$\int_X E_0 \sum_{t=0}^{\infty} \beta^t u(c_{A,t}^{NR}, c_{O,t}^{NR}; \gamma) d\mu = \int_X E_0 \sum_{t=0}^{\infty} \beta^t u(c_{A,t}, c_{O,t}) d\mu.$$

In this case γ is also interpreted as the constant percentage increase in non-agricultural consumption that gives the same expected utility with and without reform.

If the government were to change the tax mix to compensate for the lost tariff revenue by raising other taxes, a similar welfare analysis between the *status quo* and the new policy regime can be performed. Furthermore, the average welfare change provides a selection criteria to chose among alternative policies. A "utilitarian" social planner would choose the post-liberalization regime that maximizes the average welfare change.

3 Results

To assess the distributional and welfare implications of liberalizing trade in the model economy, I work under two scenarios: one with subsistence and one without subsistence (i.e. $s_A = 0$). Throughout I normalize effective labor (N) and the supply of land $\left(\bar{L}\right)$ to 1.

Under each scenario the exercise is conducted in three steps. First, without any change in fiscal or trade policy I compute the steady state. I call this the *no reform* economy. Second, I eliminate tariffs on both goods and name the new steady state the *reform* economy with liberalized trade. In this step it is assumed that the government does not change any other tax rates. In the third step, the government is compensated for the lost tariff revenue by increasing either capital income taxes, labor taxes or consumption taxes such that the path of government expenditures (G) remains constant overtime.

The results presented in the next two subsections are common to the two subsistence scenarios.

3.1 Prices and Production

Due to differential protection towards agricultural goods, the immediate effect of trade liberalization is a decline in the relative price of the agricultural good as it converges to the international relative price (recall $\rho = \frac{(1+\tau^{A})}{(1+\tau^{O})}\rho^{*} > \rho^{*}$).

Table 2, shows that after liberalization the interest rate and the wage rate do not change as they are pinned down by the international interest rate. However, due to the decline in the price of the agriculture good resources are reallocated to the non-agriculture sector leading to a fall in the price and rental rate of land (see tables 2 and 3)[18]. The intuition for this result is that since land is specific to the production of agricultural goods and less labor and capital are allocated into agriculture, the rental rate of land, determined by its marginal productivity, falls. A lower 'dividend' on land requires a lower price of land in order to align the its return to that of the other assets. This suggests one channel through which liberalization affects the distribution of wealth and income as land owners incur a capital loss and a permanent fall on land income. This finding is summarized in the following proposition.[19]

Proposition 1 *If $\tau^{A} > \tau^{O} > 0$, then any policy change towards less differential protection (including liberalization) leads to a reduction in the price of land (p_L).*

Proof. See Appendix B. ■

[18] This prediction is consistent with evidence from Latin America, where land prices have fallen in periods of trade liberalization (see World Bank, 2003).

[19] Note that the proposition is not constrained to the stationary equilibrium.

In terms of factor payments the supply side of the model suggests that on impact households are better off in terms of the agriculture good $\frac{w}{p_A}$ and $\frac{r^*}{p_A}$ increase and not affected in terms of the non-agriculture good $\frac{w}{p_O}$ and $\frac{r^*}{p_O}$ do not change .[20] The purchasing power of land owners falls in terms of both goods (see table 2).

3.2 Macroeconomic Overview

Under both subsistence scenarios the model closely matches some features of the Mexican economy (see tables 4 and 7). Also, both economies exhibit some anticipated effects of liberalization. Namely, the consumption share of GDP increases, the government share of GDP falls (when the lost tariff revenue is not compensated for), the trade deficit increases, tax revenue falls, and the composition of the trade deficit shifts towards more imports of the agricultural good.[21]

An important difference between the two economies is that without subsistence there are no distributional effects from liberalization; while with subsistence wealth and income inequality increase.

3.3 Scenario 1: No subsistence

In the absence of subsistence trade liberalization has no effect on inequality, although there are welfare gains for the majority of the population (see tables 4 and 6). The biggest welfare gains from are for those with 'zero' wealth; while the top 1 percent of the population is worse off. In fact, 61% of the population would vote in favor of reform. Wealthier households lose

[20] The workers' gain in terms of the agricultural good is consistent with the specific factors model (assuming land—specific to agriculture—and labor are the only inputs in the production of the agriculture good). However, the symmetry between the models is not preserved as the specific factors model would predict a loss in terms of the non-agriculture good.

[21] Furthermore, the economy with no subsistence only imports agricultural goods and exports a small amount of non-agricultural goods.

since the fall in the price of food is not enough to compensate the capital loss due to the fall in value of land. Overall, the average welfare gain from liberalization for the whole economy is a permanent 0.1% increase in consumption of the non-agriculture good.

An important aspect of the model with no subsistence is that the fraction of consumption that corresponds to the agricultural good is constant for every level of wealth (see figure 2). Thus the change in the relative price affects all households equally and preserves the long run distribution of wealth.

In terms of the economy's asset structure table 5 suggests that in the long-run households make up for the decline in the capital stock and for the fall in the value of land by holding more foreign bonds to keep asset holdings constant.

If the government has to maintain a constant path of expenditures (G), the fall in tariff revenue must be compensated by increasing other taxes. Table 6 shows that, except for the agents with 'zero' wealth, raising labor taxes (τ^n) is the least welfare reducing instrument; followed by consumption taxes (τ^c) and capital income taxes (τ^k). Moreover, raising τ^n yields the lowest average welfare loss for the economy as a whole.

Each instrument redistributes the tax burden differently. Increasing τ^n redistributes part of the burden on poor households as their primary source of income is from labor. Households with 'zero' wealth and 'low' or 'medium' productivity prefer raising τ^k as they have no capital to be taxed upon; while households with no wealth and 'high' productivity favor raising τ^c rather than τ^k as they likely to be big savers in the short term. Raising τ^k redistributes the burden on wealthier households and would lead to a 7% decline in overall asset holdings (see table 5).

An important finding is that if the fall in tariff revenue has to be offset by raising other taxes, more than half of the population would vote against trade liberalization.

3.4 Scenario 2: Subsistence

The main difference between the economy with subsistence and without subsistence is that trade reform is no longer neutral to inequality when there is a minimum consumption requirement for food. In the economy with subsistence the Gini coefficients for wealth, income and consumption increase after liberalization (see table 7).

When subject to satisfying a subsistence level, the fraction of households' consumption of agriculture goods is decreasing in wealth, and tends to the no subsistence proportion (see figure 2). That is, in poorer households the food share of expenditure is larger that in wealthier ones; thus liberalization has a non-homothetic effect.[22]

Even though the increase in inequality is modest, it is qualitatively in line with the estimates for Mexico from the World Bank (2004) that reports a 1.8% increase in inequality between 1992 and 2000.

The greater difference between the two scenarios is in terms of welfare. The model with subsistence predicts a greater welfare gain for the bottom three levels of wealth under study. The welfare gain of a household with 'zero' wealth and low productivity is a permanent 4.8% increase of non-agricultural consumption; while it is 1% in the model without subsistence. On average, the welfare gain with subsistence is 2.6 times that of the model without subsistence. In the model with subsistence, 70% of the population would vote in favor of the reform as

[22] This behavior is consistent with the empirical findings by McKenzie (2003), where the food share of expenditure of Mexican households with lower level of education—presumably poorer—is bigger than that of more educated households; and by Nicita (2004), who finds that 50% of the consumption of poor households in Mexico is on food.

they would experience positive welfare gains; for the rest, the capital loss due to the fall in the value of land outweighs the gain in lower relative price.

The intuition for these results is that the distortion in relative prices associated to the tariff protection, pushes low income households closer to subsistence levels by raising the relative price of food. Once the distortion is lifted, poor households are the ones that gain the most and reduce their buffer savings as they are less likely to hit the subsistence bound (see table 8).[23]

In terms of the 'optimal' tax instrument when the government has to maintain a constant expenditure path, the model with subsistence suggests that, except for the households with 'zero' wealth, raising labor taxes is the least welfare reducing policy choice, followed by raising consumption taxes and capital income taxes (see table 9). Like in the model with no subsistence when the tariff revenue must be offset less than half of the population benefits from liberalization.

4 Conclusion

The main result from the paper is that in the presence of subsistence levels trade reform leads to a *worsening* of the distribution of wealth and income in the long-run, although there are welfare gains for the majority of the population.

In the model with no subsistence trade liberalization has no impact on inequality and the welfare gains are relatively smaller than in the model with subsistence.

The model suggests that land owners would be worse off after liberalization as the rental

[23] Nicita (2004) reports that in Mexico in the 1990's, the relative price of non-animal agricultural products declined after the integration with the U.S. and Canada through the NAFTA.

rate of land and the price of land fall with the relative price of the agricultural commodity. This capital loss breaks the population into two groups: the ones that favor reform (experience welfare gains as the fall in the relative price of food offsets the capital loss) and those that oppose reform (the fall in relative price does not compensate the fall in the value of land). In the model with no subsistence 61% of the population backs the reform. In the model with subsistence 70% of the population would vote for free trade.

I also find the optimal tax instrument to offset the fall in tariff revenue when the government has to maintain a constant path of expenditures. In both cases, with no subsistence and with subsistence, labor taxes are the best instrument, although less than half of the population would support liberalization.

In future research it would be important to account for different *skills* in the labor force, explicitly model the effects of trade policy in the non-traded sector of the economy, and investigate alternative productivity processes underlying household heterogeneity aside of employment shocks.

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Appendix A

Solution Algorithm

The algorithm for computing the steady state equilibrium of the calibrated economy for a given set of tariff rates consists of three steps.

1. Solving the Firm's Problem

Given the tax rates, the tariff rates, the international interest rate, the international relative price of the agricultural good, and the exogenous supply of labor and land, the firm's production plan consists of the labor and capital allocated for the production of each good. Such allocation in turn determines the wage rate, the rental rate of land and the price of land.

2. Solving the Households' Problem

I exploit the recursive form of the households' problem to numerically solve it by iterating on the Euler equation. The method requires a grid on the state space (productivity and wealth combinations), and an initial guess of the derivative of the value function with respect to wealth at every grid point. Then one finds a decision rule that satisfies the Euler equation for next period wealth given current wealth and productivity, and the initial guess is updated based on the problem's envelope condition. This step is repeated until the derivative of the value function approximately converges. When the decision rule is not an element of the grid I approximate it by linear interpolation.

3. Computing the Stationary Distribution[24]

For any level of trade protection the state of the economy is characterized by the distribution of households over the state space. As discussed in section 2.5, the solution to the households' problem and the properties of the productivity process guarantee a unique stationary distribution. Furthermore, any initial distribution converges to the stationary distribution. To compute the stationary distribution I use the invariant densities over shocks and I approximate distribution functions over assets by a piecewise linear function over the wealth space. The grid for the distribution functions should be finer than that used to solve the household problem.

The algorithm to compute the stationary distribution consists of two steps: 1) initializing the piecewise distribution functions (one for each productivity state), and 2) iterating the distribution functions until they approximately converge. The distribution functions are updated by identifying the source of the current mass on a given grid point based on the transition probabilities and the decision rules; that is, by determining the previous period set of states consistent with the grid point.

[24] This description closely follows that in Rios-Rull (1997).

Appendix B

Price of Land Decreases with Liberalization

In this section I show how a reduction in differential protection leads to a decline in the price of land.

1. The agriculture sector contracts

Consider the following transformation of the firm's problem.

$$\max_{\{K_{A,t};K_{O,t};N_{A,t};N_{O,t};L_t\}} \rho F_A(K_{A,t}, N_{A,t}, L_t) + N_O f_O(k_{O,t}) - w(N_{A,t} + N_{O,t}) - r(K_{A,t} + K_{O,t}) - r_L L_t$$

subject to $K_{A,t}, K_{O,t}, N_{A,t}, N_{O,t}, L_t \geq 0$ where $k_{O,t} \equiv \frac{K_{O,t}}{N_{O,t}}$.

With competitive factor markets the first order conditions at an interior solution are:

$$\rho \frac{\partial F_{A,t}(\cdot)}{\partial N_{A,t}} = w \quad \text{(B1)}$$

$$\rho \frac{\partial F_{A,t}(\cdot)}{\partial K_{A,t}} = r^* - \delta \quad \text{(B2)}$$

$$\rho \frac{\partial F_{A,t}(\cdot)}{\partial L_t} = r_L \quad \text{(B3)}$$

$$\frac{\partial f_{O,t}(k_{O,t})}{\partial k_{O,t}} = r^* - \delta \quad \text{(B4)}$$

$$f_{O,t}(k_{O,t}) - k_{O,t} \left[\frac{\partial f_{O,t}(k_{O,t})}{\partial k_{O,t}} \right] = w \quad \text{(B5)}$$

Note from equation (B4) that r^* uniquely pins down $k_{O,t}$. Since labor is mobile across sectors, given $k_{O,t}$ equation (B5) determines the economy-wide wage rate.

Next need to show that as ρ falls, when the country moves towards less differential protection, $K_{A,t}$ and $N_{A,t}$.fall as well.

Note from equations (B1) and (B2) that given that the right hand side is fixed, any fall in ρ must be offset by an increase in $\frac{\partial F_{A,t}(\cdot)}{\partial N_{A,t}}$ and $\frac{\partial F_{A,t}(\cdot)}{\partial K_{A,t}}$, respectively. Hence $K_{A,t}$ and $N_{A,t}$ must fall and the agriculture sector contracts.

2. The rental rate of land (r_L) falls along with ρ.

Equation (B3) shows that there are two enforcing effects that lower r_L as ρ falls: i) r_L is proportional to ρ and ii) as $K_{A,t}$ and $N_{A,t}$.fall, so does $\frac{\partial F_{\mathsf{A},\mathsf{t}}(\cdot)}{\partial L_{\mathsf{t}}}$ given that $\frac{\partial^2 f_{\mathsf{A}}}{\partial L \partial K_{\mathsf{A}}}, \frac{\partial^2 f_{\mathsf{A}}}{\partial L \partial N_{\mathsf{A}}} > 0$.

3. From steps 1 and 2, as ρ falls due to lower differential protection, so will N_A, K_A and r_L. Since in equilibrium the market for land has to clear and all assets yield the same return the following equation must be satisfied

$$[1 + (1 - \tau^k)r^*] = 1 + (1 - \tau^k)\frac{r_L}{p_L}.$$

Thus as the rental rate of land falls, so does the price of land.

Table 1. Model Parametrization

	Parameter		Target	Source
Preferences	Discount factor	$\beta = 0.96$		RBC literature
	Subsistence level	$s_A = 0.154$		World Bank (2004)
	Agriculture share in consumption:			
	No subsistence	$\chi = 0.142$	M_A / Trade Balance	
	Subsistence	$\chi = 0.047$	M_O / Trade Balance	
	Coefficient of relative risk aversion	$\sigma = 1.5$		RBC literature
Technology	Capital share (non-agriculture)	$\alpha = 0.3$		Gollin (2002)
	Land share (agriculture)	$\lambda = 0.2$		Soloaga (2000)
	Labor share (agriculture)	$\nu = 0.4$		Soloaga (2000)
	Depreciation rate	$\delta = 0.1$		RBC literature
	International interest rate	r* = 3.5%	Trade Balance / GDP	
Productivity Process	$\pi(e_h \mid e_h)$	0.537		
	$\pi(e_h \mid e_m)$	0.317		Budar-Mejía and
	$\pi(e_m \mid e_h)$	0.311		García-Verdú (2003)
	$\pi(e_m \mid e_m)$	0.496		
	$\pi(e_l \mid e_h)$	0.369		
	$\pi(e_l \mid e_m)$	0.447		
	$E = (e_h, e_m, e_l)$	(1.91, 0.43, 0.17)	Gini coefficient (income)	
Taxes	Tariff on agriculture	$\tau^A = 24.5\%$		WTO
	Tariff on non-agriculture	$\tau^O = 17.1\%$		WTO
	Tax on capital income	$\tau^k = 6.5\%$		Mendoza, Razin, Tesar (1994)
	Tax on labor income	$\tau^n = 14\%$		Mendoza, Razin, Tesar (1994)
	Tax on consumption	$\tau^c = 7.8\%$		Mendoza, Razin, Tesar (1994)
Price	/orld Relative Price of Agriculture Goo	$\rho^* = 0.583$	(Y_A / GDP, Y_O / GDP)	

Table 2. Relative Prices

		τ^A = 24.5%, τ^O = 17.1%	$\tau^A = \tau^O = 0$
Relative Price	$\rho = P_A/P_O$	0.6194	0.5826
Inputs	r*	0.0350	0.0350
	Wage	0.9856	0.9856
	Rental Rate Land	0.0264	0.0194
	Price of Land	0.7534	0.5546
Purchasing Power	$Wage/P_A$	1.5912	1.6918
	r^*/P_A	0.0565	0.0601
	RRL/P_A	0.0426	0.0333

Table 3. Production

		τ^A = 24.5%, τ^O = 17.1%	$\tau^A = \tau^O = 0$
Labor	N_A/N	0.0535	0.0394
	N_O/N	0.9465	0.9606
Capital	K_A	0.3906	0.2875
	K_O	2.9616	3.0058
Land	L	1.0000	1.0000

Table 4. Selected Macroeconomic Variables: No Subsistence

		Data (2000)	τ^A = 24.5%, τ^O = 17.1%	$\tau^A = \tau^O = 0$	τ^κ = 10.1%	τ^n = 14.4%	τ^c = 8.2%
A = Agriculture	Y_A / GDP	0.09	0.0900	0.0669	0.0669	0.0669	0.0669
O = Non-Agriculture	Y_O / GDP	0.91	0.9100	0.9331	0.9331	0.9331	0.9331
C = Consumption	C / GDP	0.67	0.6425	0.6516	0.6399	0.6485	0.6491
I = Investment	I / GDP	0.24	0.2289	0.2272	0.2272	0.2272	0.2272
G = Government Spending	G / GDP	0.12	0.1457	0.1446	0.1471	0.1471	0.1471
TB = Trade Balance	TB / GDP	-0.02	-0.0170	-0.0234	-0.0143	-0.0229	-0.0234
TB composition	M_A / TB	0.08	0.0810	1.0000	1.0000	1.0000	1.0000
TB composition	M_O / TB	0.92	0.9190	0.0000	0.0000	0.0000	0.0000
B = Government Debt	B / GDP	0.23	0.2320	0.2344	0.2344	0.2344	0.2344
R = Tax Revenue	R / GDP	0.13	0.1551	0.1541	0.1568	0.1567	0.1566
TR = Tariff Revenue	TR / R	0.05	0.0165	0.0000	0.0000	0.0000	0.0000
	Wealth		0.4612	0.4612	0.4647	0.4605	0.4612
Gini Coefficient	Income	0.54	0.4115	0.4115	0.4110	0.4111	0.4115
	Consumption		0.1883	0.1883	0.1896	0.1885	0.1883

Table 5. Asset Holdings: No Subsistence

	τ^A = 24.5%, τ^O = 17.1%	$\tau^A = \tau^O = 0$	τ^κ = 10.1%	τ^n = 14.4%	τ^c = 8.2%
K	3.3522	3.2933	3.2933	3.2933	3.2933
L (value)	0.7534	0.5546	0.5546	0.5546	0.5546
B	0.3398	0.3398	0.3398	0.3398	0.3398
B*	0.7119	0.9696	0.5912	0.9465	0.9696
Total Assets	5.1573	5.1573	4.7789	5.1342	5.1573

Table 6. Welfare (% of no-reform c_0): No Subsistence

		$\tau^A = \tau^O = 0$	τ^κ = 10.1%	τ^n = 14.4%	τ^c = 8.2%
Low productivity	'Zero' wealth	1.016	0.581	0.451	0.560
	Median wealth	0.030	-0.678	-0.409	-0.420
	Mean wealth	-0.016	-0.750	-0.451	-0.468
	99th Percentile	-0.731	-1.875	-1.077	-1.179
Medium productivity	'Zero' wealth	1.016	0.570	0.450	0.560
	Median wealth	0.044	-0.674	-0.396	-0.406
	Mean wealth	-0.005	-0.746	-0.442	-0.457
	99th Percentile	-0.723	-1.873	-1.070	-1.171
High productivity	'Zero' wealth	1.016	0.481	0.452	0.560
	Median wealth	0.159	-0.622	-0.297	-0.291
	Mean wealth	0.107	-0.695	-0.342	-0.343
	99th Percentile	-0.638	-1.860	-0.997	-1.087
	Average gain	0.100	-0.630	-0.340	-0.351

Table 7. Selected Macroeconomic Variables: Subsistence

		Data (2000)	τ^A = 24.5%, τ^O = 17.1%	$\tau^A = \tau^O = 0$	τ^κ = 13.1%	τ^n = 14.8%	τ^c = 8.6%
A = Agriculture	Y_A / GDP	0.09	0.0900	0.0669	0.0669	0.0669	0.0669
O = Non-Agriculture	Y_O / GDP	0.91	0.9100	0.9331	0.9331	0.9331	0.9331
C = Consumption	C / GDP	0.67	0.6534	0.6639	0.6424	0.6579	0.6590
I = Investment	I / GDP	0.24	0.2289	0.2272	0.2272	0.2272	0.2272
G = Government Spending	G / GDP	0.12	0.1502	0.1467	0.1518	0.1518	0.1518
TB = Trade Balance	TB / GDP	-0.02	-0.0325	-0.0378	-0.0212	-0.0368	-0.0379
TB composition	M_A / TB	0.08	0.0798	0.6050	1.0000	0.6140	0.5965
TB composition	M_O / TB	0.92	0.9202	0.3950	0.0000	0.3871	0.4040
B = Government Debt	B / GDP	0.23	0.2320	0.2344	0.2344	0.2344	0.2344
R = Tax Revenue	R / GDP	0.13	0.1595	0.1560	0.1613	0.1610	0.1611
TR = Tariff Revenue	TR / R	0.05	0.0306	0.0000	0.0000	0.0000	0.0000
	Wealth		0.4357	0.4391	0.4420	0.4390	0.4387
Gini Coefficient	Income	0.54	0.3931	0.3943	0.3935	0.3939	0.3942
	Consumption		0.1827	0.1830	0.1862	0.1833	0.1835

Table 8. Asset Holdings: Subsistence

	τ^A = 24.5%, τ^O = 17.1%	$\tau^A = \tau^O = 0$	τ^κ = 13.1%	τ^n = 14.8%	τ^c = 8.6%
K	3.3522	3.2933	3.2933	3.2933	3.2933
L (value)	0.7534	0.5546	0.5546	0.5546	0.5546
B	0.3398	0.3398	0.3398	0.3398	0.3398
B*	1.3590	1.5648	0.8799	1.5226	1.5710
Total Assets	5.8044	5.7525	5.0676	5.7103	5.7586

Table 9. Welfare (% of no-reform c_0): Subsistence

		$\tau^A = \tau^O = 0$	τ^κ = 13.1%	τ^n = 14.8%	τ^c = 8.6%
Low productivity	'Zero' wealth	4.796	3.965	3.104	3.440
	Median wealth	0.205	-1.235	-0.658	-0.698
	Mean wealth	0.136	-1.343	-0.712	-0.761
	99th Percentile	-0.712	-2.937	-1.360	-1.574
Medium productivity	'Zero' wealth	2.778	1.880	1.380	1.667
	Median wealth	0.212	-1.237	-0.655	-0.688
	Mean wealth	0.143	-1.346	-0.707	-0.753
	99th Percentile	-0.707	-2.943	-1.357	-1.569
High productivity	'Zero' wealth	1.556	0.477	0.367	0.598
	Median wealth	0.257	-1.300	-0.632	-0.635
	Mean wealth	0.185	-1.421	-0.685	-0.704
	99th Percentile	-0.660	-3.016	-1.326	-1.518
	Average gain	0.261	-1.218	-0.610	-0.642

Figure 1

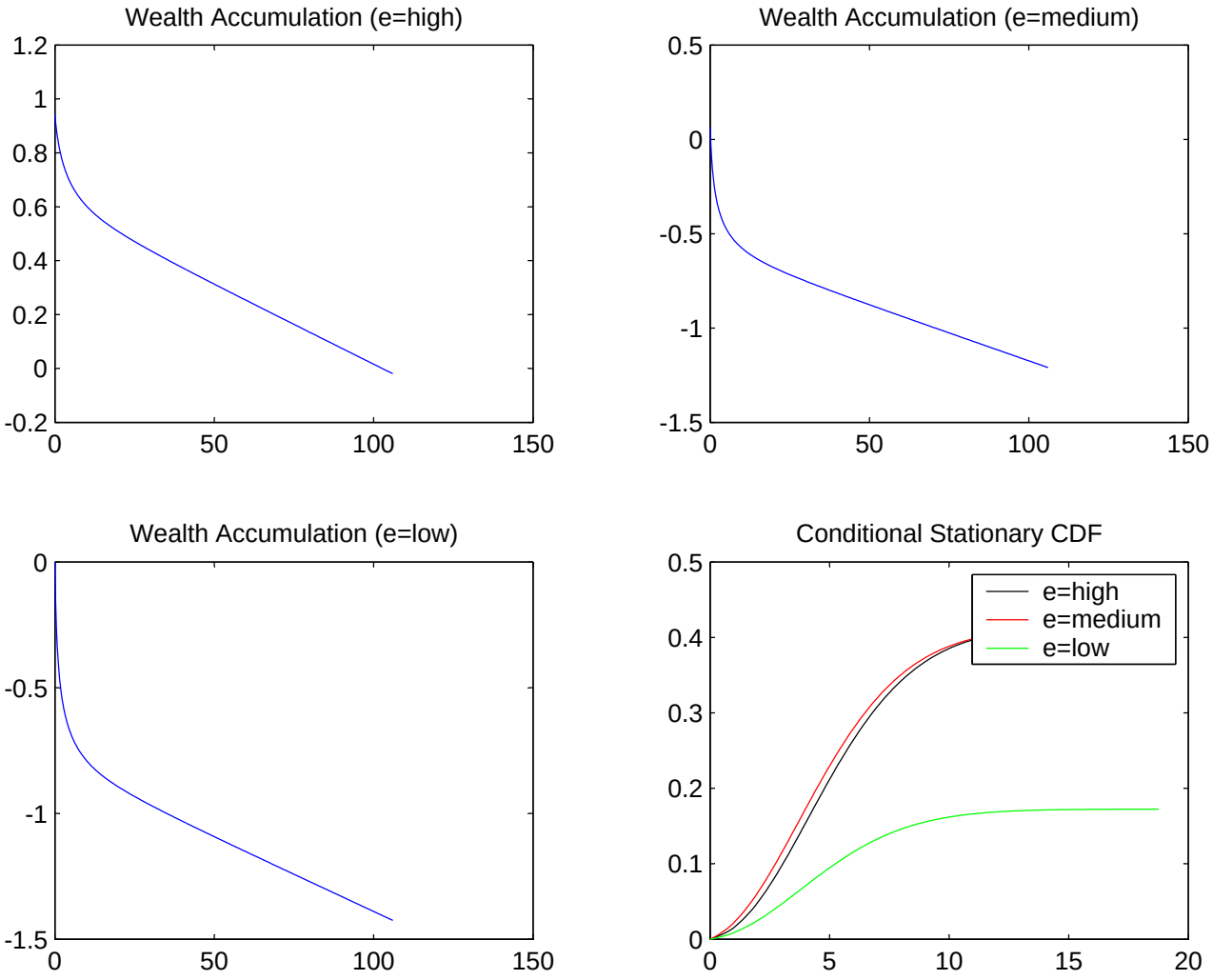
Wealth Accumulation (e=high)
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
0
50
100
150
Wealth Accumulation (e=medium)
0.5
0
-0.5
-1
-1.5
0
50
100
150
Wealth Accumulation (e=low)
0
-0.5
-1
-1.5
0
50
100
150
Conditional Stationary CDF
0.5
0.4
0.3
0.2
0.1
0
0
5
10
15
20
e=high
e=medium
e=low

Figure 2

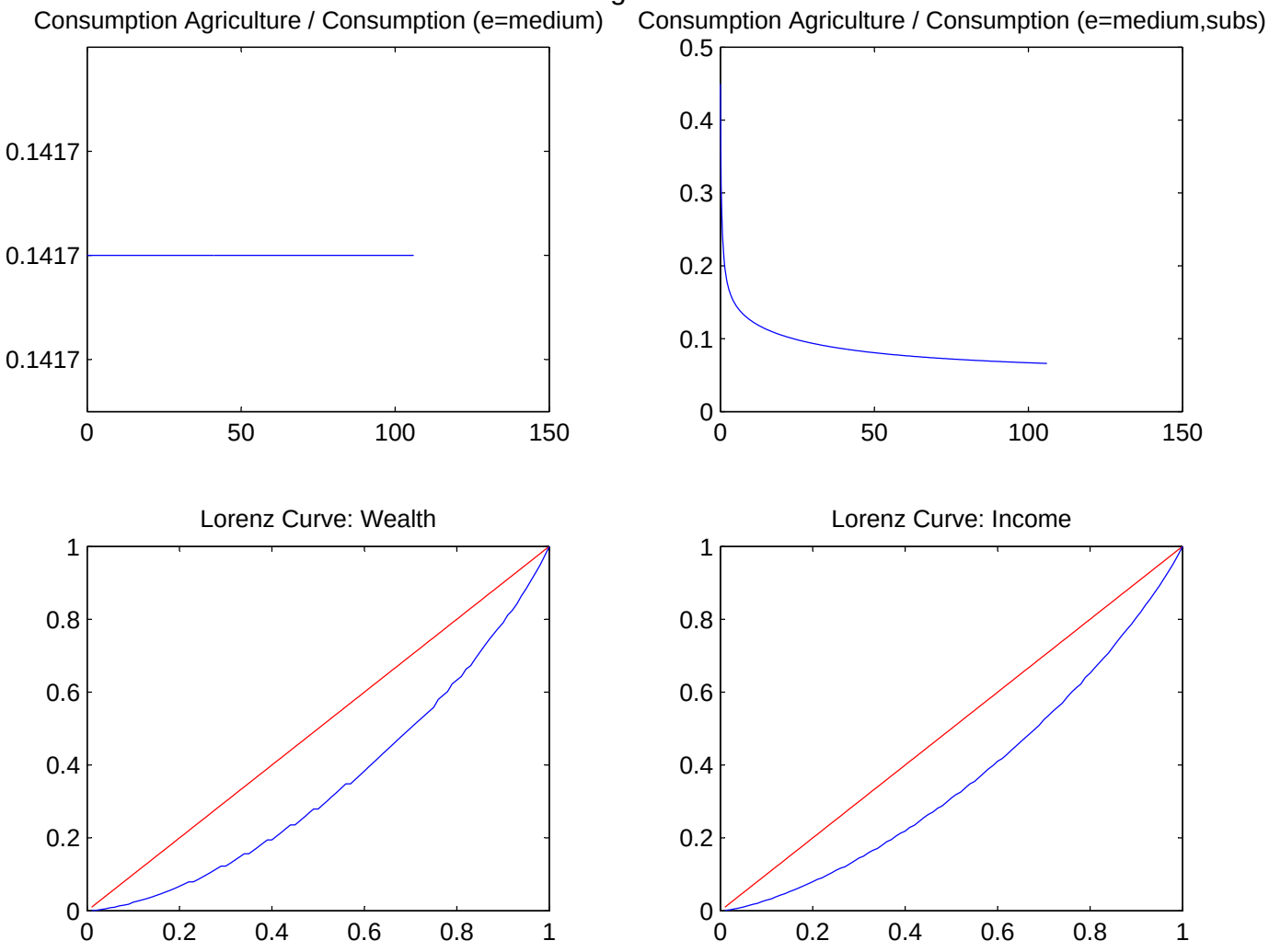
Consumption Agriculture / Consumption (e=medium)
0.1417
0.1417
0.1417
0
50
100
150
Consumption Agriculture / Consumption (e=medium,subs)
0.5
0.4
0.3
0.2
0.1
0
0
50
100
150
Lorenz Curve: Wealth
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1
Lorenz Curve: Income
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1

Figure 3. Productivity-Wealth Distribution