Trade in Indivisible Goods: Market, Transition and Developing Economies [1]

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[1] This is a very preliminary draft. Comments are particularly welcome.

Abstract

This paper examines the impact of trade when countries have different institutional arrangements in the labor market. We consider a general equilibrium setting with two final goods, one of which is indivisible, labor which differs in productivity, and no product market power. We consider three kinds of economies: market, transition, and developing, with different institutional arrangements in the labor market. In a market economy there is no labor market distortion: all workers are paid according to their marginal product. In a transition economy, workers in indivisibles earn a given wage capturing the idea that indivisibles are made in public sector where wages are independent of ability. In the developing economy, each worker gets the average product in divisibles capturing the notion of family farming in agriculture.

The effect of trade differs significantly for each of these economies. While the market economy neither gains nor loses from exporting the indivisible good, the transition economy tends to gain and the developing economy to lose from doing so. As a result, transition economies can lose from trade unless they are much more productive in indivisibles than their partners, while developing economies gain from trade if they are much less productive than their partners.

1 Introduction

In late 1999, trade ministers from WTO member countries gathered in Seattle in order to initiate a new round of trade talks. In response, Seattle streets were flooded with protesters chanting anti free trade slogans. It is well understood that trade creates losers as well as winners. Product price changes associated with freer trade result in factor price changes a la the Stolper-Samuelson theorem. However, in the absence of distortions, theory also predicts that the winners should be able to compensate the losers in each country so that trade is not harmful, though the inability to make the needed redistributions could result in reduced social welfare. It is also well understood from the theory of the second best that in the presence of other distortions, free trade could be harmful. See for example Ethier (1982). However, there is little work on what such distortions might be in practice and their policy implications.

Formerly socialist economies of Eastern Europe saw a deterioration in their standard of living during their transition to a market economy which went hand in hand with trade liberalization. What went wrong? Why did trade which seemed to have helped the market economies of the Western Europe not work for them? In this paper, we offer an explanation for this. Our argument in a nut shell is that trade in such economies reduced earning power which led to a sharp drop in effective demand and welfare. Our work suggests that trade liberalization without structural reform for such economies can have serious adverse effects.

In many developing economies a very high proportion of the population is rural. It is argued that this could be a result of the presence of family farms in agriculture which leads to too many workers remaining in this sector, see Sen (1960). Anything that raises the size of the rural sector, like more production and exports of its products, would therefore aggravate the distortion and reduce welfare. We argue that when labor is of differential ability, the distortion is reversed so that exports of agricultural goods raise rather than lower welfare by enhancing earnings. Our basic model can be interpreted as representing an economy without land constraints. Land constraints can reverse our results here and can make exporting agricultural goods disadvantageous. Our work suggests that due to this, trade can have very different effects on the welfare of land rich and poor developing countries.

We develop a simple general equilibrium model with two final goods, one of which is indivisible[1], labor which differs in productivity, and no product market power. We consider three kinds of economies: market, transition, and developing, with different institutional arrangements in the labor market.

The indivisibility assumption reflects the idea that the good must be of a minimum size.[2] We assume in the body of this paper that the indivisible good is highly valued so that all consumers will buy it if they can afford to do so. Consumers with an income, I' , at which they can just afford the indivisible good are much better off than those with an income just below I' who cannot. Hence, there is a jump up in indirect utility at I'.

We argue that both transition economies and traditional ones have factor market distortions. In transition economies, indivisible goods like refrigerators and cars tend to be relatively capital intensive. Many firms, especially the more capital intensive ones, were state owned and even if they have been privatized,

[1] Indivisibility refers to the fact that either zero or one unit of the good is purchased by a consumer. As a result, the the marginal rates of substitution between goods need not equal their price ratio.

[2] At low income levels, even clothing could be seen as indivisible good. One of the most successful projects undertaken by the World Bank involved subsidizing purchases of wood stoves. The initial cost of such stoves, around 10 to 25 dollars, prohibited their widespread usage although they are more efficient than native stoves made of mud. Although such goods can be made divisible by renting or sharing, to the extent that it is more costly to rent than buy and because of moral hazard problems involved in sharing, an essential indivisibility remains.

their wages during transition tend to be related to factors like seniority rather than productivity alone. To capture this, we assume that there is a wage per worker offered in the indivisible good sector and that in equilibrium the market clears at this wage. However, since the wage is per worker, it attracts only the bad workers who cannot earn more in divisibles. This has two effects. First it raises the cost of production in the indivisible good sector, relative to a market economy, as workers are paid more than their marginal product in the alternative occupation. Second, it raises the earnings of the less productive and can enlarge the market for indivisibles. Thus, trade which involves importing the indivisible good hurts workers in indivisibles as their wages fall. If this fall in wages results in a lower consumption of indivisibles, then social welfare falls since consumer able to afford the good are much better off than those who cannot!

In a traditional economy we focus on the distortion due to family farms. The idea is that workers in the divisible good sector, interpreted as agriculture, work in family farms and obtain the average product of labor in the farm. As this exceeds the marginal product, too many workers remain in agriculture. In the development literature this distortion has been linked with the concept of "Disguised Unemployment", see Sen (1960). However, when labor is of differential productivity, only lower quality labor remains in agriculture. As a result, the marginal worker produces more than the average product of labor in agriculture so that too few workers remain in agriculture rather than too many. In such a setting, increased output and exports of the non agricultural good reduce welfare.

We show that there are many possible effects of trade depending on the economy, the trading partner, cost differences and relative size. An unusual possibility is the occurrence of mutual losses from trade! This occurs when a developing country exports the indivisible good to a transition economy.

We proceed as follows. In Section 2 we develop the demand side of the model. In Section 3 we solve for the autarky equilibrium. Free trade equilibrium and its effects on welfare are analyzed in Section 4. Section 5 discusses the effects of land constraints while Section 6 contains some concluding remarks and directions for future work.

2 Demand

There is a single factor of production in the economy, called effective labor. Workers are endowed with different levels of effective labor which they supply inelastically. A worker of type γ has γ units of effective labor. We assume that there are two kinds of goods in the economy, indivisible and divisible. There is one divisible good, whose output N, is produced under competitive conditions. It takes one unit of effective labor to make a unit of this good which is taken as the numeraire. There is also a continuum of indivisible goods, indexed by $\theta \in [0, 1]$. Each indivisible good is produced by firms which price at cost.

There are a continuum of individuals differentiated by their productivity, $\gamma \in [0, 1]$ and by the variety, θ, of the indivisible good they have a taste for. That is, individual (γ, θ) has γ units of effective labor as an endowment and has a potential demand for the indivisible good θ. We assume throughout that γ and θ are uniformly distributed on the unit square. As a result, each good is demanded by workers with a uniform distribution of productivity over the unit interval and all firms are symmetric within and across industries. We assume there is a unit mass of such firms and individuals. Consumers obtain utility V if they purchase their desired variety of indivisible good, and zero if they purchase any other variety. Since all firms are symmetric, we denote the price of each variety of the indivisible good by P. Consumers obtain $U(n)$ if they buy n units of the divisible good which has a price of unity.

Consider what demand looks like if V is large. By large we mean that all consumers would prefer to buy the indivisible good if they could afford it. In this case, all consumers with income more than P purchase the indivisible good.[3] In this event demand at P consists merely of the number of consumers with an income in excess of P. In this manner, the demand for the indivisible good depends in a simple way on the level and distribution of income. If labor is the only source of income and the wage per effective unit of labor is unity, then income would be uniformly distributed over the unit interval and demand for any good θ would be given by the line with slope of negative one through the point $(0, 1)$ given by AB in Figure $1(a)$.

Note that individuals who are just able to afford the indivisible good are significantly better off than ones who are just unable to do so. Indirect utility jumps up at $I = P$ from $U(P)$ to $U(I - P) + V$. Moreover, marginal utility of income is higher above P than below it! As a result, any change which involves raising the consumption of indivisibles raises welfare.[4]

3 Autarky Equilibrium

In this section we outline the equilibrium in autarky for a market economy, a transition economy, and a developing economy.

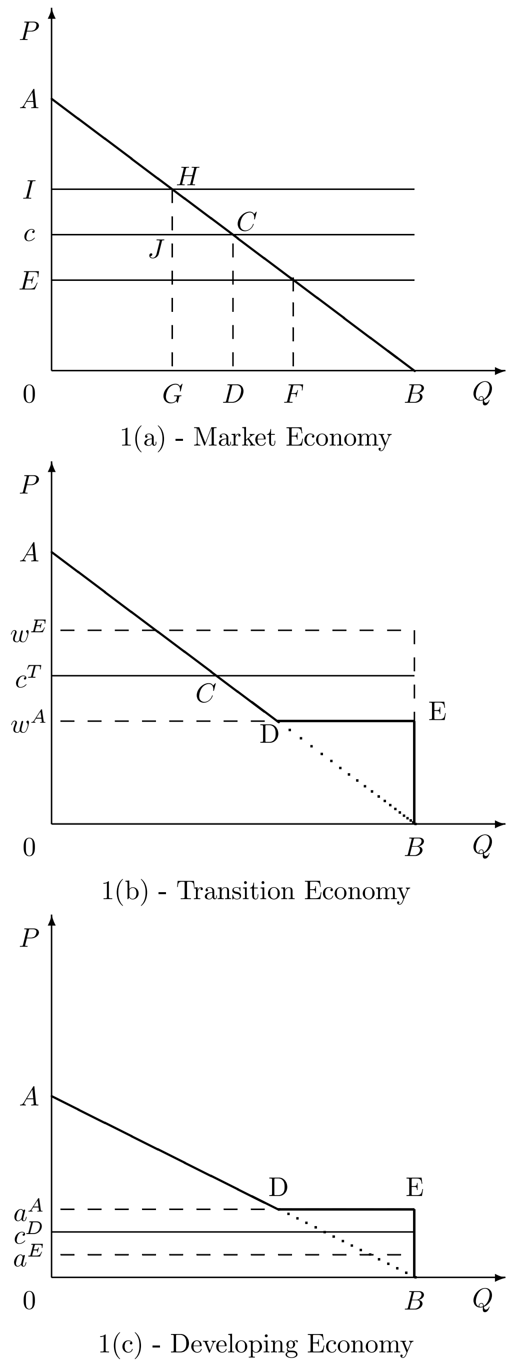
3.1 A Market Economy

In a market economy workers in both sectors are paid according to their marginal productivity. A worker with productivity γ makes γ units of the divisible good or makes $\alpha\gamma$ units of the indivisible good. We denote the piece rate in indivisibles by ρ. Each agent has the choice of working in the divisible good sector, or working in the indivisible goods sector. Hence, a worker with productivity γ

[3] This amounts to assuming that $V > U(1)$ as will become evident later.

[4] The small V case is discussed in the Appendix.

Figure 1: Demand for Indivisibles



1(c) - Developing Economy

will earn γ, as the divisible good is the numeraire, if he opts to work in the former and will produce $\alpha\gamma$ units of output earning $\alpha\gamma\rho$ in the latter. If ρ is greater (less) than $\frac{1}{\alpha}$, then only the indivisible (divisible) good sector attracts workers. For both goods to be produced in equilibrium, as must be the case in equilibrium, the piece rate in indivisibles has to be equal to $\frac{1}{\alpha}$. At $\rho = \frac{1}{\alpha}$, all workers are indifferent between working in either sector.

Note that ρ also equals the marginal cost, c, of an indivisible good, i.e.,

$$c = \frac{1}{\alpha}$$

which, in turn, equals price due to perfect competition. The allocation of labor between two sectors will be determined by the demand for labor in the indivisible good sector. The maximum level of demand is unity, and at a price of unity, nothing is demanded as the highest productivity worker makes exactly this. Thus, the inverse demand curve, depicted in Figure 1(a) by the line AB, is given by

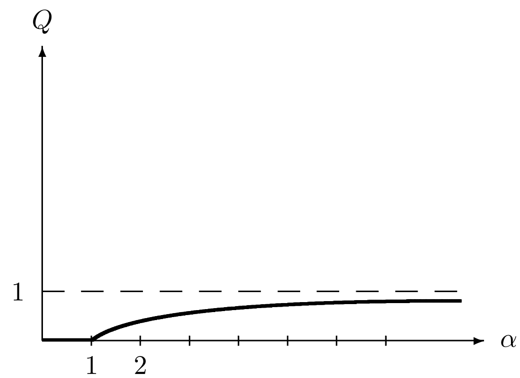
$$P = 1 - Q. \tag{1}$$

Labor is allocated across the two sectors to ensure that whatever demanded is made. Note that if $\alpha < 1$ then the indivisible industry is not viable since even the most productive worker cannot afford the good when it is priced at cost. Thus,

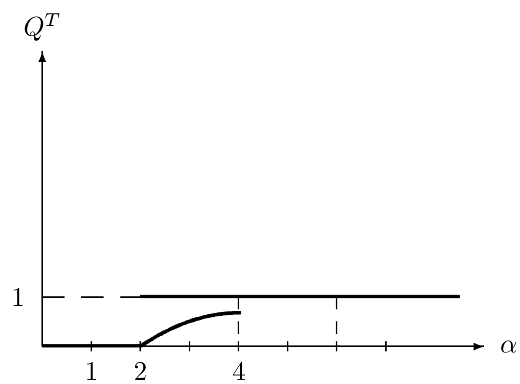
$$\begin{aligned} Q(\alpha) &= 1 - \frac{1}{\alpha} \qquad for\ \alpha > 1, \\ &= 0 \qquad for\ \alpha \leq 1. \end{aligned} \tag{2}$$

Note that in a competitive market economy, output is unique and rises with productivity in indivisibles as is evident from equation (2) depicted in Figure 2.

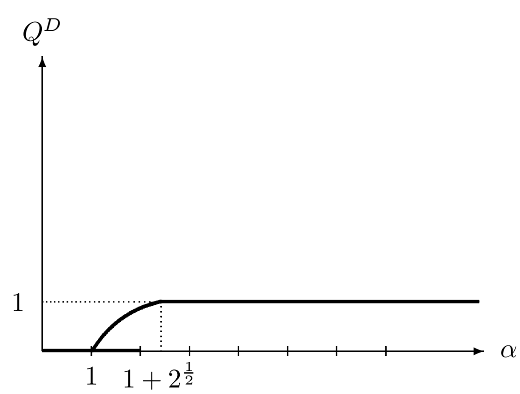
Figure 2: Output of Indivisibles and Productivity



2(a) - Market Economy

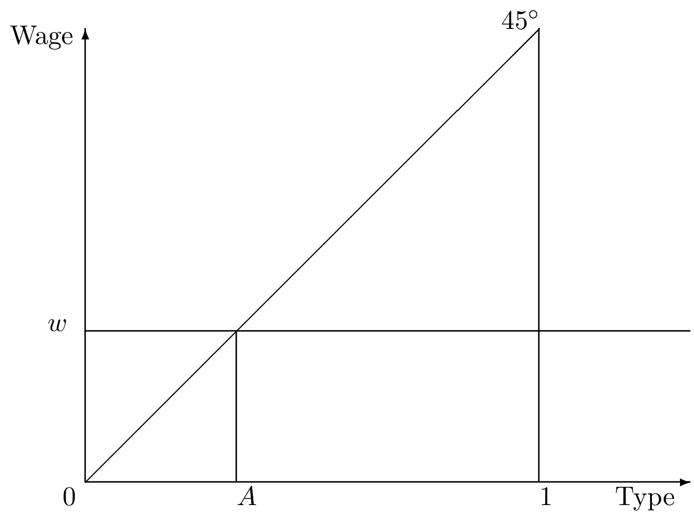


2(b) - Transition Economy



2(c) - Developing Economy

Figure 3: The Allocation of Labor Between Sectors in Transition Economy



3.2 The Transition Economy in Autarky

In a transition economy we assume that all workers in the indivisible goods sector are paid the going wage independent of their ability.[5] Each worker has the choice of working in the divisible sector, and earning the value of his marginal product there, which acts as his reservation wage, or working in the indivisible goods sector, and earning the going wage. The marginal worker is indifferent between the two. Workers with higher productivity prefer to make divisible goods while those with lower productivity work for a wage.

The allocation of labor is depicted in Figure 3. At wage w, workers with $\gamma > w$, that is workers in OA, choose to work in the indivisibles sector. The remaining workers choose to work in the divisible good sector. An increase in the

[5]The assumption that wages are equal across workets of different productivities could also be due to a complex technology which prevents piece rates, or other ways of tying earnings to productivity, from being used.

wage rate attracts agents with a higher productivity level into the indivisibles labor pool and raises the average quality of labor there. Thus, the earnings of a worker with productivity γ, denoted by $\omega^T(\gamma)$, are

$$\omega^T(\gamma) = \max(w, \gamma). \tag{3}$$

Note that workers with $\gamma < w$ earn more than what they could have earned in divisibles.

The total indivisible good output at wage w is given by

$$Q(w) = \alpha \int_0^w \gamma d\gamma = \frac{\alpha}{2} w^2. \tag{4}$$

The labor employed in this sector is w, and output per worker is $\frac{\alpha w}{2}$. The unit labor requirement (the inverse of output per worker) times the wage gives marginal cost, c^T, so that

$$c^T = \frac{2}{\alpha}.$$

Note that cost is independent of the wage. Cost is just the wage times the unit labor requirement. As the wage rises, the unit labor requirement falls. In the uniform distribution case, the two effects exactly offset each other to leave marginal costs independent of the wage.[6]

The equilibrium wage in the economy is determined by the derived demand for labor in indivisibles. As the level of aggregate indivisible good production rises there will be a higher demand for labor in the indivisible good sector, and wage level will increase. From (4) we get the equilibrium wage as a function of the aggregate indivisible good production to be

$$w(Q) = (\frac{2Q}{\alpha})^{1/2}. \tag{5}$$

[6] Note that at wage w, the total value of the product is $\frac{P\alpha w^2}{2}$ and total wage bill is w^2. The value of the product will not fall short of the total wage bill as long as $P\alpha \geq 2$ or $P \geq \frac{2}{\alpha} = c$. As a firm prices at cost, the value of output equals costs so there are zero profits.

Now, we turn to the equilibrium level of indivisible good production.

The wage distortion in a transition economy affects demand through its effect on incomes. Let the inverse demand function for the transition economy be denoted by $P^T(Q, w)$. When wages are zero, this is depicted by the line AB in Figure 1(b). If wages are given by $w^A > 0$, some agents, namely those with a productivity below w^A, represented by the segment DE, will choose to work for the indivisible goods sector. All these workers will be willing to pay up to w^A for the indivisible good. This causes demand to jump to the right at this price as depicted by the curve $ADEB$ in Figure 1(b).

Due to competition price equals unit cost, $P^T = c^T = \frac{2}{\alpha}$. The total quantity demanded will depend on whether the wage level weakly exceeds cost, $w \geq c^T$. If this is so, then at a price of c^T everyone is in the market and in equilibrium the whole market can be served. If the wage does not exceed c^T, then only part of the market may be served. Quantity demanded is given by AB for prices above the wage in indivisibles, and by unity for prices below the wage.

When is part of the market served and when is everyone served? Can there be multiple equilibria? Consider Figure 4. The curve $w(Q)$ depicts the wage level as a function of the aggregate quantity produced. Let $\bar{w}$ be the wage needed to elicit the labor needed to produce an output of unity. From (5) it follows that

$$\bar{w} = (\frac{2}{\alpha})^{1/2} = \left(c^T\right)^{1/2}. \tag{6}$$

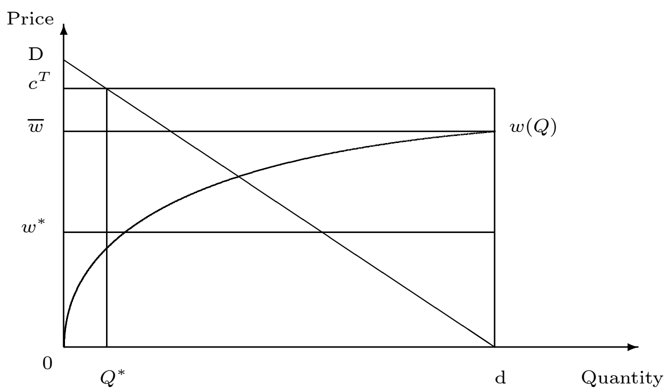
Look at the demand AB when price is set at c^T. Using (1) this gives

$$Q^* = 1 - c^T. \tag{7}$$

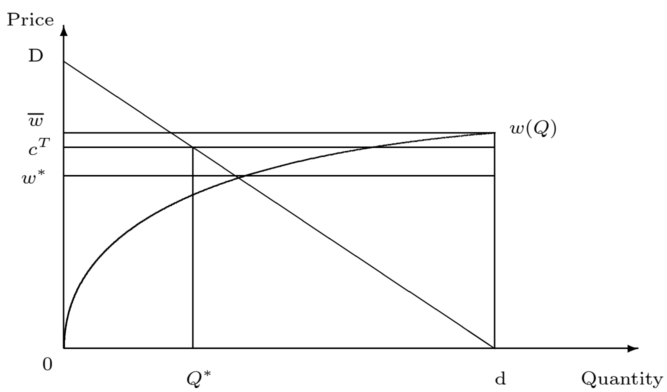
Call the wage needed to elicit Q^* to be w^* given by

$$w^* = \left(\frac{2}{\alpha}\left(1 - c^T\right)\right)^{1/2} = \left(c^T(1 - c^T)\right)^{1/2}. \tag{8}$$

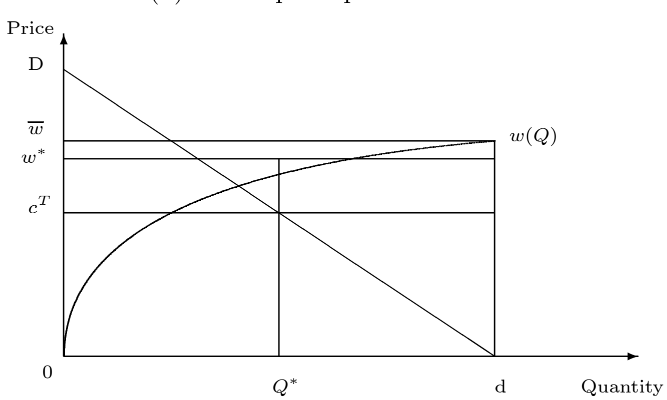
Figure 4: Equilibria in a Competitive Transition Economy



4(a) - Part Served Equilibrium



4(b) - Multiple Equilibria



4(c) - All Served Equilibrium

Note that as expected $w^* < \bar{w}$.

There are only three possibilities depicted in panels (a), (b) and (c) of Figure 4. Either

$$(a)\ c^T > \bar{w} > w^*, (b)\ \bar{w} \geq c^T > w^*,\ or\ (c)\ \bar{w} > w^* \geq c^T,$$

or correspondingly,

$$(a)\ c^T > 1,\ (b)\ 1 \geq c^T > \frac{1}{2},\ or\ (c) \frac{1}{2} \geq c^T.$$

Equivalently, in terms of α this gives

$$(a)\ \alpha < 2, (b)\ 2 \leq \alpha < 4,\ or\ (c)\ \alpha \geq 4.$$

In case (a) serving part of the market, producing Q^*, and having a wage w^* is the unique equilibrium. However, in this region the economy is not viable so that this never occurs.[7] In case (c), serving the entire market is the unique equilibrium. This follows from noting that in this event when the wage is $\bar{w}$, demand at c^T is 1 (since price equals c^T which is less than both $\bar{w}$ and w^*) which equals supply at $\bar{w}$. Thus, a wage of $\bar{w}$ and the entire market being served is an equilibrium. Serving part of the market is not an equilibrium as if part of the market was served, then at price c^T, the wage needed to elicit demand of Q^* namely w^*, exceeds price. Hence, at a price of c^T and wage of w^*, supply would fall short of demand and this could not be an equilibrium. In case (b) there are two equilibria: serving the whole market and having a wage of $\bar{w}$, or serving part of the market, producing Q^*, and having a wage w^*.

Figure 2 depicts the output level for a transition economy as a function of α. The correspondence $Q^T(\alpha)$ is given by a horizontal segment at $Q^T(\alpha) = 0$ for $\alpha < 2$. When $\alpha < 2$ costs of production in indivisibles exceed unity, and

[7] Case (a) occurs if only part of the population demands indivisibles, while all of it is active in the labor force. It does not occur here. See Krishna and Yavas (2000) for details.

the indivisible goods sector is not viable. When $\alpha \geq 4$, serving everyone is the unique equilibrium, so $Q^T(\alpha) = 1$. For $2 \leq \alpha < 4$, $Q^T(\alpha)$ is given by an upward sloping curve which lies below $Q(\alpha)$ (the analogous curve for a market economy), as well as by a horizontal one at $Q^T(\alpha) = 1$. That is,

$$\begin{aligned} Q^T(\alpha) &= 0 && for\ \alpha < 2 \\ &= 1 - \frac{2}{\alpha} && for\ 2 \leq \alpha < 4 \\ &= 1 && for\ \alpha \geq 2. \end{aligned} \tag{9}$$

Thus a transition economy looks like it is worse at providing the indivisible good when productivity is low and better when productivity is high.

3.3 The Developing Economy in Autarky

In a developing economy the traditional sector, such as agriculture, is organized on the basis of family farms. We assume that in such family farms all workers share output equally. In fact, in what follows, we deal with the agricultural sector by assuming that it is, in essence, one big family farm that produces the divisible good. This assumption allows us to abstract from asymmetries and integer problems in family size, farm size, and member ability.[8]

Workers who choose to work in the divisible good sector earn the average product there. The piece rate wage in indivisibles is determined so that the marginal worker in indivisibles earns the average product in divisibles. As a result, more able workers work in indivisibles while the less able remain in divisibles[9]. Let $\tilde{\gamma}$ denote the marginal worker. If workers up to $\tilde{\gamma}$ remain in divisibles, their average product is $\frac{\tilde{\gamma}}{2}$, which equals their earnings. Let ρ^D be

[8] An alternative interpretation would involve identical family farms, each with a continuum of members.

[9] Note that unlike the usual assumption in the disguised unemployment literature, the average product of labor in agriculture *falls* as less people work on it. This is a consequence of constant returns to scale and effective labor being the only factor of production.This need not be the case if there was a land constraint in agriculture as explained in Section 5.

the piece rate wage in indivisibles. A worker of type γ makes $\alpha\gamma$ units of the indivisible good and earns $\rho^D\alpha\gamma$ in the indivisible good sector. If $\rho^D > \frac{1}{2\alpha}$, then only the indivisible good is produced and if $\rho^D < \frac{1}{2\alpha}$, then only the divisible good is produced. As both goods must be produced in autarky equilibrium,

$$\rho^D = \frac{1}{2\alpha}.$$

Since ρ^D is the piece rate wage it equals the marginal cost of production in the indivisible good sector, so

$$c^D = \frac{1}{2\alpha}. \tag{10}$$

As in the transition economy the marginal worker in divisibles is determined by the demand side, namely, by the number of workers needed to produce the equilibrium output.[10] If demand for output is Q, then $\tilde{\gamma}$ should satisfy

$$Q = \alpha \int_{\tilde{\gamma}}^{1} \gamma d\gamma = \frac{\alpha}{2}(1 - \tilde{\gamma}^2). \tag{11}$$

Rewriting (11) gives

$$\tilde{\gamma}(Q) = (1 - \frac{2}{\alpha}Q)^{1/2}. \tag{12}$$

The average product, $a(Q)$, in the divisible good sector is hence given by

$$a(Q) = \frac{\tilde{\gamma}}{2} = \frac{1}{2}(1 - \frac{2}{\alpha}Q)^{1/2}. \tag{13}$$

As the level of aggregate indivisible good production rises there will be a higher demand for labor in the indivisible good sector, and the marginal worker will fall reducing the average product in the divisible good sector.

The earnings of a worker with productivity γ are:

$$\omega^D(\gamma) = \max(\frac{\tilde{\gamma}}{2}, \frac{\gamma}{2}). \tag{14}$$

[10] Note that the developing economy can be seen to be identical to a transition economy if wage equality occurs in indivisibles rather than divisibles. In both cases, the sector with wage equality attracts the least able.

The marginal worker is indifferent between the two sectors. All workers with $\gamma \geq \tilde{\gamma}$ obtain their piece rate wages and earn $\frac{\gamma}{2}$, while those with $\gamma \leq \tilde{\gamma}$ earn $\frac{\tilde{\gamma}}{2}$.

Now, we turn to the equilibrium level of indivisible good production. The family farm distortion affects demand through its effects on earnings. Let the inverse demand function for this economy be denoted by $P^D(Q, a(Q))$. If all workers are in indivisibles, then $a(Q) = 0$, and demand is

$$P^D(Q, 0) = \frac{1}{2} - \frac{1}{2}Q,$$

depicted by the line AB in Figures 1(c) and 5. If some agents work in divisibles, then $a(Q) > 0$ and these agents will be willing to pay up to $a(Q)$ for the indivisible good. This causes demand to jump to the right at this price as depicted by the curve $ADEB$ in Figure 1(c). The position of the jump depends on output in indivisibles.

Inverse demand is hence

$$P^D(Q, a(Q)) = \max\left\{P^D(Q), a(Q)\right\}.$$

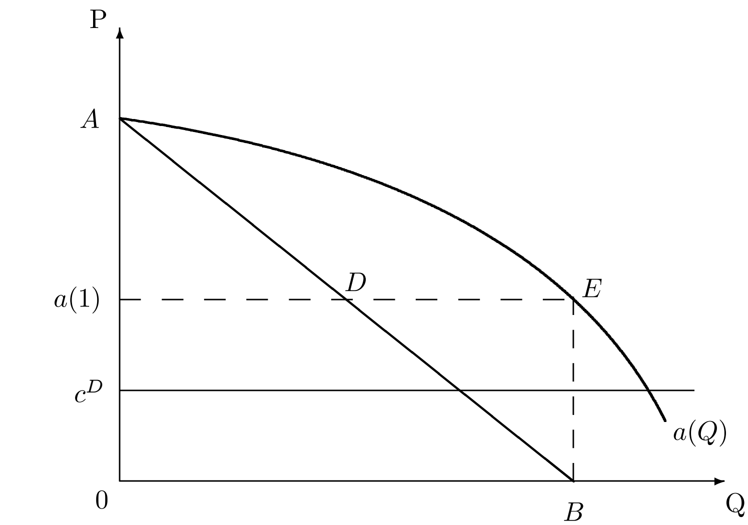
As output in indivisibles rises the average product of labor in divisibles falls so that this jump occurs at a lower price. Thus output in indivisibles has a negative effect on the demand for indivisibles!

Consider the shape of $a(Q)$. From (13) it is easy to verify that $a(Q)$ is downward sloping and concave. Moreover, that $a(Q) > 0$ at $Q = 1$. At $Q = 0$, $a(Q) = \frac{1}{2}$ and $a'(Q) = -\frac{1}{2\alpha}$. Hence, the $a(Q)$ curve at $Q = 0$ intersects the inverse demand curve but is flatter than it. Figure 5 respects these properties.

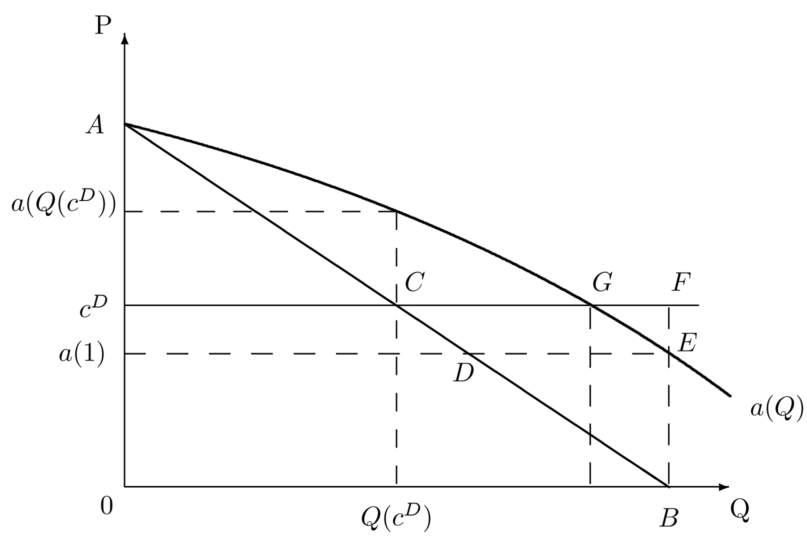
Now it is easy to see what an equilibrium looks like. Due to competition, price equals unit cost, $P^D = c^D = \frac{1}{2\alpha}$.[11] The point $a(1)$ gives the average product when everyone is served. If $a(1) > c^D$, as depicted in Figure 5(a), then

[11] Note that since costs are $\frac{1}{2\alpha}$ and the highest income is $\frac{1}{2}$, $\alpha > 1$ is needed for the indivisible good market to be viable.

Figure 5: Autarky Equilibrium in a Developing Economy



5(a) - All Served Equilibrium



5(b) - Part Served Equilibrium

the demand curve facing each firm is given by $ADEB$ and when firms price at cost, all consumers purchase the good. As a result, serving everyone is an equilibrium. It is also unique since at lower output levels, $a(Q)$ is even higher than $a(1)$ and at a price equal to cost, all consumers can still afford to buy their indivisible good.

If $a(1) < c^D$, as depicted in Figure 5(b), then serving everyone is not an equilibrium. Suppose $Q = 1$. Then the demand curve facing each firm is given by $ADEB$ and all consumers can not afford to buy their indivisible good at a price of c^D, so that we have a contradiction. Serving part of the market without rationing is not possible either. This involves selling what is demanded at a price of c^D, $Q(c^D)$. However, $a(Q(c^D))$ exceeds c^D. Hence, demand exceeds supply at this production level. However, as output level rises, $a(Q)$ falls, and at output level of unity, $a(Q)$ is less than cost as discussed above. Thus, with rationing, the equilibrium output level is such that $a(Q) = c^D$. In this event, demand facing each firm is $ACFB$. Each firm produces along CF as long as their average output is that at G, i.e. $a^{-1}(c^D)$. Some consumers (namely those with an income of c^D) are rationed, and a fraction GF/CF in Figure 5(b) cannot obtain the good. Since they cannot afford to bid up the price, this is an equilibrium.[12]

Algebraically, the type of equilibrium depends on the relation between $a(Q)$ and c^D. For serving everyone to be an equilibrium it must be when everyone is served, earnings are sufficiently high for all consumers to afford the good. This is ensured if $a(1) \geq c^D$. Using (13) and (10) shows that this is met if

$$(1 - \frac{2}{\alpha})^{1/2} - \frac{1}{\alpha} \geq 0,$$

[12] Alternatively, aggregate output equal to $\hat{Q}$ can be generated without rationing by having some products produced competitively and others produced by a single firm. In the former, the entire market is served, and in the latter, a monopoly price along AC is chosen. These monopoly profits are maintained due to Bertrand competition upon the entry of another firm.

or $\alpha \geq 1+\sqrt{2}$.

If $\alpha < 1+\sqrt{2}$, then serving everyone cannot be an equilibrium and output is given by

$$\begin{aligned} c^D &= a(Q) \\ &= \frac{1}{2}(1-\frac{2}{\alpha}Q)^{1/2}. \end{aligned}$$

Substituting for c^D in terms of α and solving for Q gives

$$Q = \frac{\alpha}{2}(1-\frac{1}{\alpha^2}). \tag{15}$$

Hence, in the traditional economy,

$$\begin{aligned} Q^D(\alpha) &= 0 \qquad for\ \alpha \leq 1 \\ &= \frac{\alpha}{2}(1-\frac{1}{\alpha^2}) \quad for\ 1 < \alpha \leq 1+\sqrt{2} \\ &= 1 \qquad for\ 1+\sqrt{2} \leq \alpha. \end{aligned} \tag{16}$$

3.4 Comparative Autarky Outcomes

The production possibility frontier, with or without a factor market distortion, is the standard Ricardian one. Since there is no unemployment, all three economies produce on the frontier. However, all three economies can yield outputs different from the socially optimal point. The market economy does so because of indivisibilities alone. A consequence of the indivisibility is that consumers just able to afford the good are much better off than those who are just unable to do so. As a result, serving more consumers is desirable in itself. Income inequality generated by differences in ability result in fewer consumers being served than feasible, which is first best due to the jump in indirect utility from having the indivisible good when using a utilitarian social welfare function. Thus, the market economy produces too little of the indivisible good.

Both the transition and developing economies have factor market distortions in addition to the indivisibility. The factor market distortion in a transition economy results in the marginal worker having a higher marginal value product in indivisibles. This worker earns the average product of all workers in indivisibles as a wage, which equals his marginal value product in divisibles. But his own productivity in indivisibles exceeds this because only workers with a productivity lower than his are drawn to the indivisible good sector. Thus, too few work in indivisibles and indivisible good output is even lower than in a market economy. On the other hand, income is distributed more equally in a transition economy, and this allows everyone to be served if the economy is productive enough. Note that productivity needs to be higher for the indivisible good market to be viable in a transition economy compared to a market one. If part of the market is served, then output in a transition economy lies below that of a market due to the adverse effects of the factor market distortion. However, if everyone is served, income inequality is low, and output is higher in a transition economy. As a result, a market economy can do better at providing indivisibles than a transition economy at low productivity levels but worse at high ones as illustrated in Figure 2.

The family farm distortion in a developing economy results in the marginal worker having a higher marginal value product in divisibles. The marginal worker earns the average product of all workers in divisibles, which equals his marginal value product in indivisibles. But his own productivity in divisibles exceeds this because only workers with a productivity lower than his are drawn to the divisible good sector. Thus, too many work in indivisibles. However, this distortion counters the indivisibility effect. Note that greater equality induced by the factor market distortion and the distortion itself help raise indivisible good output. Consequently, the traditional economy does better at providing the indivisible good than a market economy.

Note the contrast to the standard family farm distortion where workers are not differentiated in terms of their productivity and there are diminishing returns in divisibles. In such models, marginal productivity declines as more workers are employed, and hence, marginal product is less than the average product. Workers are earning their average product in the distorted sector. In equilibrium, marginal product in the non-distorted sector equals the average product in the distorted sector. As a result, marginal product in the distorted sector is less than the marginal product in the non-distorted sector, i.e., there are too many workers being employed in the distorted sector and the output level in the distorted sector is too high. In the same setting, constant marginal product and sorting of workers according their productivity levels results in the opposite outcome in terms of output and employment as shown above.

4 Trade

We now consider the effects of trade between economies with different institutions and productivity levels.

4.1 Pattern of Trade

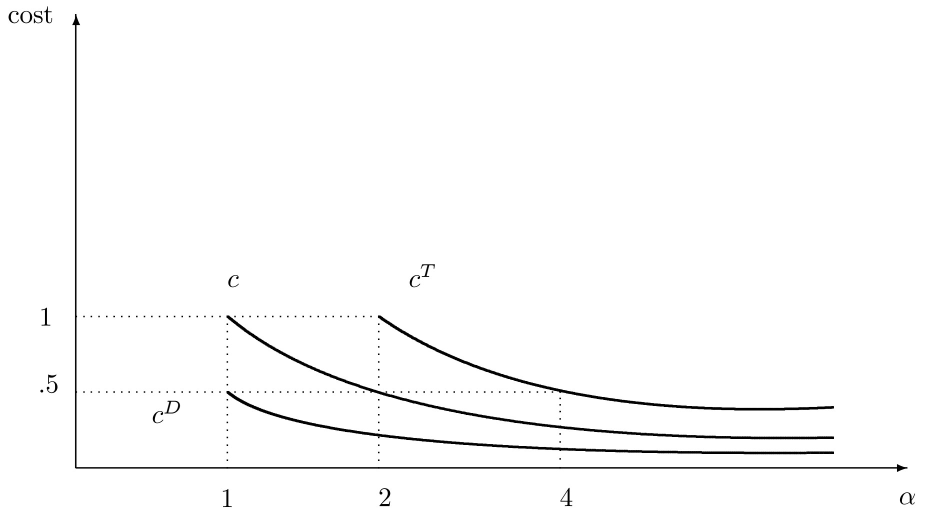
Recall that costs are given by

$$\begin{aligned} c &= \frac{1}{\alpha} \\ c^T &= \frac{2}{\alpha} \\ c^D &= \frac{1}{2\alpha} \end{aligned}$$

for the market, transition and developing economies respectively.[13] These are depicted in Figure 6. Note that $c^T > c > c^D$. In a market economy, workers in indivisibles earn the same as they would in divisibles. In a transition economy, infra-marginal workers in indivisibles earn more than they would in divisibles,

[13]Note that indivisibles sector is not viable if $\alpha \leq 1$ for market and transition economies, and if $\alpha < 2$ for a transition economy.

Figure 6: Cost in the Three Economies



i.e., they are paid too much and this makes cost higher in a transition economy than a market one. In a developing economy, infra-marginal workers in divisibles earn more than they would in indivisibles, i.e. they are paid too much or workers in indivisibles are paid too little and this makes cost lower in a developing economy than a market one.

Since costs are constant and we have perfect competition, the country which has a lower cost will export. Note that this implies that the country with the best technology in indivisibles, i.e. with the highest α, need not export indivisibles! A developing economy tends to exports indivisibles even when it is relatively bad at making them and a transition economy tends to import indivisibles despite being good at making them. Suppose the world price of the indivisible is .5 in Figure 6. A developing economy will export the indivisible as long as it has a viable market in autarky, i.e., $\alpha^D \geq .5$, a market economy will export at $P = .5$ if its productivity exceeds $\alpha^M = 2$, and a transition economy will export at this price only if its productivity exceeds $\alpha^T = 4$. Note that $\alpha^T > \alpha^M > \alpha^D$.

4.2 Welfare Effects of Trade

The effects of trade on welfare differ across economies. These effects are illustrated in Figure 1. In a market economy the standard price effect occurs. The only difference created by indivisibilities is the extra weight given to changes in consumption of indivisibles due to the jump up in indirect utility when the indivisible is purchased. As a result, the standard consumer surplus changes from price changes for indivisibles are augmented. In Figure 1(a) the autarky price of indivisibles equals Oc. If trade reduces the market price to OE so that purchases rise to OF, consumer surplus and hence welfare rises. Conversely if price rises to OI as a result of the country being small, consumer surplus falls though producer surplus rises.[14]

In a transition economy, there is a direct effect on demand as well as a price effect which operates as in the market economy. Exporting the indivisible requires more labor to be employed in the indivisible good sector and this raises wages there from w^A to w^E in Figure 1(b). This wage effect can move the economy to a position where all consumers are served from one where only some are served if $w^E > c^T > w^A$, as depicted. This must occur if the country is small and only some consumers are served in autarky. Such a small exporter of indivisibles completely specializes in indivisibles in the trading equilibrium, so that the equilibrium wage under trade is unity. Hence, all its consumers must be served in equilibrium. Conversely, importing the indivisible reduces equilibrium wages and can move the economy to a position where only some consumers are served from one where all are served. If the importing country is small, then its trading partner will be the sole producer so that there will be no employment in indivisibles and wages will be zero. As a result, all consumers

[14]There is also a potential effect on demand in this case depending on how profits are redistributed. If they are redistributed in a way that does not affect the relevant part of demand then welfare can easily fall due to trade.

cannot be served in a trading equilibrium.

In a developing economy, exporting the indivisible increases the number of people who have to be employed in indivisibles, and as a result, *reduces* the average productivity of workers in divisibles, from a^A to a^E in Figure $1(c)$. This adverse income effect reduces welfare. Exporting can even move the economy from a position where all consumers are served to one where only some are served if $a^A > c^D > a^E$ as depicted in Figure $1(c)$. Conversely, importing indivisibles raises the average productivity of workers in divisibles raising their renumeration which raises welfare and can move the equilibrium from a part served one to an all served one.

4.2.1 Mutual Losses From Trade

It is easy to construct examples of trade between a transition economy and a developing one which results in mutual losses from trade. In autarky all consumers are served in both countries since the average product in divisibles when all are served, $a(1)$, exceeds marginal cost, c^D in the developing country. In the transition economy, the wage rate when all are served, $\bar{w}$, exceeds the marginal cost, c^T. Suppose that $c^D < c^T$ so that the developing country exports the indivisible good in a trading equilibrium. As a result, in the developing country more workers are employed in making indivisibles so that the average product falls below c^D. As a result, only part of the consumers are served in the trading equilibrium, and the developing economy loses. At the same time, fewer workers are employed in making indivisibles in the transition economy so the wage rate falls below c^D, and only part of the consumers are served in the trading equilibrium. As a result, the transition economy loses from trade as well.[15]

[15] One such example occurs for $\alpha^D = 3$ and $\alpha^T = 6$.

4.2.2 Technical Change Abroad

Technical change abroad can result in welfare first falling then rising as the partner's costs fall. Consider a transition economy that imports the indivisible. Assume that the partner is initially small and relatively unproductive so that it cannot satisfy the transition economy's entire market. Also assume that all consumers in the transition economy are served to begin with. Start from a point where the transition economy's trading partner has the same costs. The welfare gains to the transition economy of a reduction in the partner's cost from the price effect are negligible while there are discrete adverse income effects via wage decreases. However, since the partner is small, wages do not fall a lot so that serving the entire market remains an equilibrium. Hence there is an initial fall in welfare as the partner's costs fall. As the partner's costs fall further, as long as all consumers in the large transition economy are served, there are both positive price effects and negative income effects and welfare could rise or fall. Once costs fall to the point where wages in the importing transition economy hit the partner's cost, there is a discrete change in regime. All consumers in the transition economy can no longer be served. From this point onwards, cost reductions abroad must raise welfare as more consumers are served when costs fall, and as V is large, welfare rises.

In contrast, for a market or a developing economy, technical change abroad raises welfare. For a market economy, there is only a price effect due to a fall in a partner's costs. As price falls, more consumers are served which raises welfare. For a developing economy, the average product in divisibles rises as costs abroad fall so that both income and price effects are positive.

In standard trade models, an improvement in a partner's productivity raises its export supply, tending to adversely affect the partner's terms of trade. This, of course is good for the importing country! Thus, the effects of technical change in a market economy in our setup are fairly standard. In a developing economy, the factor market distortion works in the same direction to further raise welfare, but in a transition economy, it works in the opposite direction resulting in non monotonicity.

5 Land Constraints

So far we assumed that productivity in the divisible (and the indivisible) good sector does not depend on the size of labor force employed in that sector. This is equivalent to assuming that labor is the only scarce factor. This may not be such a restrictive assumption in land rich countries such as the U.S. or Australia in the 18th century. However, in most settings today, especially in land poor developing countries, having fewer people in agriculture (divisibles) raises the average productivity of labor.

We can incorporate such considerations into our model by assuming that productivity of type γ in divisibles equals $\gamma\lambda(Q)$ where Q is the output in indivisibles. As Q rises, fewer people work in divisibles and as a result $\lambda(Q)$ rises. In this case we have external diseconomies of scale in the divisible good sector: as labor used in divisibles rises, productivity of labor in divisibles falls. This reduces the opportunity cost of labor and hence the unit cost of indivisibles.

When we look at such a setting, it can be shown that land constraints, as modelled, affect only the nominal variables in the economy. The autarky output of indivisibles as well as the labor allocation between sectors in all three economies is unchanged. This result follows from the observation that an increase in λ swings the line AB in Figure 1 representing productivity in divisibles out from its horizontal intercept at B. It also shifts costs in indivisibles out proportionally since the opportunity cost of labor rises. The average product curve $a(Q)$ in a developing economy and its analogue, the wage curve, $w(Q)$, in a transition economy are similarly affected. This makes nominal variables change while leaving "real" ones unchanged.

Although in autarky land constraints affect neither the type of equilibrium nor the output of indivisibles, they have profound effects in a trading equilibrium. In the absence of land constraints, exporting indivisibles, *per se*, does not benefit a market economy, benefits a transition economy, and actually hurts a developing economy. With land constraints, exporting indivisibles becomes more advantageous for all types of economies. This occurs because producing more of the indivisible good absorbs labor from the divisible good sector raising productivity there, and this raises labor earnings in all three types of economies.

6 Conclusion

In Eastern Europe and the former Soviet Union, industrial output and GDP fell sharply at the onset of price liberalization, when trade was conducted at world prices. There have been a number of interesting hypotheses put forward to explain this phenomenon. These include slow adjustment resulting in unemployment, see Gomulka (1992), investment delays caused by the unwillingness to invest till a good match is found since investment is relation specific, see Roland and Verdier (1999), and the disorganization hypothesis of Blanchard and Kremer (1997), where strong complementarities between inputs allows suppliers to exercise their bargaining power and disrupt production chains.

We take a different tack. We argue that the organizational structure of transition economies differs from market economies in so much as some sectors, pay workers wages independent of productivity. These sectors are assumed to make indivisible goods. This is meant to capture the idea that indivisible consumer goods like cars, refrigerators and other appliances are made in the public sector where wage inequality is limited. We show that trade, in particular imports of indivisible goods, reduce public sector wages and can result in significant welfare losses in general equilibrium.

Our model also helps explain why some developing economies gain through trade while others do not. There are many reasons put forward to explain such differences, see Krueger (1984) and Ray (1998) for an overview of much of this literature. There is also a substantial literature on trade with factor market distortions. Much of it focuses on minimum wages in manufacturing, see for example Brecher (1974a,b) and Davis (1998). In contrast to this work, we focus on a feature of the organizational structure of developing economies, namely that the divisible good sector, agriculture, is organized on family farm lines. We show that without land constraints, trade, in particular exporting indivisible goods reduces welfare due to adverse wage effects in agriculture. This need not be the case in the presence of land constraints. This suggests why all developing countries with a comparative disadvantage in agriculture need not gain from trade. Our work suggests that the land poor countries may gain from trade while land rich ones may lose.

What is the role of indivisibilities in our results? Indivisibilities in consumption result in an easy way to characterize demand as a function of income and its distribution. Using the standard assumption of identical homothetic preferences makes demand independent of the distribution of income. Since the factor market distortions we choose to examine work through their effects on the distribution of income, the standard model is not much use. In the absence of homotheticity, it is well understood that in general equilibrium there are very few restrictions that an aggregate excess demand function must satisfy, so that this approach is not tractable. Our modelling approach makes consuming more of the indivisible good socially desirable since consumers who can just afford the good are assumed to be much better off than consumers who just cannot, what we call the large V assumption. This makes welfare effects easier to sign but is not crucial. The income effects induced by trade remain even if V is small. Demand in the small V case is characterized in the Appendix. In a standard model the marginal utility of the two goods will be equalized so that there is no gain per se from consuming more of the indivisible good.

Our model provides a setting where the location of the factor market distortion matters. The astute reader will have noticed that the factor market distortion in the developing and transition economy is really the same. In the transition case, we worked with the wage needed to attract enough labor into *indivisibles* to make Q units of output in *indivisibles*, the $w(Q)$ curve. In the developing economy case we worked with the average product of a worker in *divisibles*, which equals his earnings, when enough labor is employed in *indivisibles* to make Q units of output there, the $a(Q)$ curve. Without a distinction between the goods in the two sectors, the effects of such a distortion would be the same since the wage in a sector with this distortion is increasing in the output of that sector.

The simple general equilibrium structure developed here provides a way to study a number of issues in trade and development. In Krishna and Yavas (2000), we argue that technical change in a closed transition economy with product market power may be immiserizing. In Krishna and Yavas (2001), we assume that the indivisible good is a consumer durable, and show that endogenous business cycles are generically produced and that these cycles have properties consistent with the data. We are currently working in several areas where our set-up may shed new light on old issues. These include the role of multinationals in development, and trade policy with product market power.

7 Appendix: Demand When V is Small

In this section we look at the derivation of demand for indivisibles when V is small. A consumer with income I chooses what to buy to maximize his utility. This choice is only relevant if he can actually afford the indivisible good he desires, that is, if $I \geq P$. Suppose that $I \geq P$. Let $U(.)$ be the standard concave utility from consuming the divisible good depicted in Figure 7. If he buys the divisible good only he gets $U(I) - I$, while if he buys the indivisible one at a price of P, and spends the remainder of his money on the divisible good he gets $V + U(I - P) - I$. Thus, he buys the indivisible if

$$V > U(I) - U(I - P).$$

This is equivalent to

$$\frac{V}{P} > \frac{U(I) - U(I - P)}{P}. \tag{17}$$

Consider the agent with productivity and income I. For him, the right hand side of (17) is given by the slope of the line AB. The left hand side of (17) is independent of a worker's income and is given by the slope of the line $0C$. As drawn, at an income of I (17) is satisfied so that the indivisible good is purchased. As income falls the right hand side of (17) rises due to concavity of $U(.)$, and the analogue to the line AB gets steeper. Thus, at a low enough income level the agent will choose not to buy the indivisible even if he could afford to do so.

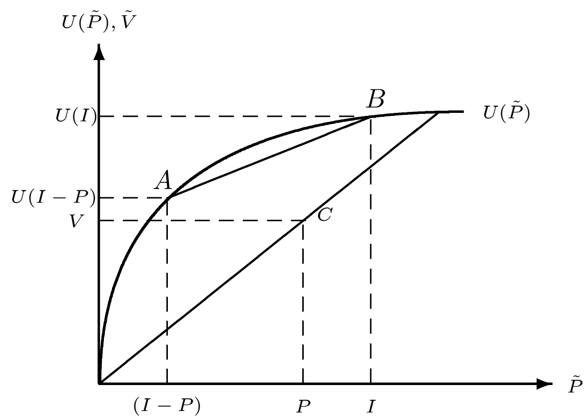
Let $i(P, V)$ be implicitly defined by

$$V = U(i) - U(i - P). \tag{18}$$

Note that $i(P, V)$ is increasing in P and decreasing in V. Totally differentiating (18),

$$dV = U'(i)di - U'(i - P)(di - dP)$$

Figure 7: Choice When V is Small



Hence

$$
\begin{aligned}
i_P(P,V) &= \frac{U'(i-P)}{U'(i-P)-U'(i)} \\
&= 1+\frac{U'(i)}{U'(i-P)-U'(i)} > 0 \\
i_V(P,V) &= \frac{1}{U'(i)-U'(i-P)} < 0 \\
i_{PP}(P,V) &= \frac{U'(i)U''(i-P)}{(U'(i)-U'(i-P))^2} < 0
\end{aligned}
$$

so that the $i(P,V)$ curve in Figure 8 is steeper than the 45° degree line from the origin and is concave as drawn. For $V>0$ and low P all agents want to buy the indivisible good so that $i(P,V)$ is negative so that the vertical intercept of $i(P,V)$ is negative.

When income equals $i(P,V)$, the analogue of AB is parallel to $0C$ and a consumer with income $i(P,V)$ is indifferent between buying the indivisible or not doing so. Consumers with an income of $I > i(P,V)$ will wish to purchase the indivisible good (if they can afford to do so) since $V > U(I) - U(I-P)$ at this income level due to the concavity of $U(.)$. It is impossible to buy the good unless income is at least P as the good is lumpy. Only if a consumer both wants to buy the indivisible ($I > i(P, V)$) and can afford to do so, ($I > P$), will he do so. Thus, only consumers with an income above the maximum of P and $i(P, V)$ will actually buy the good.

Let

$$\tilde{\imath}(P, V) = \max\{i(P, V), P\}.$$

The function $\tilde{\imath}(P, V)$ is depicted in Figure 8(a). Consumers with income in excess of $\tilde{\imath}(P, V)$, buy the indivisible while those with income below this cutoff buy only the divisible and demand for the indivisible is given by

$$D(P) = 1 - G(\tilde{\imath}(P, V)). \tag{19}$$

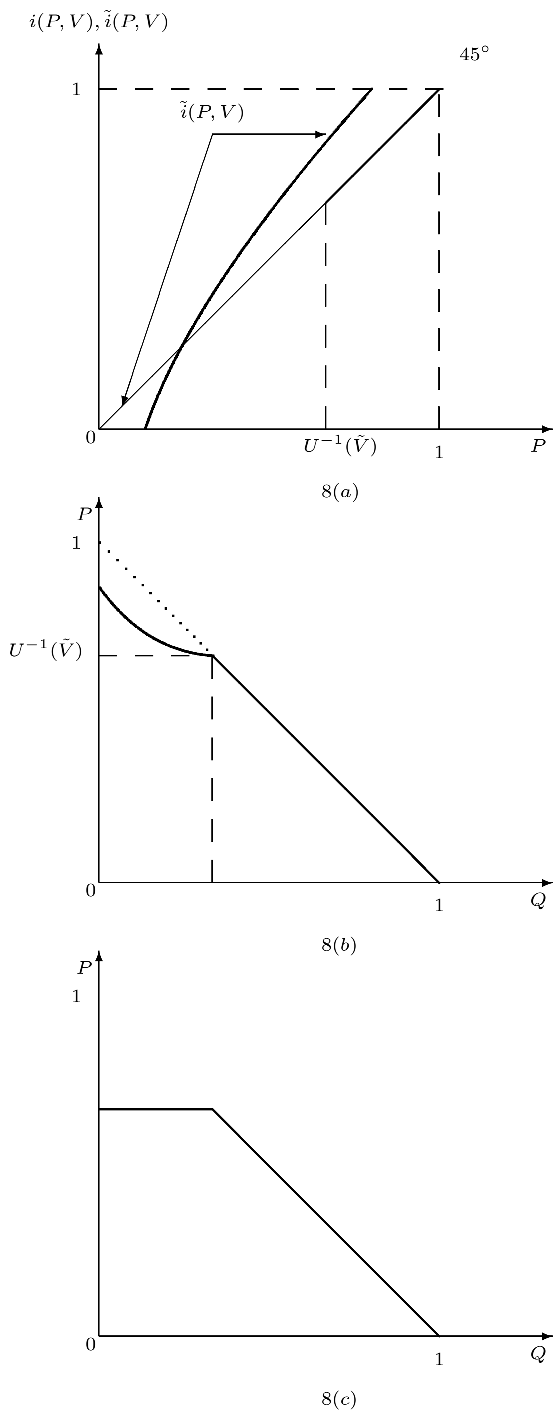
The demand function corresponding to the $\tilde{\imath}(P, V)$ function depicted in Figure 8(a) is portrayed in Figure 8(b). Since $i(P, V)$ is increasing in P and decreasing in V, an increase in V shifts the $i(P, V)$ curve in Figure 8(a) downwards and raises the intersection with the 45° degree line representing P. As a result, for V high enough, that is when this intersection occurs above the price of unity, $i(P, V)$ is never the binding constraint and we are in the large V case.

A special case arises when $U(.)$ is linear. In this case, from (18), it follows that $\frac{U(i)-U(i-P)}{P} = 1$ so that we are in the large V case if $\frac{V}{P} > 1$ in which case the cutoff income *level* is P. We are in the small V case if $\frac{V}{P} < 1$. But in this event, there is no demand for the indivisible. As a result, the demand curve is flat at $P = V$, zero above it and the same as in the large V case for $P < V$ as depicted in Figure 8(c)[16].

In the small V case there is no discontinuity in indirect utility at $I = P$, but there is a kink in indirect utility at $I = i(P, V)$. As a result, indirect utility

[16] A sufficient condition to ensure that we are in the large V case is that $V \geq 1$ since the equilibrium price must always lie below unity.

Figure 8: Deriving the Demand Curve



is not concave in income because the marginal utility of income rises once the indivisible good has been purchased.[17]

[17] Ng (1965) argues that such kinks create a rationale for the risk loving behavior by the poor observed in the demand for lottery tickets.

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