MONOPOLY POWER AND TERMS OF TRADE

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Abstract

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Abstract:
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1. Introduction:

Low income elasticity of demand was a key ingredient in the development of the Prebisch-Singer "Theory of Unequal Exchange"(Prebisch (1949) (cited in Love (1987)) and Singer (1950)). According to the theory income growth leads to a deterioration in the developing countries Terms of Trade as the share of the income spent on primary products declines. Moreover, the associated deterioration in welfare is exacerbated due to differences in market structure. Since primary products are sold in competitive markets, the benefits of technical advance are transferred to the industrialized countries (IC's) through lower prices for primary products. Over time, due to the fall in the prices of primary products the industrialized countries benefit from growth in production, relative to those of manufactured products. However, with market power on the part of Industrialized Countries Technical advance in industrial production benefits the IC's relatively more because technological progress does not reduce prices for manufactured products to the same degree[1].

The Prebisch-Singer (PS) hypothesis generated a lot of controversy. A large empirical literature noted that their empirical evidence in particular was subject to a numerous problems[2]. One problem was the choice of the initial and the terminal year. Another, was the valuation of primary products at cif (cost-insurance-freight) and fob (free on board) prices[3]. Then there are the problems of quality and weight changes, technological change,

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[1]   The policy implication Prebisch derived from this theory of unequal exchange was that an LDC should form manufacturing industries instead of following comparative advantage in the production of primary products. Pursuit of comparative advantage was myopic because the LDCs necessarily would lose in the long run from deterioration in the terms of trade.

[2] Prebisch analyzed the terms of trade of the United Kingdom for the period 1876-80 o 1946-47. Great Britain was mainly an exporter of manufactured products and importer of primary products. Terms of trade thus were expected to improve for Great Britain. Singer cited data for the time after 1950, excluding petroleum after 1973 (p. 1653, Balassa (1989)).

[3]   The ratio of fob to cif prices could show that the terms of trade improve for both trading partners if transportation costs decline.

and the availability and quality of substitutes and complements that are not controlled for in the data. As a result there has been less of an attempt to test the basic premise of the PS hypothesis.

In this paper we use experimental methods to test the basic premise of the PS hypothesis. With these methods it is possible to control variables that cannot be controlled in the field. Valuations of the commodities can be held constant and the problem of exogenous factors influencing supply and demand conditions in the initial, or terminal year, can be minimized. There are no changes in qualities and/or weights of products. The players in the experiments are trading fictitious commodities of constant quality over time, reflected by induced valuations (see Smith, 1976) for the commodities that does not change over time.

The experimental results do not support the PS hypothesis. The monopolist is unable to exploit its market power and terms of trade for the developing countries improve as income grows. The experimental results contradict the theoretical predictions.

The paper is organized as follows. In Section II the experimental design is described. In Section III we present the experimental results. Section IV concludes.

II. The Experimental Design

The Environment

The basic premise of the Prebisch-Singer hypothesis is tested. Given the low income elasticity of demand for primary products and the 'market-power' of the industrialized countries does an increase in income result in a worsening of TOT for the primary product producer (the developing country)? Thus, in the experimental design a single industrialized country (a monopoly) trades with four LDCs. The LDCs are not allowed to communicate and hence there is no room for explicit collusion.

There are four LDCs and one industrialized country in the experimental design. As a result the industrialized country is a monopsony in the primary product market (henceforth market X) and a monopoly in the manufactured product market (henceforth market Y). Despite the fact that the main interest of this study is the net barter terms of trade, the number of units of good X exchanged for good Y, experimental money is introduced in all designs. In every period, each agent (i) is endowed with a certain amount of money, M_i.[4] The exchange rate (from experimental money to dollars) is private information. Money is used because it helps the process of equilibration[5] and it serves as a medium of exchange. This last feature is especially important, since without money problems of indivisibility of commodities occur.

A set of utility functions, reflecting inelastic income elasticity of demand for primary products is derived from fairly general Engel curves, where as income increases a decreasing proportion is spent on X. From the Engel curves, the Marshallian demand is derived and then the expenditiure function. Subsequently, via the indirect utility function the direct utility function is derived.[6] If subjects are maximizing their profits in the experimental setting, they are behaving as if they have the preferences defined above.[7]

With the introduction of money the maximization problem changes slightly, since payoffs are derived from both utility (from holding goods X and Y at the end of each period) and from trading. A developing country maximizes,

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[4]   This amount should not be regarded as a budget constraint. It is sufficient to cover all reasonable transactions.

[5]   Money is an "obvious feature of any well-functioning market process". Noussair, Plott, Riezman (1995), p. 3

[6]   For the exact procedure and parametrization see Michelitsch (1993).

[7]   For details on induced preferences see Smith (1976).

$$\Pi_i = u(x_i, y_i) + p_x * (Wx_i - x_i) - p_y * y_i \qquad (1)$$

and an industrialized country maximizes,

$$\Pi_j = u(x_j, y_j) - p_x * x_j + p_y * (Wy_j - y_j) \qquad (2)$$

Where, Wx_i (Wy_j) are the resource endowments of good X (Y) for a developing (industrialized) country and the non-negativity constraints for the final allocation, x_i, y_i, x_j and $y_j > 0$. The budget constraints (as noted earlier M_i is chosen such that it is not binding) for the LDC

$$M_i \geq p_y * y_i - p_x * (Wx_i - x_i) \qquad (3)$$

and for the industrialized country.

$$M_j \geq p_x * x_j - p_y * (Wy_j - y_j) \qquad (4)$$

Assuming price taking behavior, a more stringent result than the equality of the marginal rate of substitution (MRS_{xy}) and the price ratio (p_x/p_y) is derived for the competitive equilibrium. Since utility is expressed in monetary terms, in equilibrium the marginal utility of x (u_x) has to equal the price of x (p_x) and the marginal utility of y (u_y) has to equal the price of y (p_y). Therefore, it is possible to test whether in each market prices converge to the equilibrium or not.

One possible problem in the experimental design is that subjects can go bankrupt. To avoid this[8] subjects are given a starting capital of \$5.[9] In addition to this subjects are trained several times without salient rewards to improve their understanding of the institution.

Parameterization

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[8] This is done as experimental subjects can not be asked to pay debts they accumulate in an experiment.

[9] The subjects receive their payoffs at the end of a series of experiments. This made it unlikely that the total payoff over all experiments is negative, and indeed the lowest payoff was greater than \$9.

A linear transformation of the form is chosen (12). The parameters values chosen are, $\alpha=0.9$, $\beta=0.8$, $\gamma=2000$, $\delta=100^{10}$.

$$u(x,y) = \delta + \gamma * \alpha * y^{1-\beta} * \left[\alpha^{-\frac{1}{\beta}} - x^{-\frac{1-\beta}{\beta}}\right]^{\beta} \qquad (5)$$

The choice of the parameter β, the income elasticity of demand, is especially important. For the laboratory market 0.8 was chosen. This is the parameter Prebisch used for the numerical example in his original paper (1959).

Up to a certain point all income is spent on the primary product, X. In this region, where $Y=0$, preferences can be represented by a lexicographic preference ordering. The same choice behavior is observed if an individual cares only about good X. The following functional form is chosen, with, $\eta=300$ and $\mu=0.25$, to represent such preferences.

$$u(x,y) = \eta * x^{\mu} \qquad (6)$$

The payoff tables for different combinations of final holdings of x and y, as well as two tables with the marginal utilities of x respectively y (given certain holdings of the other commodity) are given to the subjects. All three tables are given to the subjects during the training session, and again at the beginning of each experiment. All payoffs are in experimental Shillings, which are converted into U.S. dollars at a certain rate. The only difference between the tables used in the training session and the ones used in the subsequent experiments is that they are multiplied by a constant factor.

The Experimental Design (Table 1)

Four LDCs face a single industrial country (monopoly/monopsony). Four experiments

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[10]   Note, that this utility function can only be derived for an interior solution ($x>0$, $y>0$).

were conducted, each experiment consisted of a 'trainer'[11], an inexperienced and an experienced session. The sessions with inexperienced and experienced subjects consisted of a low income phase (1) followed by a high income phase (2). After the trainer, subjects participate in two more sessions, first as inexperienced, then as experienced subjects. For our purposes only the data from experienced subjects is used.

In the second phase the endowment (of both the industrialized country and the LDCs) is doubled in order to achieve a substantial effect on the equilibrium predictions. This is done to study the effect of lower income elasticity of demand for the primary product (X). The endowments are chosen to be $W_x = 5$ (10) for the LDCs and, $W_y = 10$ (20) for the industrialized country (IC) in phase 1 (2).

Table-2 gives an overview of the parameterization of the experiments as well as the allocations, prices, and trading quantities which would occur given a competitive equilibrium.

<table-2 here>

Trading Institution

The multiple unit double auction mechanism (MUDA)[12] trading institution is used. MUDA is chosen for two reasons, first, it allows simultaneous trading in multiple markets and, second, the double auction mechanism has good convergence properties. This is particularly important because it is difficult to reach a General Equilibrium in two distinct markets at the same time.[13,14]

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[11] The trainer was used to familiarize subjects with the trading institution, the payoff tables and the accounting procedures. To learn the trading institution, subjects went through a computerized training program, which allowed them to trade with computerized traders. For a discussion on how the trainer was run see Appendix.

[12] For a description of MUDA see Plott (1991).

[13] For a test of the competitive model in multiple markets (but additively separable demand) see Noussair, Plott, Riezman (1992). The authors report that in their multi-market environment only the qualitative predictions of the competitive model hold.

Subjects are not allowed to cancel bids or asks. However, in all experiments subjects are in the position of a trader, i.e., they can buy and sell units in both markets. This feature essentially enables subjects to erase their own offer, or bid, by accepting it. The reason for putting subjects in the role of a trader was to ease the process of equilibration.

In this complex environment it is possible to sell more units than the equilibrium quantity. The following example and figure-1 clarify this. Overtrading can be observed because of, both, the sequential character of the double auction and the interlinked demands in the two markets. Suppose that prices in both markets are within the equilibrium range, for instance in phase 1, at 100 in both markets. The supply and demand curves (S0 and D0 respectively) indicate the initial position of a developing country, endowed with 8 units of X and no unit of Y. At a price of 100 it is profitable to sell up to seven units of X, more than the equilibrium quantity of four. Suppose, the country sells six units of X. Holding two units of X and no units of Y it is profitable to buy two units of Y at a price of 100. Since the marginal value of X increases with the amount of Y a country holds it is now profitable to buy two units of X. After this transaction, the country now possesses four units of X and two units of Y, the equilibrium quantities. The country has exploited all potential gains from trade at these prices (or, for any price within the equilibrium range). It has done so by acting both as a seller and a buyer of X. Likewise a sequence of profitable trades is

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[14] A transaction in the double auction can be initiated by either buyers or sellers. Buyers can submit a bid which is higher than the standing bid. This bid becomes the standing bid. If a seller accepts the bid a transaction takes place with the price equal to the standing bid. Alternatively, a buyer can accept the standing offer, in which case a transaction takes place with the price equal to the standing offer. A seller can submit an offer which is lower than the standing offer. This offer becomes the standing offer. The double auction does not offer a structural advantage to either side of the market, i.e., prices tend to converge to the competitive equilibrium (and not to stay above, or below, it).

possible in which a country acts both as a buyer and seller of Y[15].

For the analysis of prices all transaction prices are taken into account. However, net quantities are reported, i.e., sales (purchases) by LDCs minus purchases (sales) by LDCs in market X (Y).[16]

Common Features of the Data Analysis

Due to the introduction of money into the system, and as utility is expressed in monetary terms, separate equilibrium predictions for both markets can be derived. The market for the primary product (market X) is analyzed first. This is followed by the analysis of the market for manufactured products (market Y).

The following econometric model is used to analyze the change in prices over time[17].

$$p_t = \alpha + \beta * p_{t-1} + \gamma * f[T(t) - T(t-1)] + \varepsilon_t$$

Where, p_t is defined as the difference between the transaction price, P_t, and the equilibrium prediction (EQ). The function $f[T(t) - T(t-1)]$ allows for a shift of prices at the beginning of the period. The functional form considered was $f(.) = [(T(t) - T(t-1))/T(t)]$. This functional form implies that the shift decreases with the number of periods. Using prices

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[15]   At these prices buying three units of Y is profitable, then selling four units of X and selling one unit of Y.

[16] Subjects were recruited from undergraduate economics classes at the University of Arizona. Each participant was paid $20 for showing up on time for all three sessions of the experiment. Subjects earned, in addition to that, salient rewards, depending on their decisions, ranging from about $10 to $85. For each subject group all sessions took place within one week.

[17] All models considered allowed for a change of prices over time. Let the t and T denote observation number (counted from the beginning of the experiment) and period number, respectively. The model $P_t = \alpha + \beta*\exp(-t) + \varepsilon_t$ assumes a constant rate of convergence from one observation to the next where α is the asymptotic equilibrium prediction. A significant coefficient on $\exp(-t)$ indicates that prices change over time (they increase if β is negative, decrease if β is positive). The model $P_t = \alpha + \beta*\exp(-t) t \varepsilon_t$ assumes that prices are constant within a period and change at a constant rate across periods. The coefficients have similar interpretations as in the previous model. In both models β was usually positive and significant, indicating a decrease of prices both within a period and across periods.
    Neither model predicted very accurately (very low R^2), since they failed to take into account simultaneously the change in price across periods and across transactions. A decrease of this form, saw-tooth, was a common pattern observed in many experiments.

lagged by one period as independent variable substantially reduces the (positive) autocorrelation.

The parameters of the model can be interpreted as follows. The asymptotic equilibrium prediction is defined by EQ + $\alpha/(1-\beta)$, $\alpha = 0$ indicates convergence to the equilibrium prediction EQ. The choice of EQ does not affect the asymptotic prediction, it only changes the value and the standard error of the estimated constant term α. If the absolute value of $\beta \geq 1$, the model does not converge to any particular point, $\beta < 0$ implies that prices overshoot the equilibrium (but eventually converge if the absolute value is less than one), $1 > \beta > 0$ greater than zero implies convergence at a constant rate to an equilibrium from one direction, $\gamma > (<) 0$ indicates that prices shift upward (downward) when the period changes.

Terms of trade are calculated as the ratio of the average transaction price in the primary product market (X) divided by the average transaction price in the manufactured good market (Y). For the statistical analysis only one measure of the terms of trade per phase of an experiment was used. This is the ratio of the average of the contract prices in the last three periods in market X and Y. This procedure reduces each experiment to two observations, namely the final terms of trade for phase 1 and two. Statistical tests are therefore conducted for all experiments within each design.

In all cases the competitive equilibrium is not a specific price but a range of prices. Prices were said to be at the competitive equilibrium if either of the following hypotheses could not be rejected:

a) $\alpha = 0$, against the alternative $\alpha > 0$, when the high endpoint of the competitive range entered the statistical model as equilibrium prediction (EQ).

b) $\alpha = 0$, against the alternative $\alpha < 0$, when the low endpoint of the competitive

range was used for EQ.

If the asymptotic equilibrium prediction (which is independent of the choice of EQ) is within the competitive range, neither hypothesis can be rejected. If the high (low) end of the equilibrium range is entered as EQ and the result is that α is greater (less) than zero it is not necessary to test the other hypothesis.

The following abbreviations used in the text. P1XE3Y represents design III, phase 1, experienced subjects, experiment 3, market Y[18].

III. Experimental Results

According to the monopoly/monopsony model, the IC should be able to lower prices in market X and to increase prices in market Y (compared to the competitive equilibrium, CE). Consequently, the terms of trade are expected to be worse than in the competitive equilibrium.

All subjects in the role of the IC are able to raise the price in their output market substantially above the competitive level, though not always to the level predicted by the monopoly model. Prices in market Y usually decrease from phase 1 to phase 2, contradicting the monopoly model. Terms of trade (ToT) are usually below the CE, but above the level predicted by the monopoly model. ToT for the experienced subjects increase in three cases. Earnings of experienced industrialized countries are between the competitive level and the monopoly level. Earnings of LDCs are usually below the competitive level.

The Market for Primary Products

The monopsony model predicts that prices in market X should be lower than the

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[18]   This annotation is shortened to XE3 in tables and graphs.

competitive equilibrium[19]and decrease, but the monopoly fails to exploit its market power. The average contract prices are displayed in figure-2.

In the beginnning of phase 1 in market X prices are volatile in some experiments but, stabilize in the later periods. Prices are generally within the competitive range at the end of phase 1, with the exception of one experiment. At the end of phase 2, prices are above the competitive equilibrium in two experiments. Only in experiment 1 are prices consistently close to the monopsony prediction. In experiment 3, prices are close to the monopsony prediction in phase 1, but substantially above the competitive level in phase 2.

Convergence

All asymptotic predictions in phase 1 are within the competitive range or below the lower bound (CEL) but, usually above the monopsony prediction. The results using (EQ=CEL) in phase 1 and (EQ=CEH) in phase 2[20] are in Table-5. Whether prices converge to CEL in phase 1, or to the monopsony prediction, is not clear. Convergence to either CEL cannot be rejected[21]in most cases. Only in experiment 1 prices converge to the monopsony level[22]. The asymptotic predictions for phase 2 are usually above CEH, the difference is often significant[23]. The exception is again experiment 1, where prices are below CEL and not significantly different from the monopsony prediction. β is positive and less than one, indicating convergence towards equilibrium from one side. In most cases β

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[19]   The competitive range in phase 1 (two) is 74-105 (37-43), the monopsony model predicts 64 (27), thus in both phases only 10 Shillings below the low end of the competitive range.

[20]   For experiment 1 the results for EQ = CEL are presented.

[21]   In P1XE4X prices converge into the competitive range and are significantly different from the monopsony prediction.

[22]   In experiment 1, prices converge to even below the monopsony level (significance level of 1%).

[23]   Prices are significantly greater than CEH in experiments 3 and 4.

is significant[24], γ usually is not significant. This indicates that prices in market X do not shift at the beginning of periods[25].

Market for Manufactured Products

In the market for manufactured products the IC has market power as a seller. The predictions of the monopoly model exceed the CE[26].

The average contract prices (figure-3) in all periods are above the high end of the competitive range (CEH) and below the monopoly level. Prices stay fairly close to the monopoly prediction only in phase 1 of experiment 3. Prices slowly but consistently fall in the second phase of that experiment. Figure-4 displays the problem a monopoly faces. For example, in period one in experiment 4, the monopolist charges prices relatively close to the (single price) monopoly level and sells four units. The monopolist then sells one unit for substantially less, which reveals to the LDCs that they can acquire units at a lower price.

In period two, only two units are sold at high prices, afterwards prices drop again substantially. In period three the monopolist holds out for a long time until finally the LDCs buy at fairly high prices. From then on average prices drop, since only one, or two, units are sold at high prices. In phase 2, even this ceases to work after period three, and only by holding out for a long time in period eight is the monopolist able to raise the price of at least one unit per period to higher levels.

The patterns of contract prices provides some insights into buyer behavior. When the monopolist tries to price-discriminate some buyers 'learn' that the monopolist sells cheaper, and subsequently withhold their demand until the seller concedes. Not all buyers, however,

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[24]   The exceptions are P1XE1X, P1XE3X and P1XE4X.

[25]   The exceptions are P2XE3X and P2XE4X ($\gamma > 0$).

[26]   The competitive equilibrium in phase 1 (2) is 89-137 (67-82), the monopoly prediction is 599 (705).

take the 'risk' to wait until the end of the period, since it is possible to be excluded from the market because of the time constraint.

<u>Convergence</u> (Table-6)

Generally prices converge from above to a level at, or above, the competitive equilibrium. For purposes of analysis of convergence, the equilibrium prediction used to calculate the differences was the high end of the competitive price range (CEH). This is done as prices tend to be above the competitive equilibrium[27]in all the experiments. Note, a significant α implies that prices are different from the initial equilibrium prediction (EQ).

The asymptotic prediction is always above CEH and always below the monopoly level. Prices, in most cases are significantly different from both CEH and the monopoly prediction[28]. The coefficient β is always positive and less than one 1 and usually significant[29] indicating convergence of prices to levels between the competitive and the monopoly prediction, γ is always positive and usually significant[30], indicating an upward shift of prices in market Y at the beginning of periods. This pattern is quite typical, as is seen in figure-4. The only exception is experiment 3, where prices are extremely stable until the last two periods of the second phase. The pattern of prices of this 'outlier' is displayed in figure-5.

An explanation for the general decrease of prices and their shift at the beginning of

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[27]   As mentioned earlier, the choice of EQ in the equation ($p_t = P_t$ - EQ) does not affect the asymptotic equilibrium prediction (ASY), only the value of the coefficient α and its standard deviation. In the one case where ASY was below the competitive range a second regression was conducted with EQ equal to the low end of the competitive range to test whether α was significantly different from zero.

[28] α is not significantly different from zero in P1XE1Y and P2XE3Y (using the monopoly prediction) respectively P2XE1Y, P2XE3Y.

[29]   The only exception is P1XE3Y.

[30]   The only exception occurs in experiment 3.

a period is the specific structure of the supply and demand. Profitable trades can occur well above the competitive equilibrium, but not substantially below it. The marginal value of X decreases rapidly with the number of units a country holds (for any constant holding of Y).[31] Figure-6 shows the supply and demand curves for X in phase 1, given that the market for manufactured products is already in equilibrium (i.e. every country holds two units of Y). Both supply and demand curves shift as units of X are traded. To show this effect the curves are drawn for the case when each country has traded none, one, two and three units of X, respectively. The upward shift of the supply curve is negligible compared to the huge downward shift of the demand curve as units of X are traded.

This feature is important to explain the evolution of prices. Transactions are profitable for both trading partners at prices well above the competitive equilibrium (CE), but not at prices substantially below CE. The range of profitable prices becomes smaller as units of X are traded, also decreasing the asymmetry in the distribution of surplus.

Terms of Trade

Terms of trade are computed as ratio of the average prices in the last three periods. The ToT are generally below CEL[32], but above the monopoly prediction (figure-7). ToT increase for three of the cases even though both models predict that ToT should worsen from phase 1 to phase 2. ToT are below CEL in phase 1 in almost all periods. In three experiments ToT are fairly close to the monopoly prediction at the end of phase 1. In phase 2, the ToT are stable and halfway between CEL and the monopoly prediction.

Terms of Trade in the Monopoly Design (Table-7)

ToT are computed as ratio of the average price in the last three periods. Both the

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[31]   X and Y are complements, i.e., the marginal value of X increases with the number of units of Y.

[32]   The low end of the competitive range.

monopoly and the competitive model predict that the ToT should worsen in design I. ToT increase in three experiments. This goes against the prediction of both the competitive and

Table-7 Terms of Trade:Design I				
Phase	E1	E2	E3	E4
1	0.17	0.25	0.14	0.47
2	0.20	0.27	0.25	0.22

the monopoly model. ToT in the last periods decrease only in experiment 4. ToT in experiment 4 increase during phase 1 (ToT in the final three periods are higher than in all other periods) and drop drastically in the last three periods of the phase 2 (before this ToT had never been below 0.45).

Trading Volume and Efficiencies

The theoretical model predicts that the IC should exert its market power by reducing the quantity in market Y, its output market. Quantity is reduced (relative to the competitive equilibrium) from 8 to 4 in phase 1 and from 16 to 4 in phase 2. The quantity traded is close to the monopoly prediction in phase 1.[33]

In phase 2, quantity traded is close to the monopoly prediction in experiment 3 (where prices have been the highest). In other cases the quantity traded is around 8. The effect of restricting output and increasing price is best seen in experiment 4. Where, in phase 2 the monopolist sold on an average 12 units during the first 8 periods at a price around 150 Shillings. In the last two periods it restricted sales to the monopoly level and increased the price to about 350.

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[33] The average quantity traded is 4.2. During the last three periods, quantities are close to the competitive prediction of 8 only in one case (P1XE4Y) . In this case the average contract price is also the lowest.

Both the competitive and the monopsony model predict the same trading volume in the primary product market. However, the quantities purchased by the monopsonist vary substantially across different experiments. In experiment 3 the monopsonist purchases up to 10 units in phase 1 and 25 units in phase 2. This also explains why prices exceed the competitive equilibrium in phase 2. Quantities in all the other experiments are fairly close to the equilibrium prediction of 4 in phase 1 and 8 in phase 2. In phase 2, experiment 1 is the exception. In this experiment the monopsonist paid prices very close to the monopsony level, but at the expense of quantity purchased. The average quantity purchased is four units.

Due to the deadweight loss the monopoly model predicts efficiencies of 95% in phase 1and 88% in phase 2. Efficiencies are particularly low in experiment 3, in which the monopsonist purchased 'too many' units at a high price in market X and also charged the highest price as monopolist in market Y. Efficiencies in that experiment range from 77 to 87% during the last three periods of both phases. In the other experiments, efficiencies are around the level predicted by the monopoly model at the end of phase 1, and often greater in phase 2.[34]

Earnings

Earnings are defined as the sum of the redemption values for the final holding of X and Y plus (or, minus) the trade surplus.[35] The values in the text are the average earnings in the last three periods of each phase.

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[34] Efficiency can drop drastically, for example, in the last period of P2XE2 efficiency drops from 94 to 80% after the average contract price in market Y increased from 141 to 198.

[35] Trade surplus is defined as revenues from sales minus expenditures on purchases. The reason for using earnings for comparisons and not trade surplus is that the latter is not very meaningful. A country can generate a high trade surplus by selling all its units and nevertheless not be in a very good position, because the redemption value is zero. This situation is comparable to a developing country exporting food while part of the population is starving.

The competitive model predicts that the IC should earn (CEH =) 1960 in phase 1 and (CEH=) 2580 in phase 2. The earnings are lower than those predicted by the monopoly model (3560 and 4636). The earnings of LDC predicted by the competitive model (phase one: CEL = 960, phase 2: CEL = 1310) are higher than those predicted by the monopoly model (488 and 559). In all the experiments the average earnings realized by LDC are always higher than the monopoly prediction and lower than CEL. The earnings of the monopolists are between the monopoly prediction and above the CEH level[36].

Experiment 3 is the exception, where, in the last four periods in phase 2 earnings of the monopsonist are below CEL. This is the case because the IC purchased a greater number of units of X at a higher price than is predicted by the competitive model.

Conclusion:

The industrialized country is unable to keep prices below the competitive equilibrium as monopsonists in market X. At the same time as monopolists in market Y they are able to charge prices which are higher than the competitive equilibrium. The buyers, unlike the sellers, cannot exploit their market power in this environment the sellers are able to do so. Terms of trade are usually between the competitive range and the monopoly level. Terms of trade increase from phase 1 to phase 2, contradicting the monopoly model. The single IC is unable to exploit its market power to the full extent.

The pure prediction of the Prebisch-Singer (PS) theory of unequal exchange does not hold. The monopoly (IC) is unable to lower prices of the primary product. However, it is able to alter the ToT in its favor as it is able to increase the price of the manufactured good. The PS thus tends to overstate the effect on ToT in this setting. In addition, TOT improve

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[36] Earnings are below CEH (but above CEL) in only 4 periods of 40 in phase 1, and in 3 periods of 30 (without experiment 3) in phase 2.

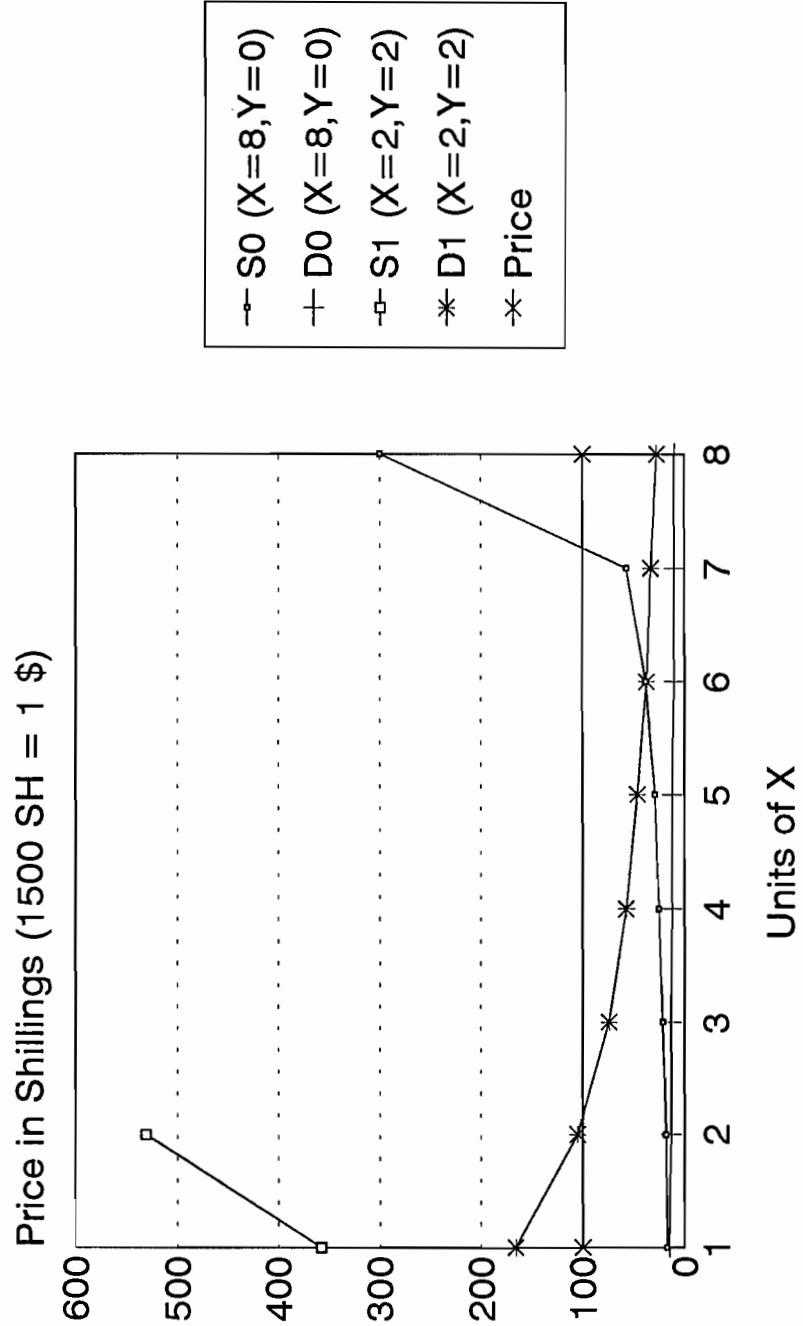as income increases thus contradicting the PS theory.

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Appendix: Trainer session.

Subjects received L-shaped squares which allowed them to identify profitable trades in each market, given their current holding of X and Y. These squares provided the following information: "It is profitable to buy below ...", pointing to the marginal value of an additional unit in that market. "It is profitable to sell above ...", pointing to the marginal value of the last unit owned. Copies of the squares are printed in the appendix. After the computerized training program subjects participated in three to six training periods with exactly the same features as the actual two experiments in which they participated during the subsequent two sessions. They did not receive any payoff for the first round of the trainer. Subjects also had the possibility to practice the communication option the MUDA software offers for subjects in design III, in which communication is allowed. During the trainer in design III the subjects were not allowed to talk before each period. This was done because oral communication was thought of as not needing practice. During the training periods subjects had extensive opportunity to ask questions as well as to check their accounting. During the first two periods of the trainer the accounting of all subjects was checked, later only questions answered. The accounting was verified before subjects came back for the subsequent session.

Figure-1: Sequential Evolution of Supply and Demand

Market X, Example for a Developing Country

Price in Shillings (1500 SH = 1 $)

Legend:
- S0 (X=8,Y=0)
- D0 (X=8,Y=0)
- S1 (X=2,Y=2)
- D1 (X=2,Y=2)
- Price

Units of X

Example: The country sells 6 units of X, then buys 2 units of Y, then buys 2 units of X
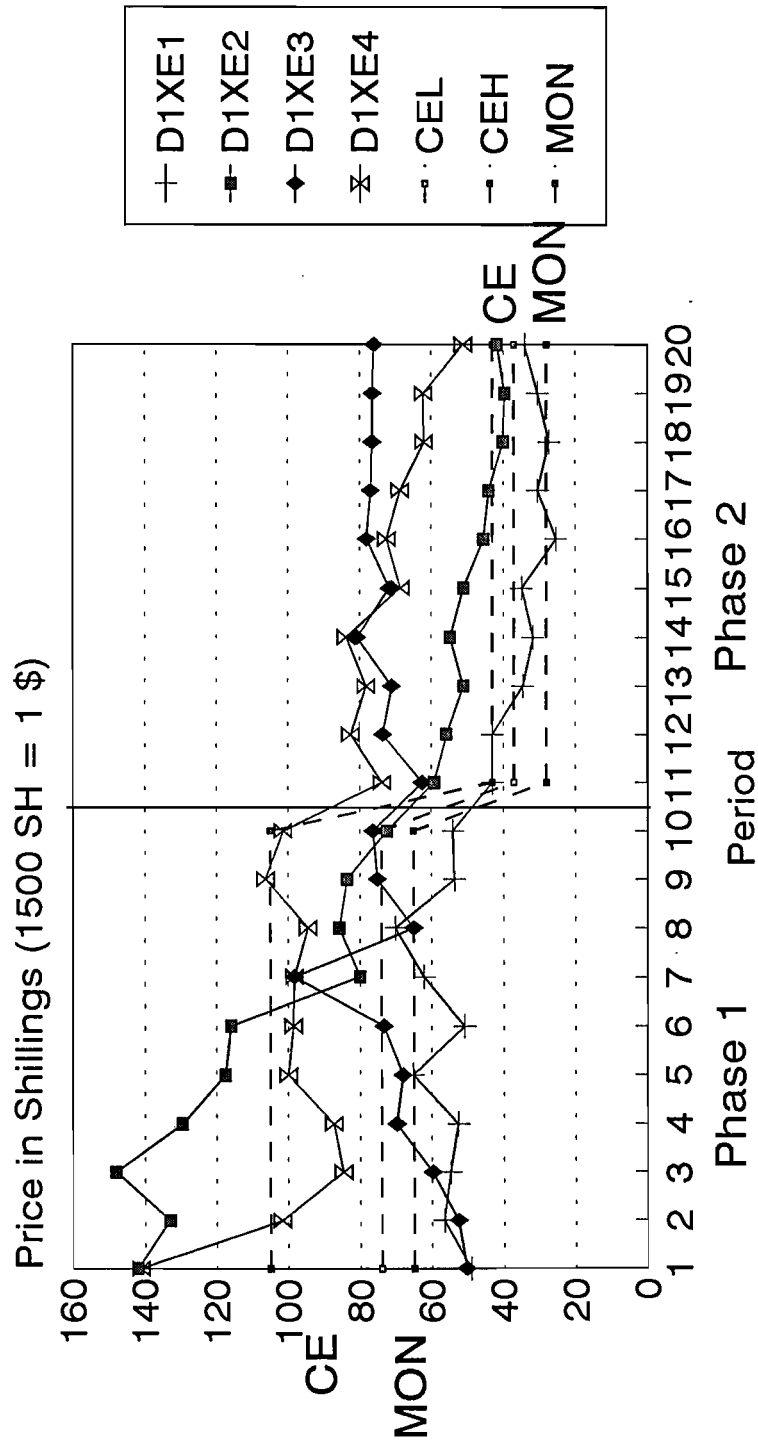
<u>Review</u>, Papers and Proceedings, 1976, 66, 274-279.

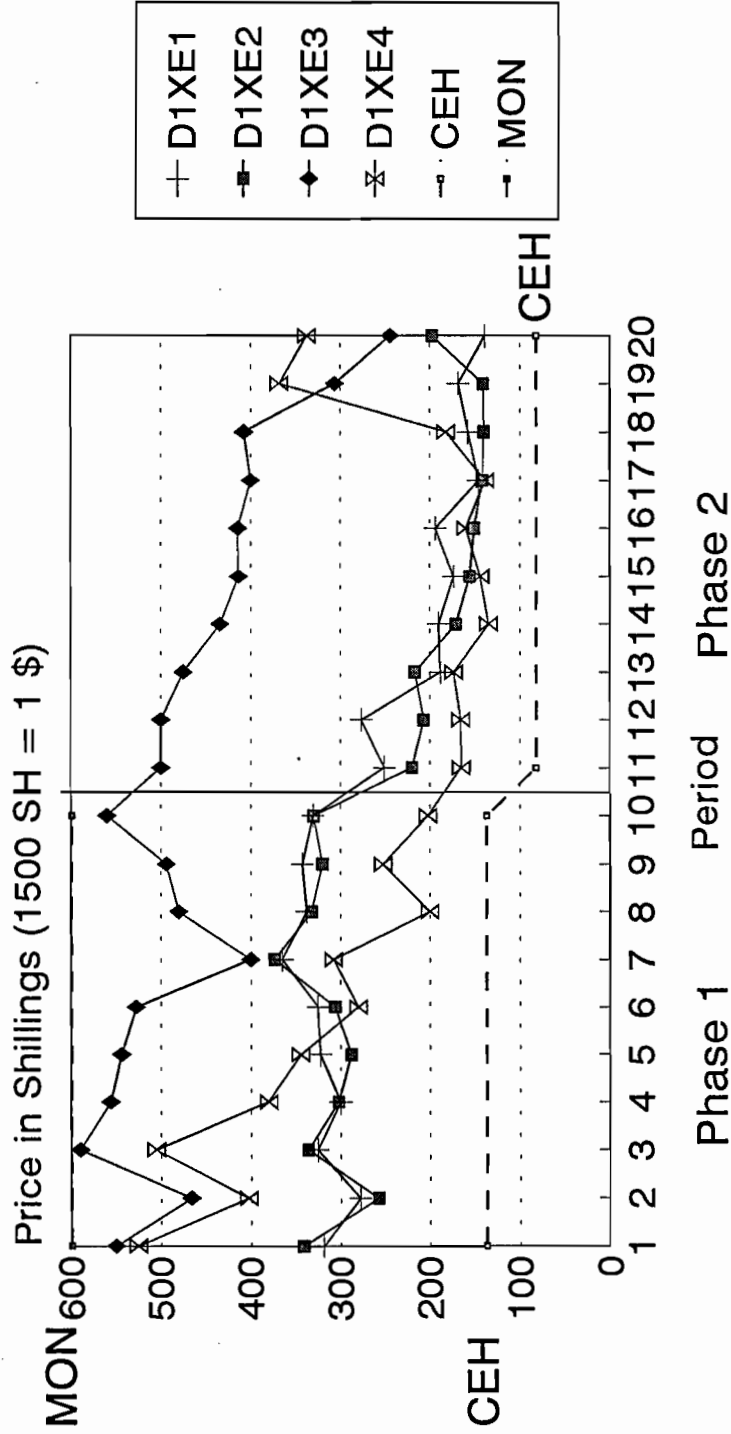Social Indicators of Development, The World Bank, <u>Johns Hopkins University Press</u>, 1991-
92.

Figure-2: Average Contract Prices

Market X (Primary Product)

Figure-3: Average Contract Prices

Market Y (Manufactured Product)

Price in Shillings (1500 SH = 1 $)

Phase 1   Period   Phase 2

Monopoly Prediction: 705 in phase-II

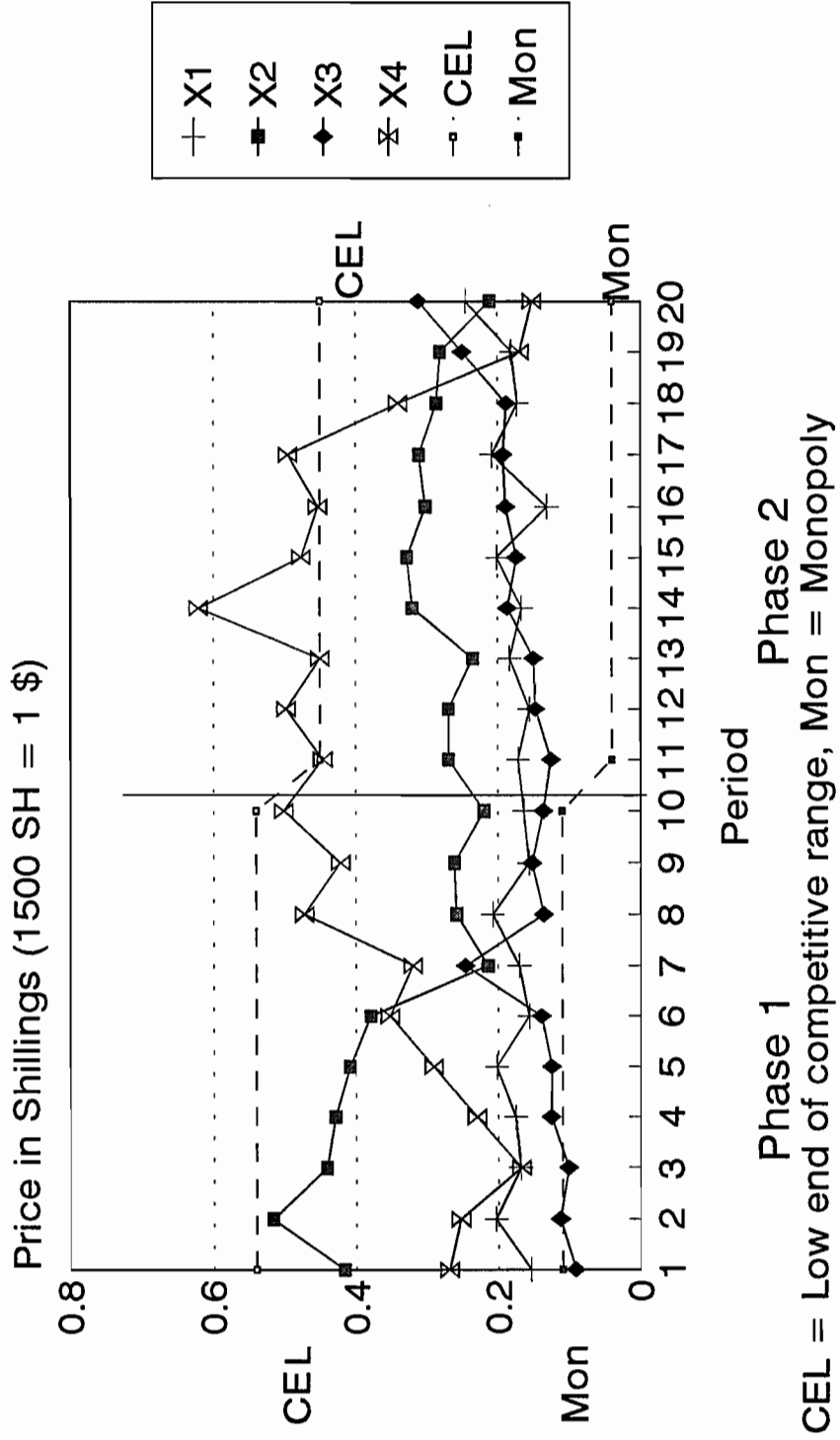Figure-4 : Experiment 4, Both Markets (Y above X)

Phase 1
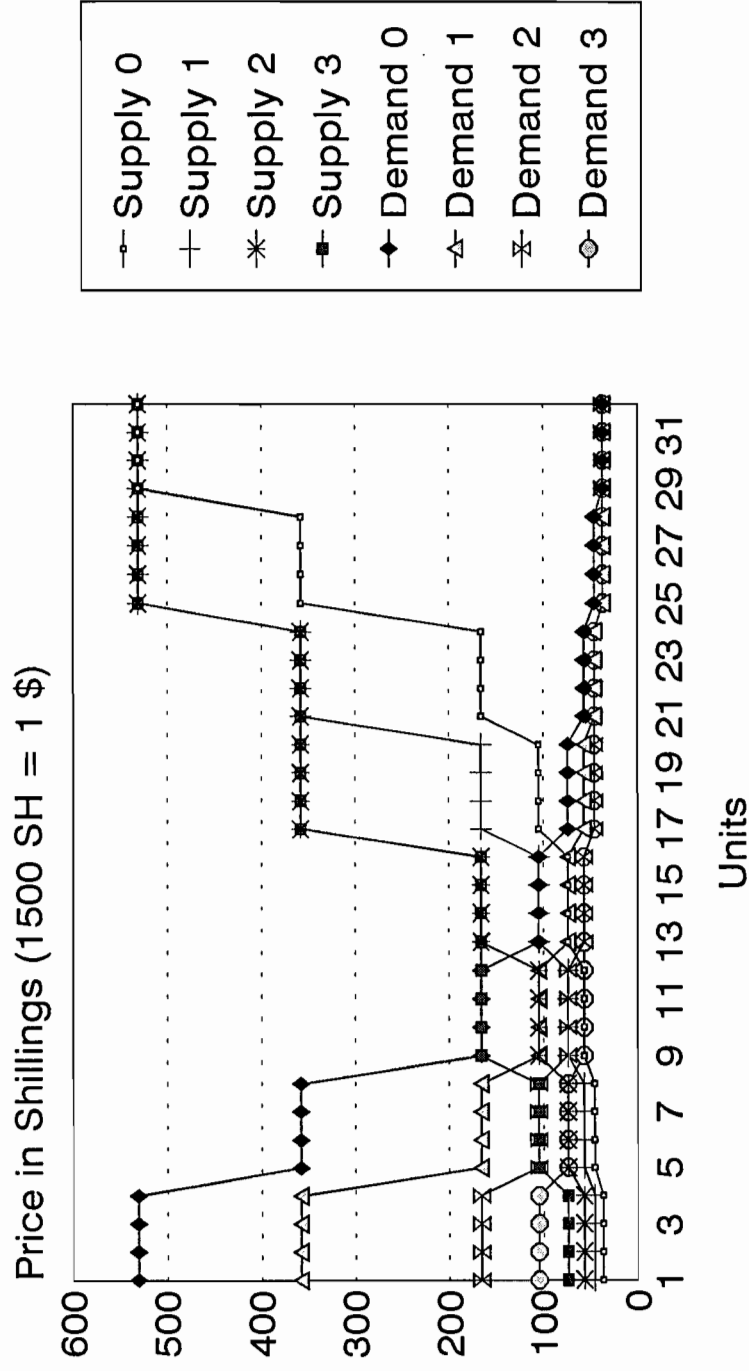
Phase 2

Figure-5 : Experiment 3, Both Markets, Experienced Subjects
Price

Phase 1

Phase 2

Prices in market Y are always above prices in market X.

Figure-7: Terms of Trade

Figure-6: Supply and Demand, Market X

Y-Market is in Equilibrium (every country holds 2 Y)

Price in Shillings (1500 SH = 1 $)

Supply and demand after each country has traded 0, 1, 2, and 3 units.