Dipartimento Economia Politica e Aziendale

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Bargains Rejected? Developing Country Trade Policy on Used Equipment

Giorgio Barba Navaretti -
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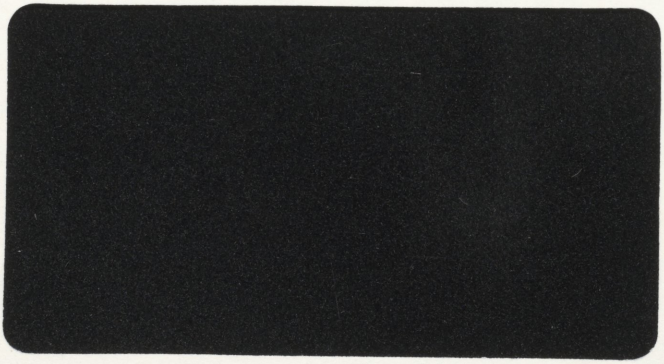

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Dipartimento di Economia Politica e Aziendale
Università degli Studi di Milano

via Conservatorio, 7
20122 Milano
tel. 39/2/76074501
fax 39/2/76009695

E Mail: dipeco@imiucca.csi.unimi.it

BARGAINS REJECTED?: DEVELOPING COUNTRY TRADE POLICY ON USED EQUIPMENT[1]

Giorgio Barba Navaretti
Universita' degli Studi di Milano
Centro Studi Luca d'Agliano and Fondazione Eni Enrico Mattei

Isidro Soloaga
The World Bank and University of Maryland College Park

Wendy Takacs
University of Maryland Baltimore County and the World Bank

ABSTRACT

Many developing countries restrict imports of second-hand goods. These policies appear contrary to the optimal choice of technique in developing countries, where low wages, small markets, and scarce technical skills would appear to call for use of more labor intensive, smaller scale, and lower-tech machines. This paper examines data on U.S. exports of new and used metalworking machine tools by type and by country of destination to investigate the determinants of used versus new machinery trade. The results indicate that technological factors, skill constraints, and market size may be more important than factor prices in determining the choice of machine. Trade restrictions on used machinery distort firms' investment decisions.

I. INTRODUCTION

Many developing countries design their trade policies to discriminate against importation of used goods through import bans, licensing requirements, or higher

[1] This paper was prepared while the first author was a visiting researcher at the International Trade Division, International Economics Department of the World Bank. Fondazione Eni Enrico Mattei and Centro Studi Luca d'Agliano have partly funded this project. We thank Anthony M. Bratkovich, Engineering Director of the US Association for Manufacturing Technology for his help unraveling the mysteries of the technological characteristics of metalworking machines. We also thank Gabriel Castillo, Will Martin, John Nash, Gary Pursell, Maurice Schiff, and James Tybout for useful suggestions on the project, and Jennifer Ngaine and Jeff Hayden for help with tables and charts. We are solely responsible for all remaining shortcomings. The views expressed in this paper are those of the authors and not necessarily those of the World Bank.

tariff rates on second-hand items. Discrimination against second-hand products is even found among the ranks of the industrialized countries; witness Australia's additional $12,000 tariff on used cars.[2] Policy makers justify these restrictions as policies to promote technological upgrading and protect domestic industries from "dumping" of cast-offs from high-income countries.

But trade restrictions on used capital goods appear contrary to the appropriate choice of production techniques in developing countries, where low wages and high interest rates would seem to call for the use of labor-intensive production processes. Older equipment is likely to be more labor-intensive than new equipment because technological change tends to be labor-saving (Bardhan, 1970; Smith, 1976; Mainwaring, 1986), because used machinery normally requires more maintenance (Schwarz, 1975; Thoumi, 1975) and because older machines are more likely to break down. If workers are paid for a regular work schedule, machine "down-time" implies idle workers, implicitly increasing the de facto labor-intensity of the production process (Bond,1983). Older machinery also may be more appropriate for firms in developing countries because the smaller optimal scale of older machines may be better suited to smaller developing-country markets and because older machines may be more flexible in their use and less specialized (Sen, 1962; James, 1974).

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[2] Wonnacott, Paul. (1994) "The Automotive Industry in Southeast Asia: Can Protection Be Made Less Costly?" mimeo, Institute for International Economics, Washington, D.C., September, p. 2.

Recent contributions on technology transfer link the choice of technique to "skills" available to a firm or in a country. Such "skills" are human capital or other technological capabilities acquired through deliberate learning and/or learning-by-doing (Benhabib and Rustichini (1991), Chari and Hopenhayn (1991), Keller (1994), Javanovic and McDonald (1993) and Javanovic and Nyarko (1995 and 1996)). New equipment may not be fully productive if the firm does not have workers with the skills needed to use them, and acquiring those skills may be costly. The skill factor is likely to affect the choice between new and used machines, especially for types of machines characterized by rapid technological change. Firms in developing countries facing skill constraints in the labor force tend to purchase older machines with lower skill requirements than new machinery.

All of these considerations imply that firms in developing countries with low wages, high interest rates, low educational levels and small domestic markets for manufactured goods would tend to opt for used rather than new machinery. In this paper we look for confirmation of these predictions using data on U. S. exports of new and used metalworking machine tools.

II. EVIDENCE ON NEW AND USED MACHINERY TRADE

U.S. export data on some types of vehicles, equipment and machinery are sufficiently disaggregated to distinguish between new and used goods. Here we concentrate on U.S. exports of metalworking machine tools by country of destination between 1990 and 1994, disaggregated by commodity classification and country of destination. The sample covers 38 types of metalworking machines,

aggregated to the 6-digit level in the Harmonized System, and exports to 23 importing countries.

Different types of metal working machine tools require different types of skills. Manual machines are operated by skilled workers or craftsmen. Numerically controlled machines are operated by both technicians and unskilled workers. Machining centers are even more complex machines that require higher-level technicians and engineers. Furthermore, machines with higher skill requirements also tend to have a faster rate of technological change. With the guidance of an engineer intimately familiar with the complexities and skill requirements of each type of machine, we developed a "skill index" for each 10-digit export category, reflecting the degree of skill required in the labor force to operate that type of machine. The value of the index ranges from 1 to 4, increasing with the level of skills required to use the machine. The specific skills associated with the index are reported in table I:

TABLE I

THE SKILL REQUIREMENT INDEX

Value of the Index	Skills Required
1	Unskilled labor
2	Skilled Craftsmen
3	Technicians
4	Higher-level Technicians, Engineers

Basic statistics on U. S. exports of new and used machine tools to low-middle- and high-income countries are reported in table II. The first column

TABLE II

UNITED STATES EXPORTS OF METAL-WORKING MACHINE TOOLS

Country of Destination:	Used machinery/Average Total machinery (Quantities)	Skill Index[4]	Used /Total (Quantities) Skill 1,2	Skill 3,4
High-income Countries[1]	0.096	2.93	0.082	0.296
Middle-income Countries[2]	0.112	2.71	0.095	0.339
Low-income Countries[3]	0.235	2.63	0.159	0.526

[1]High-income: GDP per capita > US$12,000
[2]Middle-income: $US1,300 < GDP per capita < US$12,000
[3]Low-income: GDP per capita < US$1,300
[4]Weighted average by value of shipments

shows the shares (by quantity) of used machinery in total imports of machinery from the United States. As expected, low-income countries import a higher ratio of used to new machinery, but the variation in the shares of machines imported second-hand (between roughly 10 percent for high-income countries and about 24 percent for low-income countries) is not huge. The average skill index of imported machinery is higher for high-income countries than low-income countries, but again the difference is not large. If we divide machines into "high-

tech" (skill index 3 and 4) and "low-tech" (skill index 1 and 2), the same pattern emerges; lower income countries import larger proportions of the machines used. Note also that the proportion of equipment imported used is larger for high-tech machines than for low-tech ones.

These figures provide empirical support for conclusions in the literature that used equipment will be favored by firms in developing countries, but it does not provide information on which of the many factors cited are significant in determining this choice. To cast some light on this question we conducted further empirical analysis to try to explain the new/used equipment choice.

III. EMPIRICAL TEST OF TRADE IN NEW AND USED MACHINERY

We conducted an econometric test of the hypothesis that the share of used equipment imported depends upon country-specific variables (wage rates, interest rates, skill levels in the importing countries, market size, trade policy) and smachine specific variables (rate of technical progress of the type of machinery and skill level required to operate it). The basic estimating equation was:

$$Q^u_{ij} = \alpha_0 + \alpha_1 (\frac{w}{r})_j + \alpha_2 T_{ij} + \alpha_3 S_{ij} + \alpha_4 E_j + \alpha_5 N_j + \alpha_6 M_j + \alpha_7 D_j + v_{ij}$$

where: Q_j = quantity of used machinery of type i exported to country j as a proportion of total machinery of type i imported by country j, 1990-1994

w_j = wage rate in country j in U. S. dollars

r_j = real interest rate in country j

T_{ij} = rate of technological progress in machinery of type i imported by country j, measured as the difference of unit values of new and used machinery

S_{ij} = average skill requirement index for machines of type i exported to country j

E_j = education level in country j, measured by average years of school

N_j = dummy variable = 1 if country j had a non-tariff barrier on imports of used equipment during 1990-1994, 0 otherwise

M_i = market size in country j

D_i = distance between United States and country j

v_{ij} = disturbance

The dependent variable is the share of the total amount of each machinery type each importing country imported second-hand during the period 1990 through 1994. Completely consistent trade data for new and used machinery are only available back through 1990.[3] Because many country-specific variables were not available for all of these years, we worked only with machine and country specific observations by aggregating the 5 years, using total U.S. exports of each commodity classification to each country 1990-1994 for the trade flows and averaging observations on the other variables across the five years, or over the largest number of years for which we had observations. Further details on the variables used and data sources appear in the Data Appendix. The results are presented in table III.

Equation 1 shows the results for the basic estimating equation. All of the estimated coefficients except the factor price ratio and real GDP have the expected signs and are significantly different from zero at the .05 (*) or .01 (**) level (using a two-tailed test). The estimated coefficients of both the factor-price and market size variables have unexpected signs but are not significantly different from zero. To

[3]A reclassification of the export data in 1990 created a break in the series, so although data on used machinery exports are available for previous years, the data are not based on exactly the same commodity classifications.

check whether imperfections in capital markets could be causing the lack of significance of the estimated factor-price coefficient, we reestimated the equation using wage rates and interest rates separately. The results (not shown

TABLE III

DETERMINANTS OF IMPORTS OF USED MACHINERY

Dependent Variable: Share of Machinery Imported Second-hand N=418

Estimated Coefficient of:	Equation 1	Equation 2	Equation 3	Equation 4
Constant	0.524 *(2.77)***	0.436 *(2.31)**	0.544 *(3.84)***	0.579 *(4.08)***
Wages/ Interest rate	0.012 *(1.59)*			
Wages		0.030 *(1.86)*		
GDP per Capita			-0.022 *(-1.24)*	-0.004 *(-0.21)*
Technical Change	0.065 *(8.42)***	0.072 *(11.05)***	0.075 *(11.34)***	0.075 *(11.37)***
Skill Requirement	0.080 *(3.47)***	0.077 *(4.18)***	0.072 *(3.84)***	0.070 *(3.76)***
Education	-0.056 *(-4.66)***	-0.038 *(-4.73)***	-0.028 *(-3.55)***	-0.029 *(-3.25)***
NTB	-0.110 *(-2.37)**	-0.084 *(-2.71)***	-0.107 *(-3.55)***	-0.090 *(-2.88)***
Real GDP	0.004 *(0.19)*	-0.027 *(-2.55)**		
Manufacturing Output				-0.021 *(-2.07)**
Distance	-0.00002 *(-2.45)**	-0.00001 *(-0.97)*	-0.00001 *(-2.75)***	-0.00001 *(-1.24)*
Adjusted R^2	0.392	0.388	0.386	0.392
F-value	26.57	38.87	43.13	39.22

in table III) were similar; both the coefficients of the wage and interest rate variables were insignificant, although the interest rate coefficient had the expected sign. Equation 2 shows the results of including the wage rate alone. Again the estimated coefficient of the wage variable has an unexpected sign and is insignificant. Substituting per capita GDP as a proxy for wages in Equations 3 and 4 changed the sign to the expected negative relationship between wages and the share of used equipment imported, but the estimated coefficients were still insignificant.

The technological and skill-related variables perform quite well and the results for these variables appear quite robust. To capture the rate of technological upgrading we calculated the percentage difference between the unit value of exports of new machines and used machines in each machinery category. The rationale for this method is that the greater the improvement in a new model, the greater the drop in the market price of the previous model. As expected, the results show that the faster the rate of technological upgrading, as measured by the price differences between new and used machines, the larger the share of used machines purchased and imported. The more technologically advanced the machinery, as measured by the level of skills required to operate it, the larger the proportion of machinery imported used. Also as expected, the higher the level of skills in the country, as measured by average years of school completed, the smaller the proportion of used equipment chosen.

The results on the impact of market size are mixed. Statements in the literature that smaller-scale used equipment would be more appropriate for developing countries led us to expect a negative coefficient on the market size

variable (as measured by real GDP in U. S dollars), but the estimated coefficient of this variable in equation 1 was positive, although insignificant. However, the estimated coefficient is negative and significant in equation 2. The estimated coefficient of an alternative measure of market size (real manufacturing output) is also negative and significant in equation 4. So there is some evidence from our sample that larger market size shifts demand toward larger-scale, new machinery.

The negative significant coefficient on the dummy variable for the existence of special restrictions on used equipment in all of the estimated equations is hardly surprising. Nonetheless it does indicate that restrictions on second-hand equipment do distort the pattern of trade and firm's decisions on the choice of new versus used machinery. Such restrictions deny domestic firms access to production methods and techniques that may be more profitable and efficient for them, and drive up costs by forcing firms to pay for newer, more expensive equipment.

We included the variable for distance in the estimating equation to capture the impact of transport costs. Transport costs would presumably be approximately the same (in an absolute sense) for new and used equipment of approximately the same weight and bulk. Transport costs would thus increase the cost of low-priced used equipment relative to higher-priced new equipment, and discourage purchase of used equipment. In fact the negative estimated coefficients on the distance variable indicate that transport costs, significant in equations 1 and 3, do indicate that transport costs do discourage purchase of machinery second-hand.

IV. CONCLUSIONS

The data on U. S. exports of new and used metalworking machinery tend to corroborate the view that used equipment will be demanded by firms in lower-income developing countries. The proportion of machinery bought used is especially high for "higher-tech" equipment requiring more sophisticated operating skills. Econometric tests of the determinants of used machinery trade reveal that factor prices may be less significant than technological, educational, and skill factors in determining used machinery trade. One implication of the significant and robust results for the technological, educational, and market size variables compared with the factor-price variables is that the role of factor price differentials, emphasized in much of the theoretical literature on used equipment trade may be overemphasized. The results here indicate that technological factors and skill constraints, as well as internal market size, may be equally important reasons why firms in developing countries would choose used equipment. Trade restrictions that force firms to import new equipment impose costs on firms not only because they encourage them to choose more capital intensive production techniques than would be optimal, but because they force firms to buy more expensive equipment that they may not be able to operate at appropriate scales of operation or at full efficiency due to skill constraints in the labor force.

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DATA APPENDIX

Variable	Measures	Source
Q_{ij}	Quantity of used machinery of type i exported to country j as a proportion of total machinery of type i imported by country j, 1990-1994 by country j, 1990-1994	U.S. Department of Commerce, Bureau of the Census, Exports Merchandise CD-ROM
w_j	Log of average annual wage in country j in U. S.dollars, 1990-1994	UNIDO
r_j	Average real interest rate in country j	IMF, International Financial Statistics
T_{ij}	Rate of technological progress in machinery of type i imported by country j, measured as the difference between the logs of unit values of new and used machinery	Calculated from export data, above.
S_{ij}	Skill requirement index for machines of type i exported to country j	Based on classification by Anthony Bratkovich, Engineering Director of the U.S.Association for Manufacturing Technology
E_j	Education level in country j, measured average years of school	World Bank Data Base by (STARS)
N_j	Dummy variable for non-tariff barrier on imports of used equipment in country j (=1 if restriction, 0 otherwise)	G.A.T.T. Trade Policy Review for various countries information provided by SGS (an international pre-shipment inspection company) and World Bank
M_j	Market size in country j, alternately measured as GDP in US dollars or manufacturing output in US dollars	World Bank and IMF, International Financial Statistics
D_j	Distance (in miles) from the United States to country j\	World Bank

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