NBER WORKING PAPER SERIES

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Working Paper 7674
http://www.nber.org/papers/w7674

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
April 2000

This paper forms part of a project on Globalisation and Social Exclusion supported by the Targeted Socio Economic Research programme of the European Union. We are grateful to Paul Brenton, Huw Edwards, Matthias Luecke, Carlo Perroni, and Ted To for discussions and comments. The views expressed herein are those of the authors and are not necessarily those of the National Bureau of Economic Research.

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JEL No. F1, D58, J31, O30

ABSTRACT

Recent trade and wages literature focuses on whether trade or technology has been the major source of increases in wage inequality in OECD countries since the 1980s. In this literature, no attention has been paid to demand side considerations. Using a simple heterogeneous goods trade model of the Armington type, and UK data, we show how trade shocks affecting the price of unskilled-intensive goods can be absorbed on the demand side, with little or no impact on relative wage rates. No wage impact occurs if the elasticity of substitution in preferences between imports and import substitutes is one. As this elasticity increases, trade plays an ever larger role in explaining wage inequality changes, and as the elasticity goes below one the sign of the effect changes. We suggest that since many import demand elasticity estimates are in the neighbourhood of one, there is a prima facie case that demand side considerations further lower the significance of trade as an explanation of recent trends in OECD wage inequality –beyond that reported in recent literature.

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I Introduction and background

The debate on trade and wages is driven by the sharp increase in wage inequality that occurred between the 1980s and the early 1990s in some OECD countries.[2] Two major factors have been identified in the literature as primarily responsible for this: elevated trade volumes (imports) in low-skill-intensive products (and particularly from low-wage developing countries) and technological change biased against unskilled labor. The issue in the debate is the relative importance of these two factors. Most existing literature concludes that technological change is a more important factor than trade. The outcome is important because of the pressures for protection which arise if trade is deemed to be the main source of new wage inequality.

The framework used in much of recent literature discussing these issues is that of a homogeneous goods trade model in which changes in world prices are fully transmitted to domestic prices, and from there (via zero profit conditions) to factor prices. Our contribution is to present a model with heterogeneous goods across countries—for which the homogeneous goods model is a special case—and show that, in this model, there may be no or little transmission of international price shocks onto relative wages, depending upon

[2] Increases in wage inequality have been documented for a number of OECD countries, most notably the US and the United Kingdom (e.g., Davis, 1992; Kosters, 1994; OECD, 1997; Gottschalk and Smeeding, 1997). This pattern has been observed across different types of workers (low vs. high skill), education levels (college vs. non-college graduates), and experience. Even among "observably similar workers" wage inequality has increased (e.g. Davis, 1992). There has also been documentation of a rise in unemployment in some European countries without major increases in wage inequality (Kosters, 1994; OECD, 1997; Dewatripont *et al*., 1998)—as well as of a decline in wage inequality in some key developing countries (Korea, Venezuela, Colombia and Brazil) (Davis, 1992; UNCTAD, 1997; Wood, 1997).

substitution elasticities in preferences. We then cite empirical estimates of trade elasticities to argue that the effects of trade shocks on relative wage inequality may be even smaller than currently believed.

Early papers in this area have analyzed how increased trade changes labor demand via the factor content of trade (e.g. Borjas *et al.*, 1991; Murphy and Welch 1991, and Katz and Murphy, 1992). Their conclusion that trade was a secondary factor based on factor content calculations was later criticized by Wood (1994). Subsequent papers related relative product price changes to relative wage changes (Lawrence and Slaughter, 1993; Baldwin and Cain, 1997; Leamer, 1998; Haskel and Slaughter, 1999; Harrigan and Balaban, 1999). Many of these used estimating equations derived from general equilibrium models of a Heckscher-Ohlin type. Other recent work relates relative factor shares to outsourcing and other factors (Feenstra and Hanson, 1996; Anderton and Brenton, 1998; Autor *et al.*, 1998), concluding that trade may be more important than earlier analyzes show. Demand side considerations do not appear in this literature.

II Trade and wages in a differentiated goods model

To analyze the relative importance of trade and technology for relative wage changes in the OECD, we use a trade model with differentiated goods, similar to that set out in de Melo and Robinson (1989), and more recently discussed in Bhattarai *et al.* (1999). In this model, imports and domestically produced goods are imperfect rather than perfect substitutes. The model has two traded and two produced goods, but embodies three goods in aggregate when the consumption side is included, since imports are not produced domestically and one of the domestically produced goods is not traded. Imports, the (non-exportable) domestic good and the exportable enter consumption. On the production side, the model has a domestically produced good—which is an imperfect substitute for imports—and an exportable. Each of the produced goods uses two factor inputs: low skill and high skill labor. Imports and exports are traded at fixed world prices.

In this structure, as imports and the domestically produced import substitute become perfect substitutes in preferences, the model will approach the conventional homogeneous goods form, with only two traded and produced goods. The model, therefore, is a generalization of the conventional homogeneous goods trade model, which stands as a special case when the elasticity of substitution in preferences between imports and the domestically produced import substitute is infinity. For finite elasticities, demand side effects from world commodity price changes will occur from substitution in consumption between these two goods.

More formally, denoting imports by *M*, the exportable by *E*, and other domestically produced goods by *D*, preferences are defined as

$$U(M^C, E) \qquad (1)$$

where M^C is a composite function of *M* and *D;* i. e.

$$M^C = C(M, D) \qquad (2)$$

We use Cobb-Douglas and CES functions for *U* and *C*, respectively, in later empirical implementation of the model using UK data.[3]

With *D* and *E* being the two produced goods, and *H* and *L* (high and low skilled labor) the two factor inputs, technology is represented by

[3] Cobb-Douglas and CES are the most widely used functional forms in the numerical simulation literature, and we follow that tradition here. Flexible functional forms, such as translog or generalized Leontief, do not satisfy global concavity conditions and can lead to numerical problems in computation of equilibria, and so are not used here.

$$D^S = D^S (L_D , H_D) \tag{3}$$

$$E^s = E^S (L_E , H_E) , \tag{4}$$

where D^S and E^S represent production of the (imperfect) import substitute domestic good and the exportable, respectively; $L_{D,}$ $L_{E,}$ H_D and $H_{E,}$ denote the use of high and low skilled labor in domestic good and export production. In later empirical implementation of the model, technology is modelled by means of CES production functions.

We assume, for simplicity, that the economy is a taker of prices for exports and imports, $\overline{P}_E , \overline{P}_M$, but that the price of the domestic good, P_D , is endogenously determined. Thus, unlike in a simple homogeneous goods trade model, a product price can vary and adjust to clear the domestic market even in the small country case.

Given the above, the per unit cost functions for the production of E and D, consistent with zero profits, are given by

$$P_D = g_D (W^H , W^L) \tag{5}$$

$$\overline{P}_E = g_E (W^H , W^L) \tag{6}$$

where W^H and W^L are the wage rates of high and low skilled labor, and g_D and g_E are per unit costs functions for D and E.

Full employment conditions for factors yield

$$f^H{}_D \cdot D^S + f^H{}_E \cdot E^S = \overline{H} \tag{7}$$

$$f^L{}_D \cdot D^S + f^L{}_E \cdot E^S = \overline{L} \tag{8}$$

where $f^H{}_D$, $f^H{}_{E,}$ $f^L{}_{D,}$ $f^L{}_E$ are per unit cost minimizing factor demands for H and L in the production of the domestic import substitute and the exportable.

To generate demands, the representative household in this economy maximizes the utility function (1) subject to the budget constraint

$$P_D D + \overline{P}_M M + \overline{P}_E E^D = W^L \overline{L} + W^H \overline{H} \tag{9}$$

where E^D denotes domestic consumption of the exportable.

In equilibrium, the price of the domestically produced good, P_D^*, is determined such that market clearing occurs in D, i.e.

$$D = D^S \tag{10}$$

No market clearing in either E or M is required in this model since these are internationally traded at fixed prices. Walras Law, which automatically holds for economies with demand functions generated from utility maximization subject to a budget constraint, also implies that trade balance will hold in equilibrium, i.e.

$$\overline{P}_M M = \overline{P}_E E \tag{11}$$

where E represents exports.

The feature of this structure that is relevant to the trade and wages debate is that changes in world prices of imports can be partially, or even fully, accommodated by changes in import volumes without necessarily impacting the rest of the economy. Hence, if changes in $\overline{P}_M$ occur but yield offsetting changes in M consistent with the other equilibrium conditions of the model, trade balance will still hold but these price changes will have no impact on domestic production. The domestic output of each product will remain the same, as will the use of factors by sector and relative factor prices, and no impacts on the wages of skilled and unskilled labor will occur from a trade shock. More generally, imperfect pass through of world price changes onto domestic product prices in a heterogeneous goods trade model will tend to lessen the impact of trade on wage inequality.

An outcome in which trade shocks have no impact whatsoever on wage inequality will occur if the elasticity of substitution between *M* and *D* in preferences (equation (2)) is unity, since demand-side substitution effects will fully accommodate to the world price change. If this substitution elasticity is close to one, world price changes affecting low skill intensive goods will still largely be accommodated by the demand side of the model, weakening the role of trade in explaining increased wage inequality compared to the conventional homogeneous goods model.

Empirical studies on Armington and import demand elasticities (e.g., Reinert and Roland-Holst, 1992; Shiells and Reinert, 1993; Marquez, 1994) consistently produce estimates in the neighbourhood of one.[4] The implication is that the role of trade in explaining recent increases in OECD wage inequality will be weakened once demand side considerations are added to conventional trade models and these elasticity estimates are taken into account.

III Some Calculations on the Role of Trade in UK Wage Inequality

We have used the heterogeneous goods model set out above to make trade and wages decomposition calculations using UK data to quantitatively investigate the role of demand-side effects.[5] We use data on production, consumption, and trade for 1990 to represent an

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[4] Demand functions generated by maximizing a CES utility function subject to a budget constraint imply that the own price elasticity of demand approaches the negative of the substitution elasticity as the relevant share parameter approaches zero, and so import demand elasticities and substitution elasticities in preferences are interrelated in this way.

[5] The data we use here draws on Abrego and Whalley (2000), where the application of Heckscher-Ohlin-type models in similar decomposition calculations is discussed.

equilibrium after the increase in wage inequality in the 1980s, and data for 1976 to represent pre-trade and technology change equilibrium. We calibrate the model to these two data sets, and compute counterfactuals for cases where only one of the two shocks (trade or technology) we consider occurs.

The UK data we use show a fall in the relative price of internationally traded unskilled-intensive to skilled-intensive goods of 7.9% over the period 1976-90 (based on information from Neven and Wyplozs (1999), and data on UK imports by country of origin), and a fall in the wage rates of low relative to high skilled workers of 15% over the same period (from UK Office for National Statistics' *Employment Gazette*). Technological change over the period is calculated residually in the decomposition experiments; i.e. determined via calibration such that in combination with the given product price change of -7.9% it produces a decline of 15% in W^L / W^H.

Unlike in the conventional homogeneous model (see, e.g. Leamer, 1998; Krugman 2000), factor-biased technological change can be accommodated by the heterogeneous goods structure used here since the price of the domestic import substitute is endogenously determined. In making our residual calculation, we assume that technological change is biased against unskilled labor.

We consider alternative values for the elasticity of substitution in preferences between the domestic good and imports in the model set out in Section 2 which lie in the interval 0.2 to 20. We initially set the value for the elasticity of substitution between skilled and unskilled labor in production of both goods equal to 1.25. We conduct decomposition experiments by first calibrating the model in the presence of the joint trade and technology shock. We then compute counterfactual equilibria first with only the trade shock present, and subsequently in the presence of the technology shock only. These allow for an assessment of the separate role of trade and technology in contributing to observed changes in wage inequality over the period. The experiments are repeated with different values of the substitution elasticity in preferences, so that in repeated calibrations of the model to the same data, share parameters change as elasticities vary.

In other decomposition experiments, we vary production-side elasticities between 0.5 and 5, and hold the consumption-side elasticity at 1.25. In all these experiments, technological change is obtained residually through calibration, and as parameter values change its size changes. For each model specification we conduct the same experiments of removing the trade and technology shocks between 1976 and 1990 from the model and computing the implied equilibrium wage change.

Results of these computations are presented in Tables 1 and 2. Table 1 presents results for a range of values for the elasticity of substitution in preferences (σ), and a given production-side elasticity (η). For those cases where the elasticity of substitution in preferences is close to unity (consistent with available empirical estimates), the contribution of trade to wage inequality is small. For values of σ equal to one, trade shocks have no impact on wage inequality. For values which are large (20), the impact of trade dominates that of technology.

These effects occur in this model because imports and their domestic counterparts are imperfect substitutes, and changes in relative commodity prices can (depending on σ) be accommodated wholly or partially through changes in consumption rather than production. Indeed, for the contribution of trade to increased inequality to exceed that of technology, high values (of around 17) are needed for the elasticity of substitution in preferences. These are considerably in excess of empirical estimates for import demand elasticities reported in the literature. These results thus suggest that the role of trade in driving increased OECD wage inequality may be even smaller than currently thought.[6]

Table 1
UK Technology-Trade Decompositions for Alternative Values of the Elasticity of Substitution in Preferences (s)*

	s							
	0.2	**0.5**	**1.0**	**2.0**	**5.0**	**10**	**15**	**20**
Percentage of change in W^L / W^H due to technology	102.5	101.5	100.0	97.4	87	70.3	53.9	38.9
Percentage of change in W^L / W^H due to trade	-2.5	-1.5	0.0	2.6	12.9	29.7	46.1	61.1

* Production-side elasticities are held constant across these cases, and set equal to 1.25.

Table 1 also emphasizes that the contribution of trade to wage inequality changes sign as the elasticity of substitution in preferences moves below one. With an elasticity of substitution in preferences of less than one, when the world price of imports falls the resulting increase in the volume of imports is insufficient to offset the price fall. In this case, if trade is to remain balanced, exports—and the production of *E*—must fall. This implies that the production of the import-competing good, *D*, will increase, and since *D* is intensive in L, W^L / W^H increases. In contrast, with a consumption elasticity above one, the trade shock causes the production of *D* to decrease, and W^L / W^H falls.

[6] Studies using models based on a homogeneous goods structure and reporting a relatively small trade contribution to increased wage inequality include Feenstra and Hanson (1999), and Baldwin and Cain (1997) (both for the US). The former provides an estimate of 15% (base specification), while the latter reports a 19% figure for the contribution of trade. These stand in contrast to estimates in Table 1 of around 2% for preference substitution elasticities between 1 and 2.

Less sensitivity occurs in these decompositions as other model parameters change. Table 2 reports results for a second set of decomposition experiments in which we vary production-side elasticities, keeping the demand side elasticity unchanged at 1.25. These results suggest, for a given σ, that the role of trade in accounting for wage inequality grows as the elasticity of substitution between high and low skill labor inputs decreases. The effects are, however, small, but, not surprisingly, confirm that the impact of introducing demand side considerations into trade and wage decompositions will also vary with non-demand side parameter values.

Table 2
UK Technology-Trade Decompositions for Alternative Values of the Elasticity of Substitution in Production (h) and a given value of s *

	h			
	0.5	**1.25**	**2.5**	**5.0**
Percentage of change in W^L / W^H due to technology	98.1	99.2	99.6	99.8
Percentage of change in W^L / W^H due to trade	1.9	0.8	0.4	0.2

* The consumption-side elasticity is held constant, and set equal to 1.25.

IV Conclusions

This paper highlights the absence of demand side considerations in recent literature on the role of trade in explaining recent increases in OECD wage inequality. We emphasize how in a single country heterogeneous goods trade model, demand side substitution effects can wholly or partially absorb trade shocks and insulate the production side of economies, and hence wage rates of high and low skill labor can remain little changed

We present a simple heterogeneous model in which we are able to vary the elasticity of substitution between imports and domestically produced import substitutes. As this elasticity approaches infinity a homogeneous goods trade model is approached. Using this model and UK data, we conduct trade-technology decomposition experiments isolating the separate influences of trade and technology on inequality. Our results show little role for trade when elasticities are in the neighbourhood of one, and a more prominent role under larger elasticities. Given literature estimates of trade elasticities in the neighbourhood of one, we conclude that demand side considerations will tend to further dampen the perceived role of trade in explaining recent increases in OECD wage inequality relative to current literature.

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