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# ABSTRACT

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JEL Classification: H32 and P16
Keywords: anti-variety effect, heterogeneous firms, Krugman variety effect and trade liberalization

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# Trade liberalisation with heterogeneous firms

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*August 2004 (first Draft May 2004)*

**Abstract**

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## 1. INTRODUCTION

Empirical work over the past decade shows that the standard new trade theory assumption of identical firms glosses over many important aspects of reality. See Tybout 2001 for a survey and Eaton and Kortum (2002), Bernard, Eaton, Jensen and Kortum (2003), and Bernard, Jensen, and Schott (2004), Helpman, Melitz and Yeaple (2004) for more recent work.

This empirical evidence has lead to the development of what might be called the new new trade theory, that is to say new trade models modified to allow for a more sophisticated view of firms. One branch of this theory that has been particularly successful in accounting for the new empirical findings was started by Melitz (2003); Bernard, Eaton, Jensen and Kortum (2003) also present an early model.

In this paper we examine the various aspects of trade liberalisation with heterogeneous firms using the Melitz model. Although some papers have looked at a number of aspects of trade liberalisation in the Melitz model, we are not aware of a paper that systematically studies the positive and normative aspects. We find a number of novel results and effects including a Stolper-Samuelson like result and what might be called an anti-variety effect (it works opposite to the standard gains from trade due to variety expansion). Interestingly this last effect resonates with often voiced criticism from antiglobalists that globalisation leads the world to become more homogenous by eliminating local specialities. We note, however, that despite this anti-variety effect, we find that trade liberalisation always leads to welfare gains.

The rest of the paper is organised in four sections. The next, Section 2, presents a slightly modified version of the Melitz (2003) model. Section 3 studies the positive effects of two types

of trade liberalisation – the standard reduction in the marginal cost of trading goods and the reduction of fixed market-entry costs implied by so-called technical barriers to trade. The fourth section presents our welfare decomposition and the final section concludes.

# 2. THE BASIC MODEL

This section introduces a slight variant of Melitz (2003) that is in the spirit of Helpman, Melitz and Yeaple (2004).

## *2.1. A slightly modified Melitz model*

Consider a world with two symmetric countries (Home and Foreign) each of which uses a single factor of production (labour L) to produce goods in two sectors (T-sector and M sector). The traditional sector, T-sector for short, is a Walrasian, homogenous-goods sector with costless trade. The M sector (manufactures) is marked by increasing returns, Dixit-Stiglitz monopolistic competition and iceberg trade costs $\tau \geq 1$. Home M-sector firms face constant marginal production costs and three types of fixed costs. The first fixed cost, $f_I$, is the standard Dixit-Stiglitz cost of developing a new variety (I is a mnemonic for innovation). The second and third fixed costs are what have been called 'beachhead' costs since they reflect the one-time expense of introducing a new variety into a market in a market (i.e. establishing a beachhead).[1] Specifically, the cost of introducing a new variety into a market is $f_X$ for the export market and $f_D$ for the domestic market.

Consumers in each nation have two-tier utility functions with the upper tier (Cobb-Douglas) determining the consumer's division of expenditure among the sectors and the second tier (CES) dictating the consumer's preferences over the various differentiated varieties within the M-sector.

The Melitz model allows for heterogeneous productivity levels among M-sector firms. These differences stems from randomness in the variety-innovation process in the sense that while development of a new variety always requires $f_I$ units of labour, the unit labour requirement associated with the new variety is randomly drawn from a probability distribution. The assumed distribution is part of the economic fundamentals of the model and can be thought of as part of the innovation technology. To keep the reasoning concrete, we assume a Pareto distribution, namely:

**(1)** $$g[a] = \rho \frac{a^{\rho-1}}{a_0^{\rho}}, \qquad 0 \leq a \leq a_0, \quad \rho > 0$$

where 'a' is the variety-specific unit labour requirement and $a_0$ and $\rho$ are the 'scale' and 'shape' parameters, respectively. Without loss of generality, we choose units of M-goods such that $a_0=1$.

Melitz (2003) assumes that the three fixed costs are quite different in nature. He assumes that the invention cost $f_I$ is a one-time, sunk cost paid just before production begins, and that the export market-entry cost $f_X$ is also sunk. The market-entry cost in the local market, however, must be incurred each period. To simplify calculations, we assume that all three fixed costs are sunk. Reflecting informational asymmetries or protectionism, we assume that $f_X > f_D$.

[1] See Baldwin (1988), Baldwin and Krugman (1989), and Dixit (1988).

We follow Melitz (2003) in ignore discounting and assuming that firms 'die' according to a Poisson process with a hazard rate of δ.[2] We also follow Melitz (2003) in focusing only on steady states. Because the expected life of a variety is 1/δ, it proves convenient to work with the flow-equivalent of the sunk costs:

$$F_I \equiv \delta f_I, \qquad F_D \equiv \delta f_D, \qquad F_X \equiv \delta f_X$$

## *2.2. The equilibrium*

A major accomplishment of Melitz (2003) is to endogenise the distribution of a's among active firms, but we start the analysis taking the mass of firms and the distribution of a's as given.

### 2.2.1. Short-run analysis

As is well-known, constant returns, perfect competition and zero trade costs equalises wages in the two nations. With proper choice of units and numeraire, we have:

$$p_T = w = w^* = 1$$

at all levels of openness, where $p_T$ is the price of the traditional good. With nominal wages pinned down at unity, we can refer to the M-sector unit input coefficients as the firm-specific 'marginal cost'.

Utility maximisation generates the familiar CES demand functions.[3] These, together with the standard Dixit-Stiglitz monopolistic competition results, imply that a local firm charges a local consumer price, *p* equal to *a/(1-1/σ)*, where 'a' is its firm-specific marginal cost. Firms that are active in their export market charge a consumer price of *τp*. Defining 'operating profit' as profit ignoring all fixed costs, profit earned by a typical firm in a typical market is 1/σ times its revenue in that market.[4] Thus:

**(2)** $$\pi_D[a] = \frac{s[a]E}{\sigma}, \quad \pi_X[a] = \frac{s[\tau a]E}{\sigma}; \qquad s[a] \equiv \frac{p^{1-\sigma}}{n\Delta}$$

Here the $\pi_i[a]$'s are the market-specific operating profit functions (i=D for local sales and i=X for export sales), the function s[·] is the standard Dixit-Stiglitz market share function where Δ is defined as $\Delta \equiv P_X^{1-\sigma}/n$ where $P_X$ is the standard CES price index for all consumed varieties, n is the mass of active firms per nation, and σ is the constant elasticity of substitution among M-varieties. E is total expenditure on M-varieties. By symmetry, Home and Foreign E's and Δ's are identical.

By the usual logic of fixed costs and the proportionality between efficiency and operating profit in (2), only firms with sufficiently low marginal costs will be able to sell enough to cover fixed costs (see Melitz 2003 for a proof). Firms with very low marginal costs will find it worth paying both $F_D$ and $F_X$; we call these X-type firms. Firms with intermediate marginal costs will find it worth paying $F_D$, but not $F_X$; we call these D-type firms. Varieties associated with very high marginal costs will not be able to cover even $F_D$ and so will never produce; we call these N-types (non-producers).

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[2] Either discounting or δ>0 are necessary to keep expected values of firms' operating profits finite.

[3] Demand for a typical variety j is $c(j)=p(j)^{-\sigma}E/\int p(i)^{1-\sigma}di$ where the integral is over all available varieties and E is expenditure on all M-sector varieties.

[4] A typical first order condition is $p(1-1/\sigma)=wa$; rearranging, the operating profit, (p-wa)c, equals $pc/\sigma$.

The three ranges of marginal costs corresponding to the three types of firms are defined by two cut-off conditions, namely:

**(3)** $$\pi_D[a_D] = F_D, \quad \pi_X[a_X] = F_X$$

where we define the cut-off level between N- and D-types as $a_D$, and the cut-off between D- and X-types as $a_X$. Using these cut-off levels of marginal cost, we have:

$$\Delta = \left( \int_0^{a_D} a^{1-\sigma} f[a]da + \phi \int_0^{a_X} a^{1-\sigma} f[a]da \right) (1 - \frac{1}{\sigma})^{\sigma-1}; \qquad \phi \equiv \tau^{1-\sigma}$$

where f[a] is the probability distribution function for the 'a' among active firms, and $\phi$ is a measure of trade freeness ($\phi \equiv \tau^{1-\sigma}$ ranges from zero with infinite trade costs to unity when trade is perfectly free).

Taking ratios of the two cut-off conditions in (3), we have:

**(4)** $$\frac{a_X}{a_D} = \left(\frac{\phi}{F_X / F_D}\right)^{\frac{1}{\sigma-1}}$$

Using this and assuming the regularity condition, $1-\sigma+\rho>0$, so the integrals in $\Delta$ converge, we have:

**(5)** $$\Delta = \frac{\beta}{\beta - 1} a_D^{1-\sigma} (1 + \Omega)(1 - \frac{1}{\sigma})^{\sigma-1}; \qquad 0 \geq \Omega \equiv \phi^{\beta} (\frac{F_X}{F_D})^{1-\beta} \geq 0, \quad \beta \equiv \frac{\rho}{\sigma - 1} > 1$$

Here $\Omega$ – a mnemonic for openness – is bounded between zero and unity, with openness rising from perfectly closed ($\Omega=0$) to perfectly open ($\Omega=1$). Note that we have used the fact that the distribution of marginal costs among active firms is Pareto with a shape parameter of $\rho$ and a scale parameter of $a_D$ (see Melitz 2003 for a proof).[5] Observe that $\beta$ is the shape parameter for the distribution of market shares among firm and thus is, in some sense, the parameter that is traditionally measured in the firm-size distribution literature. Note that $\Delta$ is identical to Melitz's measure of average productivity, what he calls $\tilde{\varphi}$.

### 2.2.2. Long-run equilibrium conditions

In the long run, the number of produced varieties adjusts to eliminate expected pure profit. Given (3) and the law of large numbers, the three types of varieties appear in constant proportions.[6] The fraction of N-types is $1-G[a_D]$, where $G[\cdot]$ is the cumulative density function corresponding to probability function in (1).[7] The fractions of X-type and D-types are $G[a_X]$ and $G[a_D]-G[a_X]$, respectively. Given the frequency of the three types, the condition for zero expected profit in innovation is:

**(6)** $$\left( \frac{E}{n\sigma} - \overline{F} \right) = 0; \qquad \overline{F} \equiv F_D + \frac{G[a_X]F_X}{G[a_D]} + \frac{F_I}{G[a_D]}$$

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[5] The fractals nature of the Pareto distribution implies any lower tail of the Pareto distribution is also Pareto with the same shape parameter but a different scale parameter. Obviously, this would not be true of all two parameter distributions, for example, the normal distribution.

[6] With a continuum of varieties, an uncountable infinity of varieties are created every instant to replace the dying firms, so the Central Limit theorem tells us that there is no aggregate uncertainty.

[7] Specifically, $G[a]=a^{\rho}$, given our normalization of $a_0$.

where the first term in parentheses is the ex ante expected profit on a 'winning' variety, and $\overline{F}$ is the expected fixed cost of a 'winner'.[8] $\overline{F}$ consists of $F_D$ (for all winners) plus $F_X$ times the probability of an X-type (conditional on it being a winner) plus the expected development cost of getting a winner, which is $F_I$ times $1/G[a_D]$. Free entry drives pure profit to zero as indicated.

With expected pure profit eliminated in equilibrium, total M-sector expenditure is:

**(7)** $$E = \mu L$$

where L is a the typical nation's labour endowment and μ is the Cobb-Douglas spending share on manufactures (see Melitz 2003 for a proof).

### 2.2.3. Long-run solutions

The cut-off conditions are defined by profit maximising behaviour of individual M-firms, but the number of active firms rises to eliminate expected pure profit. Thus the long-run equilibrium is defined by the two cut-offs and the mass of active firms ($a_D$, $a_X$ and n).

Given (5) and (7), we can solve $\pi_D=F_D$ for the mass of active firms to get:

**(8)** $$n = \frac{\mu L(\beta-1)}{\beta\sigma F_D}\left(\frac{1}{1+\Omega}\right)$$

From this, $E/\sigma n$ equals $\beta F_D(1+\Omega)/(\beta-1)$. Given that $G[a_X]/G[a_D]$ equals $(a_X/a_D)^\rho$, and $G[a_D]=(a_D)^\rho$, we can use (4) to solve the zero profit condition **(6)** for $a_D$. We get:

**(9)** $$a_D = \left(\frac{(\beta-1)(F_I/F_D)}{1+\Omega}\right)^{\frac{1}{\rho}}$$

Using (4) once again, we get:

**(10)** $$a_X = \left(\frac{\Omega(\beta-1)F_I}{(1+\Omega)F_X}\right)^{\frac{1}{\rho}}$$

Defining $n_C$ as the number of varieties consumed in an typical nation, $n_C$ equals $n(1+n_X/n)$ where $n_X$ is the mass of a typical nation's exported varieties. Noting from (1) that $n_X/n=(a_X/a_D)^\rho$ and using (4) and (8), we have:

**(11)** $$n_C = \frac{\mu L(\beta-1)}{\sigma F_X \beta}\left(\frac{T+\Omega}{1+\Omega}\right),$$

where $T\equiv F_X/F_D$.

## 3. POSITIVE EFFECTS OF LIBERALISATION

There are two natural definitions of trade liberalisation in this model, one concerns the variable cost of trade ϕ and the other concerns the differential beachhead cost for local and imported

[8] Total operating profit per nation is $E/\sigma$, so the expected operating profit per firm, before 'a' is known, is $E/\sigma n$.

varieties $F_X/F_D$. We start with the classical notion of liberalisation as freer trade flows, i.e. raising $\phi$.

## *3.1. Lower marginal cost of trade*

As can easily be seen from **(8)** and (9), freer trade lowers $a_D$ and raises $a_X$ (Melitz 2003). When trade is at zero freeness (i.e. infinite trade costs) $a_X=0$, i.e. even a firm with zero marginal cost cannot export. Greater openness lifts $a_X$ while lowering $a_D$, but the two do not meet even when trade is costless (i.e. $\phi=1$), as long as $F_X>F_D$.

In words, these results mean that freer trade lowers the maximum marginal cost of active firms and raises the maximum marginal cost of exporting firms. The two cut-off marginal costs meet when trade is costless, only if there is no regulatory protection, i.e. $F_X=F_D$. In the focal case where $F_X>F_D$, not all varieties are exported (i.e. $a_D>a_X$) even when trade is costless.

Turning to the mass of varieties, inspection of **(8)** shows that freer trade lowers the number of varieties produced in each nation (Melitz 2003). Specifically, the proportional change in n with respect to a proportional change in trade freeness is:

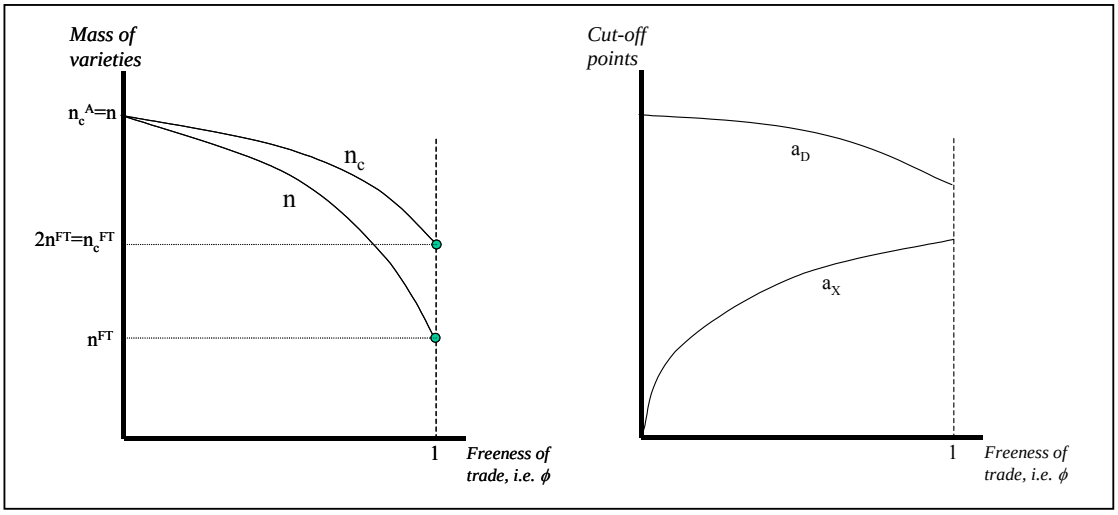
$$\hat{n} = -\beta \frac{\Omega}{1+\Omega}\hat{\phi}$$

where we have used the standard 'hat' notation for proportional changes (e.g. $\hat{x}$ equals dx/x), and $\Omega/(1+\Omega)$ is the import share (i.e. expenditure share on all imported varieties in a typical market).[9] Since the import share rises with openness, this expression tells us that the proportional decline in 'n' is magnified, as trade gets progressively freer.

### *Openness and the number of consumed varieties*

The impact on the range of varieties available to a typical consumer could be ambiguous, in principle (Melitz 2003). Greater openness raises $a_X$ and thus raises the fraction of Foreign-made varieties that are imported to Home so the rise in imported varieties could more than offset the drop in locally produced varieties. In the model at hand, however, the number of varieties bought by a typical consumer falls monotonically as the freeness of trade rises – as long as $T\equiv F_X/F_D>1$. Thus, lower variable cost of trade will produce an 'anti-variety' effect, i.e. the range of consumed varieties falls as trade gets freer.

**Figure 1: Varieties produced and consumed and cut-off points**




using **(5)**,

The basic intuition for this result flows most easily by first examining the knife-edge case of no regulator protection, i.e. $F_X/F_D=1$, as inspection of (11) shows, the number of varieties consumed is constant with respect to $\phi$. If there is no intrinsic difference between local and imported varieties, changes such as trade liberalisation that introduce more imported varieties will produce a one-for-one reduction in local varieties.

More generally, when the ratio of beachhead costs $F_X/F_D$ exceeds unity, $n_C$ falls as $\phi$ rises because imported varieties have systematically lower prices than the domestic varieties they displace. Restoring zero profits thus requires more than one D-type variety to be displaced by each extra X-type variety is imported. Conversely, if the beachhead costs are lower for imported varieties, the relationship is reversed and freer trade means a wider range of varieties available to consumers. To summarise these results, we write:

**Result 1: Raising the freeness of trade unambiguously lowers the range of varieties produced in each nation (Melitz 2003). The range of varieties consumed in each nation falls with openness as long as the beachhead costs for imported varieties exceeds the beachhead costs for local varieties. If the two costs are equal, there is no change in $n_C$ and if $F_D>F_X$, the range of varieties consumed increases.**

These results are illustrated in Figure 1.

### *Openness and productivity*

We turn next to the productivity effects of liberalisation. Melitz (2003) shows that liberalisation has a strong impact on the average productivity of an industry via selection effects (lowering the lowest viable input coefficient) and production reallocation effects (reallocating production shares from the least efficient to the most efficient firms). Or, to use a sports analogy, the batting average rises since freer trade eliminates the worst batters and gives the best batters more swings.

To illustrate this, we define average productivity measure as $A\equiv n\Delta$, which, using **(5)**,**(8)** and (9) is:

$$\textbf{(12)} \qquad A=\frac{\mu L}{\sigma}\left(\frac{1+\Omega}{{F_D}^{\beta-1}F_I(\beta-1)}\right)^{1/\beta}(1-1/\sigma)^{\sigma-1}$$

This is plainly increasing in openness, i.e. A rises with $\Omega$. To show the two-part decomposition of the overall gain, we note that the unweighted average input coefficient – defined as 'a' times f[a] integrated from a=0 to $a_D$ – equals $\rho a_D/(1+\rho)$. Since freer trade lowers $a_D$, we know that it tends to improve productivity via selection. To show the production-share-reallocation part, we use **(4)** and the first expression for market shares in (2) and the D-versus-X-type cut-off to write the production shares of typical D-type and X-type firms as, respectively:

$$\textbf{(13)} \qquad \frac{a^{1-\sigma}}{\mu L/\sigma}\left(\frac{{F_D}^{\beta-1}F_I(\beta-1)}{1+\Omega}\right)^{1/\beta}; \qquad (1+\phi)\frac{a^{1-\sigma}}{\mu L/\sigma}\left(\frac{{F_D}^{\beta-1}F_I(\beta-1)}{1+\Omega}\right)^{1/\beta}$$

where the 'a' is the marginal cost of the D- or X-type firm under consideration (these share are only defined over the relevant ranges of a's). By inspection of (13), we see that greater openness (i.e. higher $\Omega$) lowers the market share of all D-type firms. The change in an X-type's production share is equally easy to see. The proportional change in this share with respect to a proportional change in $\phi$ is $[\Omega/(1+\Omega)(1+\phi)]$ times $\phi/\Omega$ minus 1. Thus X-types' production shares rise with $\phi$ as long as $\phi>\Omega$. This is always true as long as $F_X>F_D$.

### 3.1.1. Stopler-Samuelson result

Income distribution effects can also be easily worked out. Indeed, this model displays classic Stolper-Samuelson-like behaviour.

There is only one primary factor in this model, however we can think of the owners of M-firms as owning 'knowledge capital'. In particular, we can think of there as three types of capital in this model: D-type capital, X-type capital and N-type capital, where the reward to D-type and X-type capital are the operating profit on D-type and X-type firms, respectively. Recall that although the average reward to capital must be zero (zero profit condition), this average consists of pure losses for some balanced by pure profits for others; D-type and X-type firm owners earn pure profits while drawers of 'losing' varieties earn the flow equivalent of minus $F_I$.

Of the three 'factors', labour is the simplest to deal with. Labour is numeraire so freer trade has no impact on the wage. The impact on the rental rates of D-type and X-type capital are also as simple to derive. As noted above, a firm's total operating profit is proportional to its revenue. Given that total revenue in each market is always L, firms' revenue is proportional to their production shares. Using the share analysis based on **(13)** and defining $r_D$ and $r_X$ as the operating profit flow of typical D and X type firms:

$$\frac{\hat{r}_D}{\hat{\phi}} = \frac{-\Omega}{1+\Omega} \leq 0, \qquad \frac{\hat{r}_X}{\hat{\phi}} = \frac{\Omega}{(1+\phi)(1+\Omega)}\left(\frac{\phi}{\Omega} - 1\right) \geq 0$$

This gives us a Stolper-Samuelson chain:

**(14)**
$$\frac{\hat{r}_D}{\hat{\phi}} < 0 = \frac{\hat{w}}{\hat{\phi}} < \frac{\hat{r}_X}{\hat{\phi}}$$

Note that the Stolper-Samuelson inequalities hold as long as $F_X/F_D>\phi$, which is necessarily the case when $F_X>F_D$.

An interesting implication of (14) when combined with the fact that rental rates are inversely proportional to a's is that the income distribution among active-firm owners follows a fractals-like pattern. That is, capital rental rates will follow a Pareto distribution with the shape parameter $\rho+1-\sigma$. Thus, if, for example, y% the gains from liberalisation accrue to the top x% of the income distribution, then the same is true of the top x% of the top x%. This fractal-like income distribution has received some empirical support from income distribution studies. To summarise:

**Result 2: Freer trade widens the factor-income distribution in the sense that it widens the gap between wage and the average pure profit earned by active firms. It also widens the income gap between X-type firm-owners and D-type firm-owners since it raises $r_X$ and lowers $r_D$. Finally, the distribution of profits among the winners, namely the X-type firm-owners, follows a fractal-like pattern, with most of the gain accruing to the firm-owners that earn the highest profit initially.**

**Result 3: The model is marked by a standard Stolper-Samuelson inequality chain with some reinterpretation. We interpret the claims to D-type and X-type varieties as D-type and X-type capital respectively. Noting that D-type varieties are import competitors while X-type varieties are net exporters, we find that the factor used intensively in exporting (X-type capital) gains absolutely while the import-competing factor loses absolutely. Labour is used intensively in a sector without net trade and its reward is unaffected by liberalisation.**

## *3.2. Lower regulatory protection*

The classic notion of liberalisation is a lowering of marginal trading costs, however many of the trade barriers remaining among industrialised nations are related to standards and regulation that make it difficult to introduce foreign-produced varieties into a market. These barriers, called technical barriers to trade TBTs in WTO circles, are some of the few remaining barriers to trade in manufactures among the US, Canada, the EU and Japan. Moreover, since classic trade barriers were eliminated in Western Europe by the mid-1970s, the last four decades of trade liberalisation in Western European nations has been mainly concerned with TBTs. This suggests that it is important to analyse the positive and normative implications of lowering the gap between the beachhead cost facing local and imported varieties. In particular, in this section we assume that these regulatory barriers are reflected in the beachhead costs and that this explains why $F_X > F_D$, so liberalisation involves a moving $F_X/F_D$ towards unity.

To date, TBTs have been liberalised in three main ways (Baldwin 2000), hegemonic harmonisation, internationalisation of standards, and mutual recognition. The first two are when two nations adopt common standards as a way for reducing the beachhead costs. In the first, a leader – the EU in Europe and the US in the Western Hemisphere – sets standards unilaterally and other nations follow. In the second, experts from several nations negotiate a common standard in international standards bodies like the International Standards Organisation. The third liberalisation route is to sign mutual recognition agreements, MRAs. Here nations recognise the content of each others' standards subject to minimum harmonisation, as in the EU's Single Market programme, or the recognise the right of each others' testing laboratories to certify product compliance, as in the EU-US MRA signed in 1998.

It is important to note that our measure of TBTs, $T \equiv F_X/F_D$, as well as $\phi$ always enter the expressions for n, $a_D$ and $a_X$ together, so that the impact of liberalisation of either type affects these three variables in the same direction. Since liberalising T and $\phi$ affect the three critical variables in the same direction, the impact on the variables that were the subject of Results 1 to 3 are identical when liberalisation is defined as a decrease in T. Thus greater regulatory openness affects the cut-offs, mass of varieties produced and consumers and the average productivity in the same direction as greater trade free does.

The first main difference is when $\phi$ appears independently as in the case of D-type and X-firm profits. Recall that a firm's operating profit is proportional to its revenue, which is in turn proportional to its production share. Noting that $\Omega \equiv \phi^{\beta} T^{1-\beta}$, inspection of **(13)** reveals that T enters $r_D$ and $r_X$ in the same way, so greater regulatory liberalisation reduces both operating profits by the same proportion. Thus

**Result 4: Regulatory liberalisation, defined as a lowering of $F_X/F_D$, lowers the reward to both D-type and X-type capital without altering the wage.**

The intuition for this result is clear. The beachhead costs create barriers to enter that must, in equilibrium, be compensated for by higher operating profits. Lowering the beachhead costs thus lowers flow reward to active firms.

The second main difference between the liberalisation of beachhead costs and the liberalisation of marginal trade costs concerns the number of varieties consumed, $n_C$. By inspection of (11) a reduction in $F_X$ will, all else equal, raise the number of varieties consumed.

# 4. WELFARE DECOMPOSITION

Given the assumed preferences, the indirect utility function of a consumer with expenditure $E_i$ is $U_i = E_i/P$, where:

$$\begin{aligned} P = \quad & p_A^{1-\mu}\left( n\left(\int_0^{a_D} a^{1-\sigma} f(a)da + \phi\int_0^{a_X} a^{1-\sigma} f(a)da\right)\right)^{\frac{\mu}{1-\sigma}} \\ & = (n_C\, A)^{\frac{\mu}{1-\sigma}}\left(\frac{\beta}{\beta-1}\left(\frac{n}{n_C}s_D + \frac{n_X}{n_C}s_X\right)\right)^{\frac{\mu}{1-\sigma}}; \qquad A \equiv n\Delta \end{aligned} \tag{15}$$

where we used (1) to solve the integral, and $s_D$ and $s_X$ denote $s[a_D]$ and $s[a_X]$ where $s[\cdot]$ is defined in (2). Note that $n/n_C + n_X/n_C = 1$, and $(s_D n/n_C + s_X n_X/n_C)\beta/(\beta-1) = 1/n_C$.

It proves useful to note several features of the second expression for the price index in **(15)**. First, recall that A is a measure of productivity. Second, observe that the first term inside the large parentheses equals $S/n_C$, where S is the expenditure share on all local varieties; the second term is $(1-S)/n_C$, where 1-S is the expenditure share on imported varieties.[10] This reduces to $1/n_C$, but intuition is served by decomposing the total impact on into various ceteris paribus effects.

## *4.1. Welfare effects operating via the price index*

To build intuition on the welfare effects of liberalisation in this model, it proves useful to first focus on effects that operate via the ideal price index, P. These apply to all consumers regardless of the factor endowment. To this end we log differentiate U, holding $E_i$ constant, to get:

$$\begin{aligned} \hat{U}\Big|_{dE_i=0} = \quad & \left(\frac{\mu}{\sigma-1}\right)\{\hat{n}_C\} \quad + \quad \left(\frac{\mu}{\sigma-1}\right)\{\hat{A}\} \\ & + \quad \left(\frac{\mu}{\sigma-1}\right)\left\{\frac{n}{n_C}(s_D - s_X)(\hat{n} - \hat{n}_C)\right\} + \left(\frac{\mu}{\sigma-1}\right)\{\hat{s}_D S + \hat{s}_X(1-S)\} \end{aligned} \tag{16}$$

where S is defined as $ns_D/(ns_D + n_X s_X)$. Written in this way, we can decompose the complex effects of liberalisation into four *ceteris paribus* effects. We call the first term in curly brackets, the:

■ **Melitz anti-variety effect**. The total mass of varieties available for consumption in a typical nation falls as trade gets freer (see Result 1). The ceteris paribus welfare impact of this is unambiguously negative. This Melitz variety effect contrasts sharply with the Krugman variety effect; in the Krugman model, freer trade doubles the number of varieties available to consumers when $\phi$ moves from zero to a positive number, but gradual liberalisation has no further impact on $n_C$.

The second term can be called the:

■ **Productivity effect**. Melitz (2003) shows that liberalisation strongly boosts average productivity. As shown above, freer trade unambiguously and monotonically raises A. As far as welfare is concerned this provides an unambiguous improvement.

The next effect is also novel to the Melitz model. The popular press often condemns one effect of freer trade, namely the way in which imported varieties drive out locally produced varieties. For

[10] A locally produced variety's share is $a^{1-\sigma}/\Delta$, so $S \equiv (n\rho/a_D^{-\rho})\int a^{1-\sigma}a^{\rho-1}/\Delta da$, which solves to $\lambda n s_D$.

example, the way in which traditional snack food varieties – think of chips and vinegar wrapped in a newspaper – are pushed out by big international brands – think of MacDonalds. Our decomposition of effects allows us to consider explicitly this substitution of imported varieties for local varieties, what we call the:

■ **MacDonaldisation effect**. As Result 1 shows, freer trade reduces the range of locally produced varieties, n, and the range of all varieties consumed, $n_C$, but the former falls faster than the later so the share of imported varieties in the typical consumption basket rises. The third curly bracketed term captures the welfare implications of shift between local and imported varieties, holding all else constant (in particular, A and the shares $s_D$ and $s_X$). We know that $s_D$-$s_X$ is negative, as long as $F_X$>$F_D$, and from Result 1, we know that $\hat{n}$ minus $\hat{n}_C$ is negative. Thus the pure substitution of imported for local varieties is unambiguous welfare improving, despite the fact that many decry the disappearance of traditional varieties. The intuition for this is easy.

As far as consumers are concerned, there is no distortion in the choice among varieties, so the fact that freer trade pushes out local varieties must reflect a welfare improving choice of consumers (imported varieties are cheaper). Of course, if one supposed that there is some intrinsic cultural or nationalist value to the availability of traditional varieties, this unambiguous impact on individual welfare might be mitigated or reversed in a social welfare evaluation. Indeed, many nations spend taxpayer's money on keeping old ways and goods alive. It would be trivial to capture this notion by extending the decomposition to allow for an additive social welfare term on $n_C$.

The fourth term reflects the other part of the local-versus-imported variety shift. As trade gets freer, the share of spending on local varieties falls and that on imported varieties rises, where the local-variety spending share is proportional to S. Performing the ceteris paribus exercise of allowing these shares to change without altering the $n/n_C$ ratio, we get the fourth term, which we call the:

■ **Share-shifting effect**. The first and second terms inside the fourth curly bracketed term are negative and positive, respectively – see (13). Since S>(1-S) for all level of openness, as long as $F_X$>$F_D$, the share-shifting effect is negative. We can also see this from the fact that the term inside the large parentheses in (14) simplifies to $1/n_C$, so the total derivative of this with respect to $\phi$ must be negative. Since the McDonaldisation effect is unambiguously positive, the share-shifting effect must be unambiguously negative.

### 4.1.1. Overall welfare impact of freer trade

By definition of A, we know that the overall price index P equals $A^{\mu/(1-\sigma)}$, so the openness and productivity results from above tells us that the overall impact of freer trade is unambiguously positive. In other words, considering all the ceteris paribus effects together, we know that the positive welfare impacts of greater productivity and McDonaldisation outweigh the loss of consumption variety and share-shifting.

**Result 5: Freer trade lowers the ideal price index (Melitz 2003).**

## *4.2. Welfare effects operating via expenditure*

Freer trade's welfare effects that operate via expenditure are much simpler to characterise given our Stolper-Samuelson chain (see Result 3). Categorising consumers into four classes according

to the factor ownership, we have labourers, D-type firm owners, X-type firm owners, and non-producing-variety firm owners. To summarise, we write:

**Result 6: Free trade has no ceteris paribus impact on the welfare of labourers and non-producing-variety firm owners (see Result 3). X-type firm owners gain and D-type owners lose.**

### *4.3. Total welfare effects by class*

Consider next the overall impact on welfare. Given Result 5 and Result 6, we know labourers and non-producing-variety firm owners gain unambiguously from trade since they see no change in their nominal income and a drop in the cost of their consumption basket. Likewise, the result for X-type firm owners is trivial. They gain both the income and price index sides. The result for D-type owners is almost as easy. Their nominal income is proportional to $a^{1-\sigma}/A$ (for $a \leq a_D$), and $P=A^{\mu/(1-\sigma)}$, so their welfare index is $a^{1-\sigma}A^{\mu/(\sigma-1)-1}$. Because freer trade raises A, D-type firm owners gain if and only if $\mu/(\sigma-1)$ exceeds 1. To summarise:

**Result 7: Freer trade implies unambiguous welfare gains for labourers, non-producing-variety firm owners, and X-type firm owners. D-type owners gain if and only if spending on manufactured varieties is sufficiently high, namely $\mu$ exceeds $\sigma-1$. In the likely case that $\sigma>2$, then D-type firm owners unambiguously lose from freer trade.**

## 5. CONCLUSION

This paper details the positive and normative effects of reciprocal trade liberalisation in a model where firms are heterogeneous. We demonstrate that liberalisation of marginal trade barriers and fixed costs trade barriers (technical barriers to trade) leads to what might be called an anti-variety effect in that liberalisation lowers the number of varieties consumed. This is in stark contrast to the well-known Krugman variety effect. We also show that liberalisation produces a Stolper-Samuelson like result. Agents that own an active variety can be thought of as owning capital. There is only one primary factor (labour) but two types of capital in the model – claims to D-type varieties (import competitors) and claims to X-type varieties (exporters). The Stolper-Samuelson result is that the factor used intensively in exporting (X-type capital) gains from liberalisation while the import-competing factor loses. Labour is used intensively in a sector without net trade (traditional sector) and its reward is unaffected by liberalisation.

We also provide a decomposition of the total welfare impact, highlighting four partial effects. Three of these are unique to the model, namely, the Melitz anti-variety effect, the Melitz productivity effect, and the MacDonalisation effect. We show that the first effect tends to lower welfare while the other two tend to raise it. Overall, the four effects imply that the representative gains from trade liberalisation. If we identify factor ownership with particular classes of consumers, we can say that freer trade implies unambiguous welfare gains for labourers and X-type firm owners. D-type owners gain if and only if spending on manufactured varieties is sufficiently high.

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