

# Good Jobs, Bad Jobs, and Trade Liberalization

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## Abstract

This paper merges the Melitz (2003) model with a heterogeneous firm variant of the Shapiro-Stiglitz (1977) model of efficiency wages. The combined model features involuntary unemployment and heterogeneous wages for homogeneous labor. The selection effects of trade liberalization operate, as in Melitz, according to firm marginal cost. But these marginal costs now reflect both variation in marginal physical productivity and firm-specific efficiency wages. For this reason, firms vulnerable under trade liberalization are those where the firm wage is high relative to firm productivity, and this may include both high and low wage jobs, or what workers may perceive as “good” or “bad” jobs. The labor rents associated with “good” jobs distort producer output decisions and tend to raise aggregate unemployment. The firm exit decision effectively treats the wage received by labor as an externality, since exit is driven by high marginal costs, whether due to low physical productivity or high wages. The merged model provides a convenient framework for articulating the efficiency enhancing effects of trade, even as it makes sense of claims that trade may threaten (some) good jobs at good wages.

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# Good Jobs, Bad Jobs, and Trade Liberalization

## I. Introduction

Treasury Secretary Henry M. Paulson, Jr., speaking in March 2007, cited a Pew Research Center survey to the effect that “more and more Americans seem to doubt that trade brings greater benefits than costs.” While the public in the survey was roughly evenly split on the overall benefits of freer trade, among those stating an opinion there was an overwhelming sentiment that trade costs jobs and lowers wages.

While the public expresses a marked view that trade liberalization threatens good jobs at good wages, the precise meaning of a “good job” is open to interpretation. High or growing productivity; security; good working conditions; or high pay.

Insofar as these are simply reflections of firm or worker characteristics, it is unclear why trade liberalization should pose a threat. Even if new competition due to liberalization should raise competitive pressures that might reduce shared firm or worker rents, it is not clear why this should result in job losses before the rents are fully eroded.

The Melitz model of firm heterogeneity provides a particularly appealing setting to explore these issues. *Ex ante* investments under uncertainty create *ex post* rents for surviving firms. Because more productive firms earn greater *ex post* rents, this provides a natural reason why in simple models of rent sharing workers at more productive firms may earn higher wages. An example is the fair wage model of Eggert and Kreickemeier (2006). However, in these models, while jobs may come under threat, it is only the worst jobs with the lowest wages.

One reason wage heterogeneity may arise is simply heterogeneity in the productivity of workers themselves. This is the case, for example, in Yeaple (200x), where the firms are identical and *ex post* differences reflect only the underlying differences in the workers they employ. This heterogeneity of worker productivity is undoubtedly important in practice, but not the focus of the present study.

There is no reason that worker or firm *productivity* need be the *only* influence on the wages of workers. Factors extrinsic to productivity *per se* but intrinsic to the particular firm or workforce characteristics may also affect wages. Ben and Jerry’s Ice Cream, with a “socially aware” reputation, may find it harder to squeeze labor in a way that may differ even from another premium ice cream firm. If labor unrest depends on the quality of leadership among workers,

which may itself have a stochastic component, then different firms may find it easier or harder to find labor peace and this may affect wages. Idiosyncratic firm differences in the organization of production may imply differences in the ability to monitor workers or in the notional cost of negligence, hence also in the need to use wages to motivate diligence.

If these factors extrinsic to productivity do affect firm wages, then potentially even some very productive firms offering high wages may find that liberalization places them under pressure. If the ability of firms to re-negotiate the wage contract in light of such pressures is perfect, then trade should be able to place downward pressure on wages paid at good jobs, but it should not cause the loss of such jobs. Hence to consider the loss of good jobs, there needs also to be some rigidity, some inability to re-negotiate in light of new pressures.

In short, the central aim of this paper is to understand how trade liberalization can threaten “good jobs”. The elements at the heart of our interpretation are three. The first is heterogeneity among firms that creates *ex post* rents to which labor may lay claim. The second is that there be a stochastic element of wage determination extrinsic to productivity. And the third is a wage setting process at the firm level that lends a rigidity to wages that may cost good jobs in the face of new competitive pressures. In principle, there are very many potential models that could implement these elements. We develop a particularly simple variant that integrates the Melitz (2003) model of firm heterogeneity with the Shapiro-Stiglitz (1977) model of efficiency wages. We believe this provides a transparent way to model the potential for loss of good jobs at good wages in the face of trade liberalization.

While the central focus of our paper is on the loss of “good jobs at good wages,” we also have something to say about the impact of trade liberalization on the aggregate unemployment rate. In a very broad class of models, conditions in the labor market external to the firm matter for wage negotiations inside the firm, and these in turn then have implications for macro variables such as unemployment. For example, in a formal bargaining model, the unemployment rate and the average wage outside of the firm would affect a worker’s outside option, hence the wage bargain to be struck within the firm. Similarly here, the wages chosen by firms to satisfy a no-shirking constraint will be in a tight relation between the unemployment rate and a variable closely tied to the average wage. And this relation implies a type of tradeoff in the labor market. If trade liberalization indeed eliminates high wage jobs on average, it will also lower the

unemployment rate by relaxing incentive constraints, and vice versa if it eliminates low wage jobs on average.<sup>1</sup>

The present paper focuses on positive questions regarding the loss of what workers perceive to be “good jobs” and the aggregate employment implications of trade liberalization. We do not provide a full welfare analysis. Nonetheless, a few points regarding welfare are worth keeping in mind through the discussion. Here all labor is homogeneous and all income accrues to labor, hence conditions that diminish total real income also diminish average real income to workers. Imperfect monitoring is itself a distortion that lowers total real income by requiring unemployment to enforce effort. The *heterogeneity* of firm-level monitoring creates an additional distortion. Heterogeneous wages paid by firms of common productivity leads to too little output from a social perspective by the firm that pays high wages. Labor is misallocated. A similar effect is at work when a high productivity firm exits when its wage outmatches its productivity, even as a low productivity, but even lower wage firm survives. In short, it is worth bearing in mind that “good jobs” may not be good for aggregate welfare even though they are understandably valued quite highly by those who possess them. We nonetheless believe that our positive analysis will be helpful as an input to understanding the political economy of trade liberalization, since private actors are guided by private returns and even public actors will not focus exclusively on aggregate welfare.

There are several recent papers that also consider unemployment and job loss in a Melitz-type model of heterogeneous firms. Egger and Kreckemeier (2006) integrate Melitz (2003) with the fair wage model of Akerlof and Yellen (1990). Firm-level wages in their model are a weighted average of firm productivity and an unemployment-adjusted average wage. Unemployment arises because the fair wage constraint prevents wages from fully adjusting to insure full employment. While trade liberalization may cost jobs in their model, it does so only at the least productive firms offering the lowest wages. Hence their model does not offer a sense in which trade may threaten good jobs at good wages. Helpman and Itskhoki (2007), Felbermayr, et al. (2007) and Janiak (2006), integrate Melitz (2003) with Pissarides-type (2000) search models and show conditions under which trade integration may raise or lower equilibrium unemployment.

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<sup>1</sup> Here it is crucial to keep in mind that we are abstracting from heterogeneity of labor *per se*. This should be thought of as a *within* effect.

An earlier literature, including Copeland (1989), Brecher (1992) and Hoon (2001), considers the implications of efficiency wages in trade models. None of these papers considers the channels we consider in the current paper, and in particular they rule out the sort of intra-industry reallocations that seem to be important in practice and that are the focus of Melitz (2003). The paper by Matusz (1996), which analyzes efficiency wages in a Krugman-style model of intraindustry trade, is the most relevant to our project, and we discuss Matusz' model further below.

Section II of our paper lays out our labor market model of efficiency wages when monitoring costs differ across firms. This labor market is merged with the Melitz (2003) model of heterogeneous firms in Section III and IV. Our results about the effects of trade liberalization on wages, jobs, unemployment, and economy-wide efficiency are presented in Section V and VI.

## **II. Unemployment, Efficiency Wages, and the Firm**

### **A. Shapiro-Stiglitz with Heterogeneous Firm Level Monitoring and Iceberg Effort Costs**

Individual workers are assumed to be infinitely lived and risk neutral, discounting the future at rate  $r$ . Subject to an intertemporal budget constraint, they maximize the expectation:

$$(1.1) \quad E \left[ \int_0^{\infty} U(w_t, e_t) e^{-rt} dt \right]$$

The real wage that enters utility for a worker at firm  $i$  is given as  $w_i = \frac{W_i}{P}$ , where  $W_i$  is the nominal wage at firm  $i$  and  $P$  is the aggregate price index (to be developed later).

Depending on the employment and effort status of a worker, the utility takes the following forms:

$$\begin{aligned}
 U(w, e) &= w && \text{if the worker shirks} \\
 U(w, e) &= \frac{w}{e}, \quad e > 1 && \text{if the worker exerts effort.} \\
 U &= 0 && \text{if the worker is unemployed}
 \end{aligned}$$

Here the cost of effort is modeled as an “iceberg” cost that shrinks the perceived real wage of the worker, although of course not shrinking the nominal wage paid by firms and received by workers (both of which treat the aggregate price index  $P$  as given).<sup>2</sup>

Workers lose their job only if the firm dies or they are caught shirking. Firm death happens at an exogenous rate  $\delta$ . If workers at firm  $i$  were to shirk, they would face a probability  $m_i \in (0,1]$  of detection, with a penalty of being fired and spending a period in unemployment before finding a new job.

Workers at firm  $i$  have fundamental asset equations that reflect their status as shirkers or non-shirkers. Let  $V_{Ei}^S$  and  $V_{Ei}^N$  be the expected lifetime utility respectively of shirkers and non-shirkers currently employed at firm  $i$ . Let  $V_U$  be the expected lifetime utility of a worker currently unemployed (noting that this is independent of any firm because unemployed workers are unattached).

Then the fundamental asset equations for employed non-shirkers and shirkers respectively are:

$$(1.2) \quad rV_{Ei}^N = \frac{w_i}{e} + \delta(V_U - V_{Ei}^N)$$

$$(1.3) \quad rV_{Ei}^S = w_i + (\delta + m_i)(V_U - V_{Ei}^S)$$

These consist of the flow benefit,  $\frac{w_i}{e}$  or  $w_i$  respectively, plus an expected capital loss in the case of a shift to unemployment, where these terms differ because shirkers face a higher probability of a move to unemployment due to firm  $i$ 's monitoring  $m_i$  for shirking. This departs from the conventional Shapiro-Stiglitz framework in allowing for firm specificity in monitoring ability, the wage, and the value of employment at a particular firm.

These two equations can be re-written as

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<sup>2</sup> The iceberg cost of effort,  $U=w/e$ , departs from the traditional Shapiro-Stiglitz formulation of the cost of effort as  $U=w-e$ . This responds to the critique by David Romer (2006) that the conventional formulation would give rise to a secular trend in unemployment. A consequence is that the aggregate price index  $P$  is simply a scale variable in Equation (1.1). Moreover, changes in  $P$ , for example due to trade liberalization, will not *directly* affect the balance of incentives to work or shirk, since it affects them proportionately (cf. Steven Matusz (1996)). The new formulation also has the important consequence for us, developed below, that the *ranking* of firms by marginal cost is a function only of firm-specific parameters, hence invariant to the liberalization episodes we consider.

$$(1.4) \quad V_{Ei}^N = \frac{w_i}{e(r+\delta)} + \frac{\delta}{r+\delta} V_U$$

$$(1.5) \quad V_{Ei}^S = \frac{w_i}{r+\delta+m_i} + \frac{\delta+m_i}{r+\delta+m_i} V_U$$

Firm  $i$  recognizes the incentive to shirk. Hence in light of these incentives and its own monitoring ability, it chooses a wage sufficient to induce employees to work rather than shirk. This requires that  $V_{Ei}^N \geq V_{Ei}^S$ , a non-shirking constraint which firms will choose to meet with equality. Solving for the non-shirking wage constraint at firm  $i$ , we find:

$$(1.6) \quad w_i = \frac{erm_i}{m_i - (e-1)(r+\delta)} V_U$$

or, establishing notation,

$$w_i = \tilde{m}_i r V_U, \quad \text{where} \quad \tilde{m}_i = \frac{em_i}{m_i - (e-1)(r+\delta)}.$$

Equation (1.6) is the firm-level equivalent of the Shapiro-Stiglitz no-shirking constraint. First, note that since  $V_U$  is common to all firms, wages will vary across firms only due to monitoring ability and that equilibrium wages decline with improvements in monitoring. Second, note also that this is a *notional* wage. That is, this is the wage required of a firm with monitoring ability  $m_i$  if it is to elicit effort, and is well defined although in equilibrium not all firms will survive.

Obviously, (1.6) only makes sense for the parameter restriction

$$\frac{m_i}{(r+\delta)} > (e-1)$$

The left-hand side is the probability of detection relative to the discounted probability of losing your job anyway. This must exceed the utility penalty of effort. As long as workers are patient, exogenous job loss isn't too likely, or effort isn't too costly, this restriction will be satisfied.

Equations (1.4), (1.5), and (1.6) together give us three equations in the three values. Solving for these:

$$V_U = \frac{w_i}{r\tilde{m}_i}$$

$$V_{Ei}^N = V_{Ei}^S = V_{Ei} = w_i \frac{m_i - (e-1)\delta}{erm_i} = P^{-1} W_i \frac{m_i - (e-1)\delta}{erm_i}$$

We see that the value of being employed strictly exceeds the value of unemployment at any wage on offer,

$$V_{Ei} - V_U = P^{-1} \frac{W_i}{m_i} \left[ 1 - \frac{1}{e} \right]$$

where the gap equals the wage gap of shirking to non-shirking discounted by the probability of detection. The gap implies that unemployment is indeed involuntary.

Since the value of unemployment is not premised on the conditions of individual firms, we deduce from  $V_U = w_i \frac{m_i - (e-1)(r+\delta)}{erm_i}$  that relative wages for any two firms 1 and 2 are

$$(1.7) \quad \frac{w_2}{w_1} = \frac{m_2}{m_1} \frac{m_1 - (e-1)(r+\delta)}{m_2 - (e-1)(r+\delta)} = \frac{W_2}{W_1}$$

which is constant, monotonically decreasing in  $m_2$ , and increasing in  $m_1$ . What is crucial here is that the fact that relative real wages are constant also implies that relative nominal wages are constant. With firm level physical marginal productivities also constant (as developed below), we finally arrive at the conclusion that relative marginal costs across firms will be constant. That is, firms can be ordered according to their marginal costs even before we have developed other elements of the equilibrium.

Assume that there is some firm that monitors effort perfectly, hence that  $m_i = 1$ . We will choose the wage paid at such a perfect monitoring firm as our numéraire, so that the nominal  $W_1 \equiv 1$ . This gives rise to a notional nominal wage schedule

$$(1.8) \quad W_i = \frac{m_i (1 - (e-1)(r+\delta))}{m_i - (e-1)(r+\delta)}$$

which is greater than unity for  $m_i \in (0,1)$  and decreasing in  $m_i$ . Firms pay a wage premium when their monitoring is less than perfect and that premium decreases as their monitoring improves. Although the nominal wage schedule is fixed, real wages of course are free to move with changes in the aggregate price index  $P$ .

This nominal wage schedule will play a central role when we turn to the Melitz side of our model.

## B. Aggregation

The next step is to connect wages to unemployment. For this we need an equilibrium density of the wages paid by active firms  $f(W_i)$ , which of course will be common knowledge in the economy. Whatever the equilibrium density is, it allows us to calculate

$$E(V_{Ei}) = \left[ \frac{e-1}{e} \right] P^{-1} E \left( \frac{W_i}{m_i} \right) + V_U$$

or, establishing notation,

$$(1.9) \quad V_E - V_U = \left[ \frac{e-1}{e} \right] P^{-1} \left( \frac{W}{m} \right)^*, \quad \text{where } V_E \equiv E(V_{Ei}), \quad \left( \frac{W}{m} \right)^* \equiv E \left( \frac{W_i}{m_i} \right)$$

We are now ready to consider the flow benefits of being unemployed. Since unemployed workers here receive a zero wage, the flow benefits consist entirely of the expected capital gain from re-employment. Let  $a$  be the instantaneous probability of re-employment of an unemployed worker. Then the fundamental asset equation for an unemployed worker is:

$$(1.10) \quad rV_U = a(V_E - V_U)$$

We can substitute (1.9) into (1.10) to get

$$(1.11) \quad rV_U = a \left( \left[ \frac{e-1}{e} \right] P^{-1} \left( \frac{W}{m} \right)^* \right)$$

The instantaneous probability of re-employment of an unemployed worker,  $a$ , can be examined in terms of the steady state, which requires that flows into and out of unemployment be equal. Let  $L$  be the total size of the labor force and let  $U$  be the total number of unemployed. In equilibrium separations happen at rate  $\delta$ . Then the steady state imposes that:

$$aU = \delta(L - U)$$

or, defining the unemployment rate to be  $u \equiv \frac{U}{L}$ ,

$$(1.12) \quad a = \delta \left( \frac{1-u}{u} \right)$$

Substituting (1.12) into (1.11) gives

$$(1.13) \quad rV_U = \delta \left( \frac{1-u}{u} \right) \left( \left[ \frac{e-1}{e} \right] P^{-1} \left( \frac{W}{m} \right)^* \right)$$

Now we can substitute (1.13) into the individual firm's no-shirking constraint (1.6), noting that the aggregate price index cancels out:

$$(1.14) \quad W_i = \mu_i \left( \frac{1-u}{u} \right) \left( \frac{W}{m} \right)^* \quad \text{where} \quad \mu_i \equiv \tilde{m}_i \delta \left( \frac{e-1}{e} \right)$$

This no-shirking constraint for firm of type  $i$  is an extremely important equation. It relates any nominal wage to a firm-specific constant  $\tilde{m}_i$ , the parameters  $\delta \left( \frac{e-1}{e} \right)$ , and the macro variables

$$\left( \frac{1-u}{u} \right) \text{ and } \left( \frac{W}{m} \right)^*.$$

We now focus on (1.14) for the perfect monitoring firm, which we label firm 1, which is the firm whose nominal wage we have chosen as our numéraire. This implies

$$(1.15) \quad u = \left[ \frac{\mu_1 \left( \frac{W}{m} \right)^*}{1 + \mu_1 \left( \frac{W}{m} \right)^*} \right]$$

which is strictly between 0 and 1, as required.

Equation (1.15) is a central element of the macro side of our model, so it is crucial to examine it closely. Here  $\mu_1$  is just a constant, so the focus must be on  $\left( \frac{W}{m} \right)^*$ . Note from

Equation (1.8) that at the firm level, and for fixed monitoring ability  $m_i$ ,  $\left( \frac{W_i}{m_i} \right)$  is simply a

constant. Note also that across firms  $\left( \frac{W_i}{m_i} \right)$  declines monotonically in  $m_i$  and so indexes the

wage distortion imposed by less than perfect monitoring. Because of the constancy of  $\left( \frac{W_i}{m_i} \right)$  at

the firm level, changes in the average wage distortion  $\left( \frac{W}{m} \right)^*$  come about solely due to the

redistribution of output shares across firms (including exits). From Equation (1.9), the capital

gain associated with moving out of unemployment rises with the average wage distortion  $\left(\frac{W}{m}\right)^*$ .

In this case, unemployment becomes less daunting and effort will be forthcoming only if there is a higher unemployment rate  $u$ , which explains the positive association of these variables in (1.15).

The development to this point has assumed that workers discount the future at rate  $r > 0$ . When we turn to integrating our labor market model with the Melitz model, we will take the limiting case where  $r \rightarrow 0$ , to be consistent with his assumption that firms do not discount the future. By inspection of equations (1.8) and (1.15), focusing on this limiting case has no implications for the key results of this section.

In summary, we have developed a Shapiro-Stiglitz model with heterogeneity in firm monitoring and iceberg costs of effort. This has delivered a few key relations that we will carry over to the Melitz side of our problem. The first is that it has delivered a schedule of nominal wages relative to that paid by the perfect monitoring firm. This will play a key role in pinning down firm marginal costs. Second, it has delivered a key macro relation between the no-shirking unemployment rate and a measure of the average level of a firm distortion composed of the ratio of the nominal firm wage to its monitoring ability. That ratio will emerge endogenously from the Melitz side of the model and so determine the equilibrium unemployment rate.

### **III. Links Between Models of Heterogeneity in Productivity and Monitoring**

In the next section we develop a variant of the heterogeneous firm model of Melitz (2003) and show how to link it to the heterogeneous efficiency wages model based on Shapiro and Stiglitz (1984) that we derived in Section II. We first discuss the high level links between the models and then derive the key elements formally.

Equilibrium in a standard Melitz model may be analyzed in three parts – structure, scale, and the link between the two. By the equilibrium *structure*, we mean the price, quantity, wage bill, and profits for each firm  $i$  per unit mass of firms, as well as the determination of the marginal entrant. In the Melitz framework, and for given parameters, this is fully determined by the distribution of marginal costs across firms. And in Melitz’s own model, the variation in marginal costs across firms is fully described by the variation in firm physical productivity in

marginal cost, indexed by  $\varphi_i$ , which in turn determines the marginally profitable firm  $\phi^*$  and the probability of successful entry  $p_{in}$ .

With the structure of the economy and the probability of successful entry pinned down by  $\phi^*$ , we can define the economy's scale by the mass of firms that seek to enter,  $M_e$ , and the mass of surviving firms,  $M$ . Conditional on the structure, these are pinned down by the expected death rate of firms and the aggregate labor force.

Finally, the *link between structure and scale* comes from the labor demand per unit mass implied by the equilibrium structure of the economy. This is given by the total revenue per unit mass divided by the average wage, where both are defined to include entry, fixed, and marginal costs. This takes a particularly simple form in Melitz, where all firms pay a common competitive wage, taken as the numéraire, and so labor demand per unit mass is simply equal to revenue for this mass.

Turning to our model, equilibrium structure is also fully determined by the distribution of marginal costs across firms. However marginal costs in our model vary across firms not only due to variation in firm level productivity,  $\varphi_i$ , but also due to firm-specific no-shirking wages  $W_i$  in marginal cost activities. Indeed firm marginal costs will be given as the ratio of these two,  $\frac{W_i}{\varphi_i}$ .

Our measure of *inverse* marginal costs (productivity) is then defined as  $z_i \equiv \frac{\varphi_i}{W_i}$ . This allows us to use Melitz's results on the determination of the economy's structure as a function of the distribution of marginal costs without modification, where these are now indexed by  $z_i$ .

Equilibrium scale of the economy also differs from Melitz. It still features adjustment of the mass of active firms  $M$  and the mass of entrants  $M_e$  to ensure labor market equilibrium consistent with the probability of successful entry and the steady state. However labor market equilibrium now requires this mass to adjust so that total labor demand equals the total labor force adjusted for the unemployment rate  $u$ . From our firm-based efficiency wage model, the unemployment rate  $u$  is in a one-to-one relation with the average wage distortion  $\left(\frac{W}{m}\right)^*$ . And this is itself determined by the structure of the economy, in particular the marginal entry type  $z^*$ .

The link between the structure and scale of the economy also varies from that of Melitz. As before, this link comes from labor demand per unit mass implied by the equilibrium structure of the economy. Again, this is given by total revenue per unit mass divided by the average wage, both defined to include entry, fixed, and marginal costs. However, because we no longer have competitive factor markets, the average wage departs from unity. Hence we have to take the total revenue and average wage, as determined by the equilibrium structure of the economy, and convert these into the implied labor demand per unit mass of firms. The total mass of firms then adjusts to attain labor market equilibrium, which here requires that that total employment is consistent with the unemployment rate required for non-shirking given the average wage distortion.

In sum, just a few elements serve to link the models. To follow the Melitz framework, all firm variation in costs must affect only marginal costs. Hence we assume all firms have common monitoring and pay a common wage  $W_f$  in all fixed cost activities. For convenience, we assume that these fixed cost activities have perfect monitoring, which from Section II implies  $W_f \equiv 1$ . Hence firm level variation in monitoring will affect only wages in marginal cost activities, giving rise to marginal costs  $\frac{1}{z_i} = \frac{W_i}{\phi_i}$ . These firm level marginal costs, combined with the distribution of firm types, determine the structure of the economy. This structure, again in combination with the distribution of firm types, determines the average wage distortion  $\left(\frac{W}{m}\right)^*$ . This, in combination with results from Section II, determines the unemployment rate  $u$  as well as the labor demand per unit mass of firms. And these in turn determine the equilibrium mass of firms in the economy, hence the full equilibrium.

We turn now to show these results more formally.

## **IV. The Product Market**

### **A. The Consumer's Problem**

Preferences over goods are identical and homothetic, hence can be represented by those of a representative consumer. The representative consumer's problem is identical to that in Dixit

and Stiglitz (1977) and Melitz (2003). Consumers allocate expenditures across available varieties to:

$$\begin{aligned} \text{Min } E &= \int p(i)q(i)di \\ \text{s.t. } &\left[ \int q(i)^\rho di \right]^{\frac{1}{\rho}} = U \end{aligned}$$

We also have  $0 < \rho < 1$ , and  $\sigma = \frac{1}{1-\rho}$ .

These deliver demand curves for product  $i$  of the form:

$$q(i) = \left[ \frac{p(i)}{P} \right]^{-\sigma} Q$$

where  $Q \equiv U$  and  $P$  is an aggregate price index given by

$$(1.16) \quad P = \left[ \int p(i)^{1-\sigma} di \right]^{\frac{1}{1-\sigma}}$$

The demand curve above is a key input to the producer's problem.

## B. The Producer's Problem

Firms face a sequence of problems. There is an unbounded mass of potential firms. In the first stage, a mass  $M_e$  of firms will enter, pay a fixed entry cost of  $f_e$ , and receive information about their type. Here a firm's type is represented by the pair  $(\varphi_i, m_i)$  covering both productivity and monitoring ability in variable costs. We saw above in equation (1.8) that there is a simple relation between equilibrium no-shirking wages and monitoring. This means that the firm can immediately translate the productivity-monitoring draw  $(\varphi_i, m_i)$  to a productivity-nominal-wage draw  $(\varphi_i, W_i)$ . As it turns out, the firm's individual choices are affected only by the ratio

$z_i \equiv \frac{\varphi_i}{W_i}$ , although we will be interested in examining  $\varphi_i$  and  $W_i$  separately in order to analyze

market equilibrium.

Here  $z_i$  can be thought of equivalently as wage-adjusted productivity in marginal cost or as the inverse marginal cost for firm  $i$ . Having learned its type  $z_i$ , firm  $i$  will produce if its

variable profits cover its per period fixed costs  $f$ ; otherwise it will exit before producing. In what follows, we work from the individual firm problem and aggregate up.

### C. The Individual Firm

We consider now the problem of an individual firm that has already sunk the cost  $f_e$  to learn its type  $z_i$ . Physical labor requirements in firm  $z_i$  follow Melitz:

$$\ell(z_i, \varphi_i) = f + \frac{q(z_i)}{\varphi_i}$$

Note that firm level physical labor demand requires knowledge of  $\varphi_i$  (not only  $z_i$ ), so must be recovered to establish labor market equilibrium once the structure of the economy (including the wage bill for a firm of type  $z_i$ ) is determined.

As we noted, our use of the Melitz approach requires that the only locus of firm level variation is in marginal costs. Hence we assume that the firm pays a wage  $W_f \equiv 1$  for labor employed in its fixed costs and a wage  $W_i$  for labor employed in its variable costs.

A particular firm  $i$  thus faces a demand curve as defined in the consumer's problem above and chooses output to maximize profits,

$$\pi_i = p_i \cdot q_i - f - W_i \frac{q_i}{\varphi_i} = p_i \cdot q_i - f - \frac{q_i}{z_i}$$

The first order conditions yield the familiar price as a markup on marginal cost:

$$p(z_i) = \frac{W_i}{\rho \varphi_i} = \frac{1}{\rho z_i}$$

Prices and maximized profits vary across firms only because of variation in  $z_i$ . That is, firms with a common inverse marginal cost  $z$  may be paying different nominal wages, which are offset by productivity differences, but they charge the same price, will produce the same quantity, and have the same revenue and profits. Hence we will drop the subscript  $i$  henceforth except as necessary to clarify limits of integration.

### D. Aggregation

We have seen that the combination of a primitive distribution on  $(\varphi_i, m_i)$  and the equilibrium from the labor market, we can derive the joint distribution for  $(\varphi_i, W_i)$ . Knowledge of this joint distribution allows us as well to calculate the distribution of inverse marginal costs  $z \equiv \frac{\varphi}{W}$  with cumulative distribution function  $G(z) \equiv \Pr[Z \leq z]$  and density  $g(z)$ . The full equilibrium will feature a cutoff level of inverse marginal cost,  $z^*$ , such that firms with  $z < z^*$  exit immediately upon learning of their draw.

Given  $g(z)$ , we can also define the equilibrium density of active firms:

$$\mu(z) = \frac{g(z)}{1 - G(z^*)}, \quad z \in [z^*, \infty)$$

If there is a mass  $M_e$  of entering firms, then the number of them at any given inverse marginal cost  $z$  is  $M_e g(z)$ , and the number of those that survive and produce is  $M \mu(z)$ .

The definition of the CES price index gives

$$\begin{aligned} P &= \left[ \int_{z^*}^{\infty} p(z)^{1-\sigma} M \mu(z) dz \right]^{\frac{1}{1-\sigma}} \\ (1.17) \quad &= M^{\frac{1}{1-\sigma}} \left[ \int_{z^*}^{\infty} p(z)^{1-\sigma} \mu(z) dz \right]^{\frac{1}{1-\sigma}} \\ &= M^{\frac{1}{1-\sigma}} \tilde{p} \end{aligned}$$

where  $\tilde{p}$  is implicitly defined in the last step. As usual in this type of model, holding the density of firms fixed, the price level is decreasing in the number of firms, which is the love-of-variety effect.

Substituting in  $p(z) = (\rho z)^{-1}$  gives

$$\tilde{p} = \left[ \rho^{\sigma-1} \int_{z^*}^{\infty} z^{\sigma-1} \mu(z) dz \right]^{\frac{1}{1-\sigma}} = \frac{1}{\rho \tilde{z}}$$

where, making the dependence of  $\tilde{z}$  on  $z^*$  explicit,

$$\tilde{z}(z^*) = \left[ \int_{z^*}^{\infty} z^{\sigma-1} \mu(z) dz \right]^{\frac{1}{\sigma-1}}$$

This last variable,  $\tilde{z}$ , is a measure of aggregate inverse marginal costs and plays a key role in the determination of equilibrium in the product market.

### E. The Marginal Firm and Equilibrium Structure of the Economy

Equilibrium structure in an autarkic Melitz economy is determined by the solution of two relations between average profits  $\bar{\pi}$  and the marginal cost of the marginal entrant  $z^*$ . The first of these two relations is a free entry condition (FE), which asserts that from an unbounded set of *ex ante* identical firms, a sufficient mass enters so that the average profits from entry equal the fixed cost of entry. Written in these terms, the FE condition is:

$$\left[1 - G(z^*)\right] \frac{\bar{\pi}}{\delta} = f_e$$

For a given marginal entrant  $z^*$ ,  $1 - G(z^*)$  is the *ex ante* probability of successful entry,  $\bar{\pi}$  the per-period average profits for successful entrants, and  $\frac{1}{\delta}$  the factor that yields expected value when the stochastic exit rate for successful firms is  $\delta$ . Solving, we have:

$$\bar{\pi}(z^*) = \frac{\delta f_e}{1 - G(z^*)} \quad (\text{FE})$$

This formulation points at the path to solution, which is to link average profits to the marginal entrant. The first step draws on the aggregate measure of inverse marginal cost  $\tilde{z}(z^*)$ , from above. The second step is to show that total profits can be written as  $\Pi = M \pi(\tilde{z})$ , so that average profits are:

$$\bar{\pi}(z^*) = \pi(\tilde{z}(z^*)) = \frac{\Pi}{M}.$$

The proof follows Melitz and is omitted here.

The second of the two key relations is the zero cutoff productivity (ZCP), which requires that the firms with the highest marginal costs that actually produce should have variable profits equal to the per-period fixed cost, or  $\pi^V(z^*) = f$ . To convert this to a form amenable to the simple determination of equilibrium via  $\bar{\pi}$  as a function of  $z^*$  requires only a few more steps.

Generally, variable profits for an active firm are given by  $\pi^V(z) = \frac{r(z)}{\sigma}$ , and the revenue for this firm is given by  $r(z) = R[P\rho z]^{\sigma-1}$ , where  $R = PQ$  is aggregate expenditure. Ratios of variable profits are equal to the ratio of revenues and depend only on the ratio of inverse marginal costs, so that we can write  $\pi^V(z_1) = \left(\frac{z_1}{z_2}\right)^{\sigma-1} \pi^V(z_2)$  for any active  $z_1$  and  $z_2$ . Recalling that  $\pi(\tilde{z})$  is equal to average profits  $\bar{\pi}$ , we can write this out for inverse marginal costs  $\tilde{z}$  and  $z^*$  as  $\bar{\pi} = \left[\frac{\tilde{z}(z^*)}{z^*}\right]^{\sigma-1} \frac{r(z^*)}{\sigma} - f$ . If we further define  $k(z^*) = \left\{ \left[\frac{\tilde{z}(z^*)}{z^*}\right]^{\sigma-1} - 1 \right\}$ , and recall that the zero cutoff productivity has  $\frac{r(z^*)}{\sigma} = f$ , we can impose this condition by requiring:

$$\bar{\pi} = fk(z^*) \quad (\text{ZCP})$$

The remainder of the derivation follows Melitz and is omitted.

The Free Entry and Zero Cutoff Productivity conditions define two relations in  $\bar{\pi}$  and  $z^*$  and can be solved for equilibrium values as in Melitz. The equilibrium exists and is unique under the same conditions.

The equilibrium  $z^*$  completely determines the structure of the economy. We now need to go on to recover the average wage, determine the associated unemployment rate consistent with no-shirking, and thus determine the mass of firms that provides for equilibrium in the labor market.

## F. Labor Supply and Demand

The labor force in our model is divided into four elements:

- $U$  the unemployed
- $L_e$  workers in fixed entry cost sector
- $L_f$  workers in per-period fixed cost activities
- $L_v$  workers in variable cost activities

The aggregate labor force constraint is

$$L = U + L_e + L_f + L_v$$

For entry, we need to consider the steady state. The number of new entrants every period is a fraction of the incumbents which is exactly equal to the number of firm deaths,  $\delta M$ . Thus labor devoted to new entry in steady state is:

$$L_e = \frac{\delta M}{1 - G(z^*)} f_e$$

The physical levels of employment in fixed cost is simply

$$L_f = Mf$$

For the variable cost activity, we now have to make precise the distinction between wages and physical marginal productivity. It is the latter that gives employment in each firm. The complexity arises because firms with a given  $z$  (and hence a given level of output) may have an infinite number of physical productivities  $\varphi$ .

Physical variable labor demand for firm  $i$  is given by  $\ell_v(z, \varphi) = \frac{q(z)}{\varphi}$ . From the joint distribution of  $(\varphi_i, W_i)$  and the equilibrium  $z^*$  we can construct the equilibrium joint distribution represented by the density  $\psi(\varphi, z)$ . With the mass of firms  $M$  and this joint density, total employment in variable costs is given by:

$$L_v = M \int_{z^*}^{\infty} \int_{\phi \in \Phi} \frac{q(z)}{\varphi} \psi(\varphi, z) d\phi dz$$

We can now write the labor market clearing condition in quantity terms as:

$$(1.18) \quad (1-u)L = M \left[ \frac{\delta}{1 - G(z^*)} f_e + f + \int_{z^*}^{\infty} \int_{\phi \in \Phi} \frac{q(z)}{\varphi} \psi(\varphi, z) d\phi dz \right]$$

Note that for a given unemployment rate  $u$  (hence average wage distortion  $\left(\frac{W}{m}\right)^*$ ), the mass of firms  $M$  is directly proportional to the labor force size  $L$  and employment  $(1-u)L$ .

## G. National income

Now we turn to determining the level of nominal national income. Although active firms make nonnegative profits, the free entry condition requires that these profits just equal steady state payments to workers in sunk cost activities. Thus total national income is simply total

payments to labor: payments to workers in sunk cost activities, fixed cost activities, and variable production.

Multiplying each firm's employment of labor in variable cost  $\ell_{v_i}(z_i, \varphi_i) = \frac{q(z_i)}{\varphi_i}$  by the firm-specific wage  $W_i$  gives the firm's wage bill in variable cost as

$$z^{-1}q(z) = z^{\sigma-1}Q[P\rho]^\sigma$$

which allows us to conclude that aggregate payments to labor in variable cost are

$$M \int_{z^*}^{\infty} z^{\sigma-1}Q[P\rho]^\sigma \mu(z) dz = MQ[P\rho]^\sigma \int_{z^*}^{\infty} z^{\sigma-1} \mu(z) dz = MQ[P\rho]^\sigma \tilde{z}^{\sigma-1}$$

which, using

$$Q = M^{\frac{1}{\rho}} q(\tilde{z}), \quad P = M^{\frac{1}{1-\sigma}} (\rho \tilde{z})^{-1},$$

becomes

$$M \frac{q(\tilde{z})}{\tilde{z}}$$

To get total payments to labor we add employment in fixed and entry cost activities, where the wage is one. Thus nominal national income is

$$(1.19) \quad R = M \left( \frac{\delta}{1-G(z^*)} f_e + f + \frac{q(\tilde{z})}{\tilde{z}} \right).$$

## H. General equilibrium

With the structure of the economy determined by  $z^*$  in Section IV.E., there are five aggregate variables that need to be computed: the unemployment rate  $u$ , nominal national income  $R$ , the price index  $P$ , the mass of active firms  $M$ , and the average labor market distortion

$$\text{index} \left( \frac{W}{m} \right)^*.$$

Solution of the general equilibrium is recursive. Given  $z^*$ , we have three equilibrium probability distributions. These are the equilibrium joint density of productivity and inverse marginal cost  $\psi(\varphi_i, z_i)$ , the productivity density of active firms  $\mu(z)$ , and the nominal wage density of active firms  $f(W_i)$ .

From Section II, we calculate the average labor market distortion index,

$$\left(\frac{W}{m}\right)^* = \int_1^{\infty} \frac{W}{m} f(W) dW .$$

This is inserted into (1.15) to get the unemployment rate  $u$ . The mass of active firms  $M$  can then be found using  $u$  and  $\psi(\varphi, z)$  in (1.18). Next, national income  $R$  can be found from (1.19).

Finally, the price index  $P$  is found from (1.17).

This completes the solution of the model.

## V. Autarky to Free Trade in Two Special Cases

We have developed a general model that integrates the Melitz model of heterogeneity in firm productivity with a Shapiro-Stiglitz model amended to allow for heterogeneity in firm monitoring abilities. We have shown that the *structure* of the economy is isomorphic to that in

Melitz and a function of firm marginal costs  $mc_i = \frac{W_i}{\varphi_i} = \frac{1}{z_i}$ , which depend on firm variation in

both wages and productivity. Before turning to examine the consequences of trade liberalization in the general case, it will prove useful to consider two special cases, each of which shuts down one of the two influences on marginal costs.

### A. The Melitz-Type Model

Our first special case is what we term a ‘‘Melitz-type’’ model. Marginal costs are assumed to vary with heterogeneity in firm productivity, but we assume that all firms have the same monitoring ability hence pay the same nominal wage. If all firms monitor with the same efficacy,

then they also offer the same nominal wage and  $\left(\frac{W}{m}\right)^*$  is a constant independent of the marginal

firm, so by Equation (1.15) unemployment is also at a fixed rate. If we go further to assume that

all firms monitor perfectly, this unemployment rate  $u$  is equal to  $\frac{1}{1-\delta(e-1)}$  and all nominal

wages are equal to unity.<sup>3</sup>

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<sup>3</sup> The unemployment rate is positive in spite of perfect monitoring because in the SS setting shirking workers are still paid for the instant prior to firing and you thus still need positive unemployment to insure effort.

With  $W_i \equiv 1$ , we have  $mc_i = \frac{1}{z_i} = \frac{1}{\varphi_i}$ , as in Melitz. Figures 1A and 1B illustrate results

familiar from Melitz, where in the  $(w_i, \varphi_i)$  space, all firms lie on the  $w_i \equiv 1$  line. In autarky, firms whose marginal costs are higher than  $mc_a^*$  (productivity lower than  $\varphi_a^*$ ) exit without producing.

In a move from autarky to free trade steady states, the highest marginal cost (lowest productivity) firms  $[mc_a^*, mc^*]$  exit; the next lower marginal cost firms  $[mc^*, mc_x]$  contract; the next lower marginal cost firms  $[mc_x, mc_\pi]$  succeed in exporting, although their profits fall; and finally the lowest marginal cost firms,  $mc \leq mc_\pi$ , become super-exporters and raise their profits. Homogeneous labor and a common monitoring technology imply that nominal wages are unchanged. Still, the economy achieves higher productivity through the elimination or contraction of high marginal cost firms to the benefit of low marginal cost firms. And workers will be better off as a result of the availability of cheap imported varieties and through a possible increase in variety available locally.

The fact that the average wage distortion does not change implies that neither will there be a change in the unemployment rate. Within the context of our model, this justifies Melitz in having put aside issues of aggregate unemployment, since if the only source of heterogeneity in firm marginal costs is firm-level productivity, then unemployment, while it does exist, does not change in the move from autarky to free trade.<sup>4</sup>

The Melitz model has many great features. But its constraint that all wages for all workers are identical makes it impossible to make sense of public concerns that trade destroys good jobs – no job is any better than any other. And the fact that there are aggregate gains from liberalization combined with the homogeneity of jobs suggests that all workers will benefit, at least eventually, from such a liberalization. This makes it hard to make sense of worker concern about trade and suggests the need for a richer model in which there is a clear sense of some jobs being better than others.<sup>5</sup>

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<sup>4</sup> This result contrasts with Matusz (1996), where trade liberalization in a monopolistic competition model reduces unemployment. The key to the difference is that in Matusz' specification an equilibrium increase in variety reduces the incentive to shirk. Our specification of utility neutralizes this effect, for reasons discussed in section II.A

<sup>5</sup> As noted by Kletzer (2001), import-related job losses are often associated with extended spells of unemployment and substantial declines in wages when re-employed.

## B. Firm-Level Variation *Only* in Wages

A second special case arises when we abstract from heterogeneity in firm productivity and allow *only* for heterogeneity in firm monitoring, hence in wages. For this case, we set  $\varphi_i \equiv 1$  and thus have  $mc_i = W_i = \frac{1}{z_i}$ . Hence in this case, we can speak synonymously of marginal costs or wages. Note also that the fact that identical workers receive different wages at different firms means that workers perceive some jobs as being better than others. Figures 2A and 2B illustrate the relevant cases in autarky and in a move from autarky to free trade. In the figures, all firms in the  $(W_i, \varphi_i)$  space lie on the  $\varphi_i = 1$  line at wages  $W_i \geq 1$ . Exactly as in the previous case, in autarky firms with high marginal costs exit before producing. However, since all firms now have the same productivity, variation in marginal costs arises only due to differences in the wages that must be paid. Hence firms in autarky whose poor monitoring technology would require wages  $W_i > mc_a^*$  exit before producing.

This model also provides a first opportunity to make sense of the public perception that free trade destroys good jobs at good wages. In a move from autarky to free trade, the highest wage firms in existence, those with wages  $W_i \in (W^*, W_a^*]$ , exit and all the high wage jobs at these firms are destroyed. The existing firms that offer the next highest wages, those with  $W_i \in (W_x, W^*]$  contract and dismiss some of their workers. As we head down in the wage distribution to relatively low paying jobs, those with wages in the range  $W_i \in (W_\pi, W_x]$ , firms expand employment to reach new export markets, but even this export success is insufficient to raise their total profits. Employment expands most sharply at the firms offering the lowest wages, those in the range  $W_i \in [1, W_\pi]$ . And it is only these last firms, the ones offering the lowest wages and who become super-exporters, who actually have their profits rise as a result of liberalization. Indeed, the profit gains to these firms offering the lowest wages exceed the combined profit losses to all other firms, including those forced to exit.

Since the output response is greater at firms with better monitoring offering lower and lower wages, we can be sure that the average wage distortion falls in the move from autarky to free trade. One compensation in this case is that the aggregate unemployment rate will for this reason fall. All workers will also benefit from the lower prices and possibly increased variety

arising from trade. However, with a lower average wage, and all of the highest paying jobs eliminated from the economy, there are likely to be many workers who see themselves as worse off on account of liberalization.

This model in which the only source of variation in marginal costs is due to firm differences in wages has the great merit that it presents a very stark articulation of the public concerns that trade destroys good jobs at good wages. If we constrain all firms to have a common technology, then those that pay the highest wages are at risk of exit or contraction in the move from autarky to free trade. Trade destroys the best jobs.

Nevertheless, there are good reasons to believe that this model in which all variation in firm level marginal costs is due to differences in wages is at best incomplete. Most pointedly, it would have the implication that high wage firms are also small and unprofitable firms. The data contradict this (Idson and Oi, 1999). Like the Melitz model, which allowed marginal costs to vary only with firm productivity, this model in which marginal costs vary only due to firm level wage differences has important shortcomings. We will now turn to the general model, which allows for marginal costs to vary for both reasons to see that we can address the concerns that arise in the two special cases.

## **VI. Trade Liberalization in the General Case**

This section will consider the consequences for firms and workers of trade liberalization in our general model. Sections VI.A. and VI.B. consider this in detail for the case of a move from autarky to free trade. In Section VI.C., we will discuss liberalization in economies that are already partially open.

We divide our discussion of a move from autarky to free trade into two pieces. The first will consider the case of a liberalization that affects the structure of the economy, but not its scale. As discussed above, the link in our model between structure and scale is the average wage distortion,  $\left(\frac{W}{m}\right)^*$ , through the impact of this on the equilibrium unemployment rate. Depending on the primitive distribution of productivity and monitoring  $(\varphi_i, m_i)$ , our model is consistent with either a rise or fall in this average wage distortion with liberalization. As a base case, we begin by assuming that liberalization has *no* impact on this average wage distortion. This implies that the structure of the economy will change, but not its scale. Once the analysis of a change in

structure is complete, we go on to consider how we would need to amend the conclusions of that analysis once we allow for changes in scale as well.

The analysis in this section, in formal terms, is comparative steady state analysis. A complete analysis of the time path of adjustment would be required to make definitive statements about welfare and political economy. That is beyond the scope of this paper. Nonetheless, the basic nature of the adjustments required along the path to the new steady state does emerge from our model. We believe that this provides a powerful heuristic for understanding the forces at work in identifying winners and losers, hence also in understanding the political economy of liberalization.

### A. Changes in Structure Only

We consider here the special case in which our economies move from autarky to free trade, but in which the average wage distortion, hence also aggregate employment, is unchanged. This implies that the analysis of the structure of firms' price and output decisions in the product market, as well as profit, entry and exit, will be precisely as in Melitz, so long as we use our own measure of inverse marginal cost, given by  $z$ . Here, though, workers have attachments to specific firms because of rents created by differences at the firm level in wages.

We can use Figures 3A and 3B to think about the comparison of autarky and free trade as it affects profits of firms and employment of workers. The lowest feasible wage is the perfect monitoring wage and equals one by choice of numéraire. In Figure 3A, the ray labeled  $mc_a^*$  indicates the highest level of marginal cost consistent with zero post-entry profits, and thus defines the cutoff for active firms. Firms with lower marginal costs are to the southeast of the  $mc_a^*$  ray, and firm size is monotonically decreasing in marginal cost. An implication is that even if monitoring ability and physical productivity are *ex ante* uncorrelated, there will be an *ex post* correlation between productivity and wages, because only high productivity firms can afford to stay in business while paying high wages. If *ex ante* monitoring costs and productivity are positively correlated, our model offers a potential explanation for the firm size-wage premium: highly productive firms are likely to have higher monitoring costs and consequently pay higher wages. As long as the high wages don't completely offset high productivity, high wage firms will also be big firms on average (this conjecture was also made by Bulow and Summers (1986)). Our model is quite consistent with the Idson and Oi (1999) explanation for the firm

size-wage premium. Idson and Oi dismiss the efficiency wage model on theoretical grounds and claim in their title that “Workers are more productive in large firms” which is why they are paid more. With an *ex ante* correlation between monitoring costs and productivity, efficiency wages and productivity are complementary rather than substitute explanations for the firm size-wage premium.<sup>6</sup>

The impact of the shift in comparative steady states from autarky to trade, illustrated in Figure 3B, gives rise to three additional critical values in inverse marginal costs. The first is  $mc^*$ , the marginal entrant under free trade. Next is  $mc_x$ , the marginal exporter. Finally is  $mc_\pi$ , the highest marginal cost for which a firm sees its profits rise with free trade. Accordingly, these boundaries define Regions I to IV in the figure.

The impact of trade on firms’ profits and output is straightforward. All firms in Region I exit with trade, so their profits and output fall to zero. Firms in Regions II and III also see a decline in profits. For firms in Region II, the entry of foreign firms into their home market reduces their domestic demand and profits, yet leaves them incapable of finding a sufficient foreign market to justify the fixed costs of exporting. Output for these firms declines. It is notable that firms in Region III suffer a decline in profits in spite of the fact that they not only survive in the domestic market but also find a foreign market for their products; the losses in the home market are not fully compensated by the new profits in the export market. Total output for these firms expands and so the decline in profits is attached to the fixed cost of entering the export market. Only the largest firms, those in Region IV, find that their profits rise with trade. Notably, firms can find their way into Region IV either by their inherent productivity or by effective monitoring of workers, which allows them to elicit effort at low wages.

The analysis of the impact on workers is only slightly more complex. We have set aside until the next subsection any impact of trade on the average wage distortion and equilibrium unemployment. The nominal wage of a worker who maintains employment at a specific firm is

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<sup>6</sup> We have modeled the monitoring ability of a firm as a simple stochastic draw. If one were to model monitoring itself as an increasing returns activity, one might imagine large firms would have an incentive to monitor more thoroughly, which taken alone might suggest that large firms would pay *lower* wages, contrary to evidence. However a contrary influence, likewise not developed here, is the possibility that the organization of work at large firms differs from that in small firms (e.g. more teamwork) that may make monitoring *more* difficult, giving rise to higher wages. The fact, as well, that not all labor is homogeneous suggests not leaning too heavily on any one piece of evidence to judge the merits of any particular model of firm wage formation.

determined by the firm specific monitoring technology and parameters of the model, so is unaffected by trade liberalization.

This leaves only two channels for trade to affect workers. The first, as in Melitz, is that liberalization lowers the typical price and may raise total variety of products available to workers *qua* consumers. This benefits all workers and should be considered as a potential offset to losses incurred by some workers.

The second channel for trade to affect workers here is via changes in employment, which is most directly related to the fate of firms in the output market. We have already seen that firms in Region I exit the market, hence all workers at these firms lose their jobs. Firms in Region II contract their output, hence workers at these firms may be seen as facing a probability of job loss related to the degree of contraction. Firms in Regions III and IV expand employment sufficiently in the new steady state to provide precisely the same number of new jobs as those lost via firings among firms in Regions I and II.

Workers at firms in Regions III and IV should expect to be unambiguously better off with the move from autarky to free trade. The firms there are expanding output, so should have no unusual layoffs. And they enjoy gains from lower typical prices and possibly increased variety.

The situation is more intricate for workers initially with firms in Regions I and II. As noted, on one side are the common variety and price gains from liberalization. On the other side is the certainty (Region I) or probability (Region II) of job loss. In the model workers must pass through a period of unemployment before finding new employment. Since workers always prefer to be employed rather than unemployed, this is a cost. The magnitude of the cost of a job loss is higher the higher the initial wage. While we don't have an explicit model of the transition between steady states, this particular comparative steady state creates a great deal of turnover while costing zero net jobs. This should be good news for those currently unemployed, who are happy to accept any job on offer and suddenly find a lot of hiring going on, even though the transition would require more people to pass through unemployment.

This comparative steady state also provides a window on the debate over whether trade liberalization threatens "good jobs". A precise way to state the consequences for jobs here is that liberalization destroys jobs with high marginal costs of production. Sometimes these are low wage jobs with very low productivity; sometimes they are high wage jobs with productivity that may be high but is not quite high enough to secure the jobs.

However, there is another – from a worker’s perspective, quite natural – way to interpret the consequences of the shocks. This is to hold fixed the type of firm, indexed by its productivity  $\phi$ , and compare what happens to different types of jobs at comparable firms defined in this way. Figure 4 provides a simple window on this way of looking at the world. To the previous diagram, Figure 4 adds the average wage in autarky,  $\bar{w}_a$ , and a specific productivity level  $\phi_0$ , which for illustrative purposes was chosen to intersect the average wage line at the boundary of Regions II and III. Perhaps the simplest definition of a “good job” in autarky is one that pays a wage above the average, i.e.  $W_a > \bar{W}_a$ . Holding productivity fixed at  $\phi_0$ , we see that trade threatens *all and only* good jobs. Controlling for firm productivity  $\phi_0$ , the highest paying jobs are those in Region I – all of which are lost in the opening to trade. The next highest paying jobs are those in Region II – some, but not all, of which will be lost to trade. Controlling for productivity, only the lowest paying jobs survive the opening to trade. Indeed, trade leads to an expansion of these jobs and most sharply among the lowest paying of these (those along  $\phi_0$  in Region IV).

We see that the public perception that trade destroys good jobs at good wages does have foundation in the context of this model. Some workers who in autarky would enjoy high wages will find that a move to free trade eliminates their jobs. Indeed, if we condition on productivity, trade always destroys the best jobs.

Having acknowledged this, it is also crucial to understand the limits of this way of thinking. Yes, trade will eliminate some of what workers perceive as good jobs, and conditioning on productivity, trade always destroys the best jobs. Yet this is perfectly consistent with the possibility that trade will simultaneously expand the number of high wage jobs sufficiently that the average wage will rise. Indeed, we will argue below why we think this is the normal case. The net gain for specific workers and for workers as a whole will then need to account for changes in prices and variety, which will typically be additional sources of gain, as well as for changes in aggregate unemployment. Moreover, in this model, all income accrues to labor. Good jobs are naturally very attractive to those who have them; however, the associated inefficiencies cost labor as a whole.

## **B. Changes in Structure and Scale**

In the previous section, we abstracted from the possibility that liberalization may affect the average wage distortion, hence unemployment, so turn to this now. The firm level wage distortion,  $\left(\frac{W_i}{m_i}\right)$ , is a constant, so unaffected by liberalization. The average wage distortion across all firms is affected by the redistribution of output (including exit) across firm types that may have different levels of distortions. At any marginal cost, indexed by  $z$ , there exist firms with heterogeneous wage distortions. While we can make specific predictions about which firms will exit according to the ordering by  $z$ , it is not possible to say whether the average wage distortion will rise or fall with liberalization without knowledge of the full joint distribution of  $(\phi_i, m_i)$ .<sup>7</sup> In short,  $\left(\frac{W}{m}\right)^*$  is a function of  $z^*$ , but it need not be monotonic.

### *1. The Average Wage Distortion, Macro Effects, and the New Steady State*

The macro implications of changes in the average wage distortion come directly from our heterogeneous firm model of efficiency wages: a rise in the average wage raises equilibrium unemployment. From Equation (1.15):

$$u = \left[ \frac{\mu_1 \left(\frac{W}{m}\right)^*}{1 + \mu_1 \left(\frac{W}{m}\right)^*} \right]$$

As discussed in Section II.B., rise in the average wage distortion, through firm selection effects, raises the expected capital gain from moving between unemployment and employment, so makes unemployment less daunting, requiring a rise in the structural unemployment rate to maintain the balance of incentives to elicit effort.

This rise in unemployment relative to the case of no change in the average wage distortion changes the scale of the economy, but not its structure. Because of the general second best nature of the economy, we cannot rule out that with a sufficient rise in the unemployment rate, total real income may decline with liberalization, although we would consider this an unusual case. Similarly, even as the average price of products declines, there can be a rise in the

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<sup>7</sup> Unfortunately even knowledge of movements in the average nominal wage would not suffice to determine the qualitative change in the average wage distortion, as they need not be monotonically related.

economy's price index because the rise in unemployment causes a decline in the total mass of varieties available in the market. The fact that the *possibility* of absolute losses might arise in a model with factor market distortions would not be surprising, although such an outcome in the world seems unlikely.<sup>8</sup>

The rise in unemployment anticipated with the move from autarky to free trade reduces the steady state mass of firms of each type relative to the previous case in which employment was unchanged. In principle, a sufficiently sharp rise in the average wage distortion, accompanied with a sharp rise in the required unemployment rate, could lead to a reduction of the presence even of the most productive export firm types in the new steady state and a loss in total employment there.<sup>9</sup>

## 2. Political Economy

The main thrust of the political economy for comparative steady states from the view of firms can be understood through examination of Figure 3B. As before, the move from autarky to free trade divides the space into four key regions in terms of marginal costs. All firms with  $mc > mc_\pi$ , i.e. those in Regions I, II, and III, lose profits as a result of the move of comparative steady states from autarky to free trade. Only the largest firms, those with  $mc < mc_\pi$  gain. Hence a move from autarky to free trade should be supported only by the largest firms.

Turning to workers, we start with several general observations. Trade always serves to lower the typical price and (unless unemployment rises sharply) will also raise the total (local and imported) number of varieties available in the market to consumers. Hence typically the price index will fall in the move from autarky to free trade, which is a gain to all workers.

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<sup>8</sup> We anticipate doing simulations that would allow us to confirm this possibility.

<sup>9</sup> While the present paper develops only comparative steady states, it would be interesting to study transition dynamics for the case in which the rise in the average wage distortion, hence also the unemployment rate, in the new steady state requires a smaller mass even of the highly productive firm types. We conjecture that in this case the transition will feature *overshooting* of both the average wage and the unemployment rate along the path to the new steady state. The logic is simple. Apart from exogenous firm deaths, firm exits only arise when expected present discounted profits are negative. But firm profits are monotonically decreasing in marginal costs. Hence if the "crowding" of the market by the excess prevalence of low marginal cost firms during the transition relative to the steady state leads to exit, this exit will be among the highest marginal cost (small) firms. But if indeed these small firms are on average also the low wage distortion firms, then this change in composition will lead the average wage distortion to be higher in the transition than in the steady state. All else equal, the rise in the average wage distortion also requires a higher unemployment rate to insure effort, since the no-shirking constraints have to hold at all times. Our conjecture, then, is that both the average wage distortion and unemployment will overshoot in the transition to the new steady state. Confirming this conjecture is beyond the scope of the present paper.

Selection effects from liberalization may also alter the distribution of types of jobs in the economy. We have to treat distinctly three separate concepts, namely the average wage distortion,  $\left(\frac{W}{m}\right)^*$ , the average nominal wage,  $W^*$ , and the general equilibrium impact on the average real income of workers. As we have noted, the unemployment rate is linked directly to the average wage distortion. We have seen at the firm level that a “good job”, i.e. one that pays a high wage (relatively) is one where this distortion is high. Yet when the average rises, unemployment rises, which is costly directly due to lost output and also due to associated loss of variety. While the average nominal wage in the economy seems likely to be positively associated with the average wage distortion, close examination reveals that this connection is not a necessary one. Still, we may expect that  $\left(\frac{W}{m}\right)^*$  and  $W^*$  may typically move together, which would in such cases suggest a tradeoff between high unemployment and high average wages in the typical job. It is worth keeping in mind, though, that “good jobs” come at a price. Here all income accrues to workers, so that average real income to workers is maximized exactly when total real income is maximized. The distortions that give rise to “good jobs” here lower aggregate real income and so also lower the average real income of workers.

There are also important distributional effects – job loss will fall particularly heavily on some. Since firms in Region I exit and those in Region II contract output, all workers in Region I firms lose their jobs and some in Region II firms lose their jobs as well. It is interesting to observe that although firms in Region III lose profits with the liberalization, workers there do not lose jobs, and so should have no reason to oppose liberalization on this basis.

### **C. Trade Liberalization in Partially Open Economies**

We now consider the consequences of trade liberalization in economies already partially open. We can again separate our discussion into the impact on the structure of the economy, which follows Melitz, and the scale, which requires adjustment for aggregate unemployment. Because the Melitz results are well known, we highlight only the novel consequences in our framework. In the discussion that follows we continue to assume that large firms typically pay higher wages.

The three types of liberalization in partially open economies are (1) An increase in the number of trading partners; (2) A reduction in variable iceberg trading costs; and (3) A reduction in the fixed costs of entering export markets.

The key analytic elements to keep track of are: (i) The shifts in margins between those who produce and those who exit, between those who do or don't export; and between those whose profits rise with the specific liberalization and those whose profits fall; and (ii) Whether the liberalization raises the average wage distortion, with consequent implications for the unemployment rate.

The three types of liberalization in partially open economies share some features. In particular, all three require lower marginal costs for firm survival. This forces the exit of the smallest firms, eliminating the jobs of workers at those firms, which we have suggested will typically, but not always, be lower wage jobs.

The liberalizations differ in their impact on the margins of which firms do or do not export. The increase in the number of trading partners makes it harder for the small exporter to continue, while the decrease in either the marginal or fixed cost of exporting makes entry into foreign markets easier. The logic is simple. An increase in the number of trading partners implies that a firm has opportunities in more markets, but with more competitors, it will have a smaller slice of each market. With the fixed per-market cost of export penetration unchanged, the initially smallest exporters will find that the new per-market demand is too small to justify the fixed cost of entry; they will exit the export markets, requiring lower marginal costs to survive. By contrast, a reduction in variable or fixed costs of trade raises demand or reduces costs associated with entering exporting, so leads to new exporters, i.e. to the entry of relatively high marginal cost exporters.

Firms who cannot export even with the liberalization, or in the case of an increase in the number of trading partners, exit exporting, will find that their domestic market, profits, and employment are all eroded. The jobs lost will not typically be the economy's highest wage jobs, although some of them could be relatively highly paid.

In the case of an increase in the number of trading partners, there will be an interval of surviving exporters near the marginal exporter whose profits fall even as their employment rises due to the larger number of fixed costs involved in servicing the new markets and the smaller demand per market (including the home market). Similarly, in the cases of declines in variable or fixed trade costs, there will be an interval of firms who newly enter the export market, whose employment and output rise, but whose penetration of the foreign markets is insufficient to compensate them for profits lost in the domestic market and the fixed costs of entering foreign markets.

In the case of an increase in the number of trading partners, the greatest gainers are the largest firms, who expand both employment and profits. The fixed costs of trade associated with entry to the new markets are of secondary importance to them, but they gain both by the access to new markets and by the exit of previously marginal exporters. These more than compensate for the loss of domestic market share. The profits of the largest firms also increase in the case of a decline in variable trade costs.

The consequences for pre-existing exporters in the case of a decline in fixed costs of trade are more subtle. We have examined this for a case in which productivity (inverse marginal costs) follows the Pareto distribution. In the case we examine, the smaller pre-existing exporters gain profits from the reduction in the fixed cost of trade while the largest pre-existing exporters lose profits.<sup>10</sup> The intuition for this contrast is straightforward. The benefit of a reduction in the fixed cost of trade is constant for exporters large or small. But since lost revenues are proportional to initial presence in each market, the costs are considerably greater for the larger firms. Hence even if the decline in fixed costs benefits smaller exporters on net (as in our example), sufficiently large firms will find that the lost sales from new entry in all markets outmatches the gain from a lower fixed cost of exporting.

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<sup>10</sup> This provides a small corrective to Melitz (2003), p. 1718, where he claims that all pre-existing exporters lose both revenue and profits as a result of a decline in the fixed costs of trade. The decline in revenue is correct, but the decline in profits is true only for the larger pre-existing exporters.

One of the important consequences of these analyses is that, unlike the case of a move from autarky to free trade, the output and so employment response of firms will not be monotonic in the size, or equivalently, marginal cost of the firm. In particular, output responses will typically be sharpest among firms at either the bottom of the size distribution, where they exit, or in the middle of the distribution, where they transit into or out of exporting. Given that we continue to assume that wages and size are positively correlated, the exit of the smallest firms generally would be expected to raise the average wage. But sharp changes in employment in the middle of the distribution could push either way depending on the direction of employment change (entering or exiting exporter status) and on whether the gains or losses are for jobs above or below the initial average wage. In either case, if the liberalization raises the average wage, the unemployment rate must rise; if it lowers the average wage, the unemployment rate will fall.

## **VII. Conclusions**

There is a strong public perception that trade threatens “good jobs at good wages.” Yet much of the international trade literature abstracts both from issues of aggregate employment and the attachment of workers to particular jobs. Nearly all of the literature that has addressed unemployment has done so in the context of inter-sectoral reallocation, although empirically the vast majority of re-allocation in response to liberalization occurs within sectors.

The recent appearance of models of firm heterogeneity in models of intra-industry trade, notably that of Melitz (2003), provides an opening to address these issues. In this paper, we merge Melitz’s model with the Shapiro-Stiglitz (1984) model of efficiency wages, amended to allow for firm heterogeneity in monitoring. Unemployment arises, as in Shapiro and Stiglitz, as a necessary condition for workers to exert effort. However, our firm based model allows us to go beyond Shapiro and Stiglitz to separate the effects of changes in a firm’s own wage from changes in the economy’s average wage on incentives to shirk, so also on unemployment. While a rise in an individual firm’s wage reduces incentives for shirking, a rise in the average wage raises incentives for shirking and in equilibrium requires a higher unemployment rate consistent with the supply of effort by workers. This meshes well with the Melitz results on the move from autarky to free trade. Here, when this liberalization raises the average wage, which we consider the normal case, it will also raise the unemployment rate.

We also provide a coherent account of the sense in which the public perception that trade threatens good jobs at good wages is correct, if only partial. Framing the issue as a comparison between firms with common levels of technical capability ( $\varphi_i$ ), a move from autarky to free trade indeed eliminates the highest paid jobs, causes contraction of the next highest paid jobs, expands relatively poorly paying jobs, and expands most sharply the lowest paying jobs. Those who lose high paying “good jobs” will not be pleased. However we also show that the productivity-normed perspective is only partial. In particular, it operates even if the net effect of the move from autarky to free trade is to raise the *average wage*. There are good reasons to believe this is the normal case. If the average wage rises with liberalization, as we have noted, so also will the unemployment rate.

Our ability to speak about the attachment of specific workers to specific jobs also provides an opportunity to fill in some elements of political economy missing from the Melitz model. In the original formulation, the move from autarky to free trade creates winners and losers among firms – only the super-exporting firms see their profits rise – but leaves all workers favoring liberalization. This is not an appealing model of worker perspectives on liberalization. In our formulation, unless unemployment rises very sharply, workers who keep their jobs will all experience gains via price reductions and possibly variety gains. This source of gains is also available to workers who lose their jobs, but for many this will be insufficient compensation for the loss of job-specific rents.

This combination of results also suggests a potential rise in the variability of outcomes for workers. Average wages will be expected to rise. But so will the unemployment rate. Some workers will lose what they perceived to be good jobs. If their initial wage was sufficiently high, those workers won't be able to expect to find an equally highly paying job even if the average wage in the economy rose.

In short, this paper provides a framework that allows us to make sense of the public perception that trade threatens good jobs at good wages. Viewed from the proper perspective, this perception is perfectly correct. But it is only partial. A full view of the effects of liberalization also must take account of the productivity enhancements that comes from the equilibrium selection for relatively productive firms. This can be expected to raise the average wage in the economy, although it may also raise certain measures of dispersion of outcomes and leave at least some of those who lost jobs to trade considerably worse off.

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**Figure 1A**  
**Melitz-Type Model and the Autarky Entry Decision**

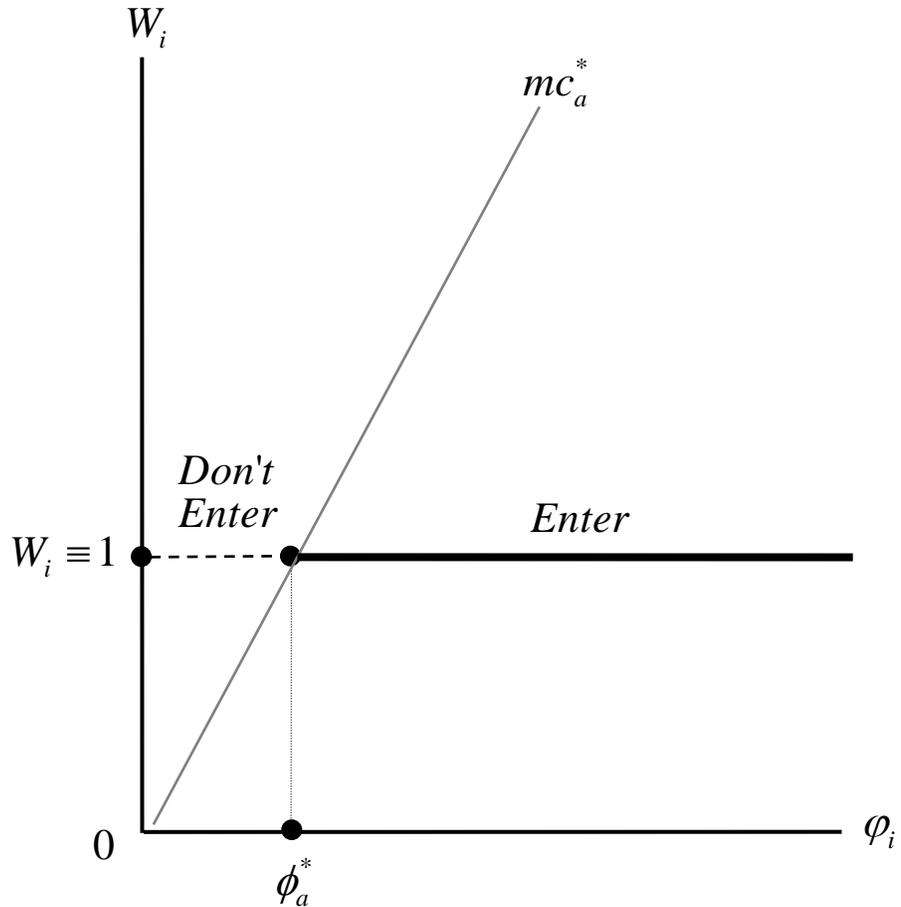


Figure 1A illustrates the first of three models of the entry decision. Generically, all three models condition entry to production on random draws that deliver sufficiently low marginal costs. In a Melitz-type variant of the model, homogeneous labor and identical monitoring costs require firms to pay a common wage  $W_i \equiv 1$  so that the only source of firm-level variation in marginal costs arises from variation in marginal physical productivity  $\phi_i$ . Here, the decision to produce in autarky requires a productivity draw of  $\phi_i \geq \phi_a^*$ .

**Figure 1B**  
**Melitz-Type Model:**  
**Autarky to Free Trade**

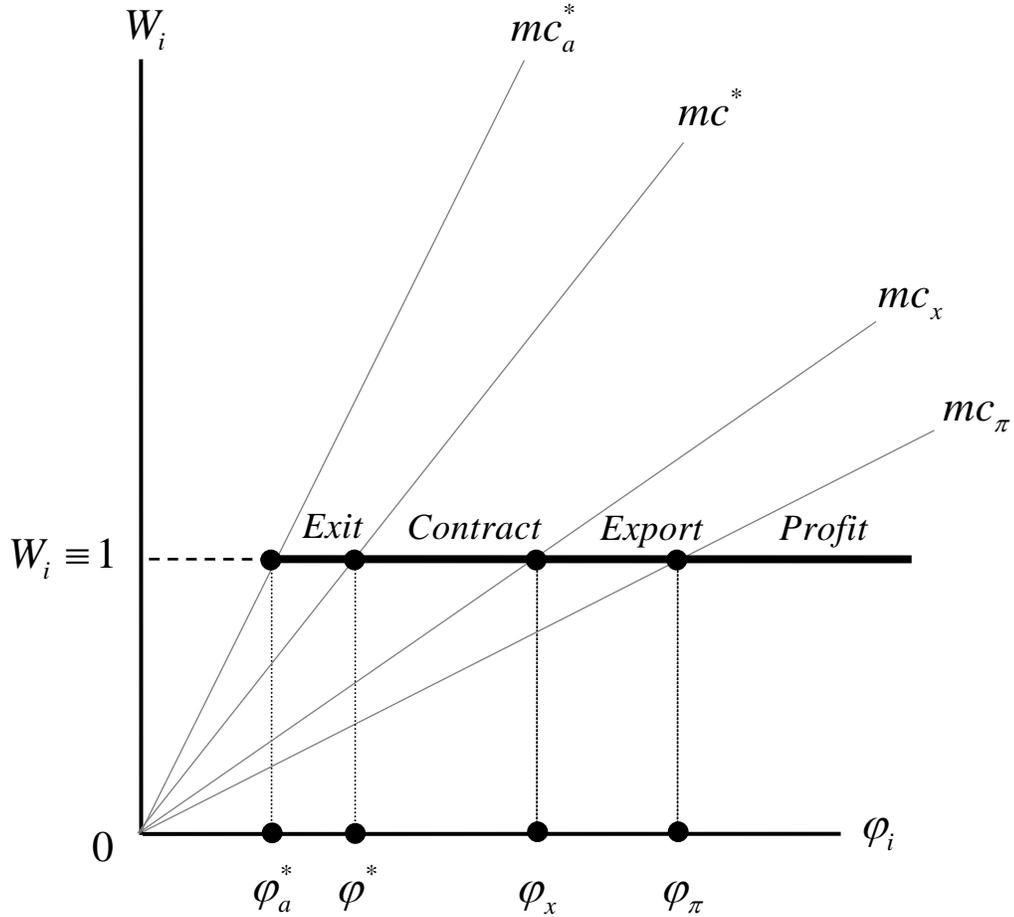


Figure 1B illustrates the move from autarky to free trade in our model when we suppress firm heterogeneity in monitoring, so again the only firm level variation in marginal costs arises, as in Melitz, from differences in marginal physical productivity. The consequences of this liberalization are familiar from Melitz. The lowest productivity firms exit; the next lowest productivity firms contract output; the next higher export, but are unable to maintain their autarkic profit levels; finally, only the super-exporters have higher profits with trade.

**Figure 2A**  
**Heterogeneous Firm Shapiro-Stiglitz Model**  
**and the Autarky Entry Decision**

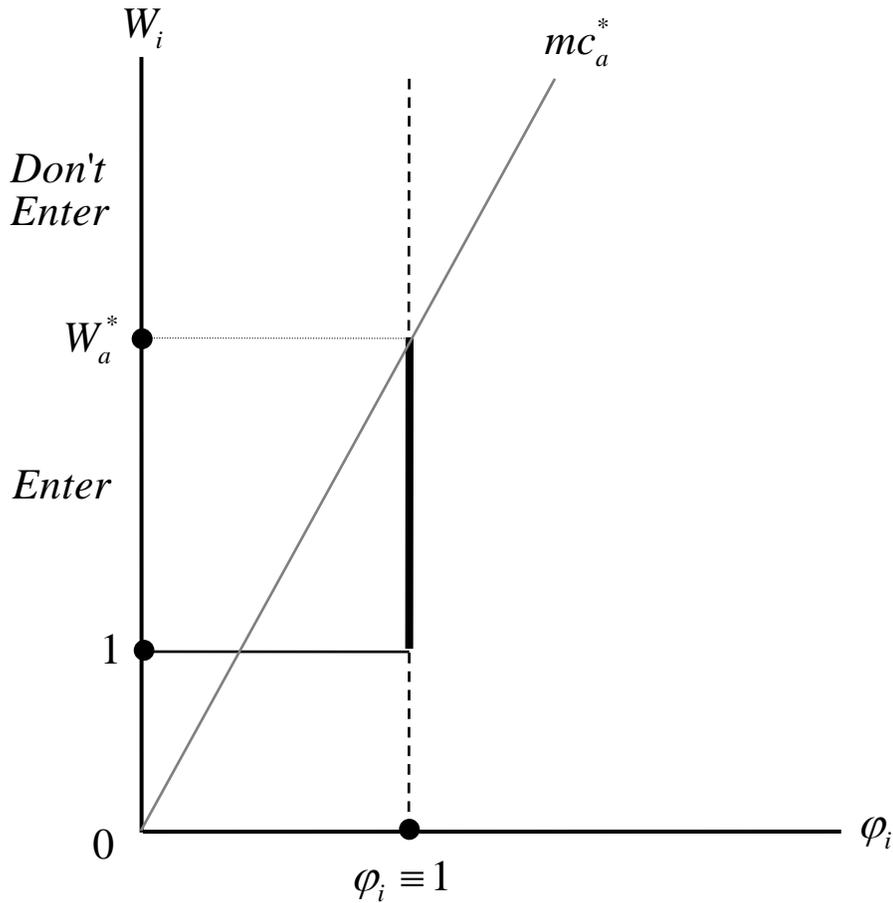


Figure 2A presents the alternative extreme to the Melitz-type approach. In it we abstract entirely from firm-level variation in marginal physical productivity by assuming  $\varphi_i \equiv 1$ . Firm level variation in marginal costs is thus assumed to arise here entirely due to firm level variation in wages  $W_i$ . Marginal costs are  $mc_i = W_i$ , where these firm-level efficiency wages reflect monitoring differences across firms. The minimum feasible wage is unity by choice of numéraire. Firms successfully produce only if  $W_i \in [1, W_a^*]$ .

**Figure 2B**  
**How Trade Threatens “Good Jobs at Good Wages”**

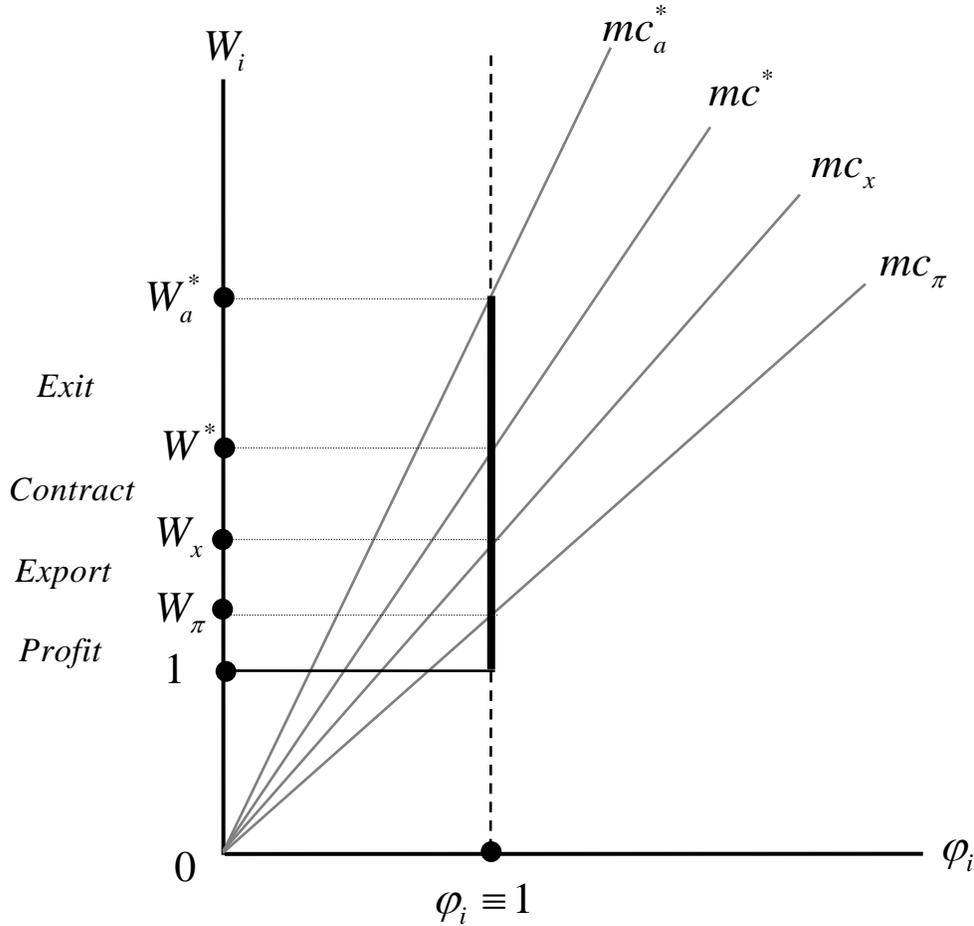


Figure 2B illustrates the consequence of a move from autarky to free trade in the model in which we allow variation in marginal costs to arise only due to firm-level wage variation arising from firm differences in monitoring. It is straightforward to see that it maps the Melitz analysis precisely into this alternative determinant of marginal costs. This also provides the starkest articulation of public fears that trade destroys good jobs at good wages. All of the highest wage jobs, those with  $W_i \in (W^*, W_a^*]$  are destroyed with the liberalization. Firms that pay the next highest wages,  $W_i \in (W_x, W^*]$ , have a contraction of employment. Firms paying the next lower set of wages,  $W_i \in (W_\pi, W_x]$ , manage to penetrate export markets, although on net they lose profits. The firms that pay the lowest wages,  $W_i \in (1, W_\pi]$ , become super-exporters, have the sharpest rise in employment, and are the only firms to profit from this liberalization. Here trade does destroy good jobs with good wages. While shortcomings in this model variant motivate our hybrid model, the threat to good jobs at good wages will survive as a *conditional* prediction.

**Figure 3A**  
**The General Model and the Autarky Entry Decision**

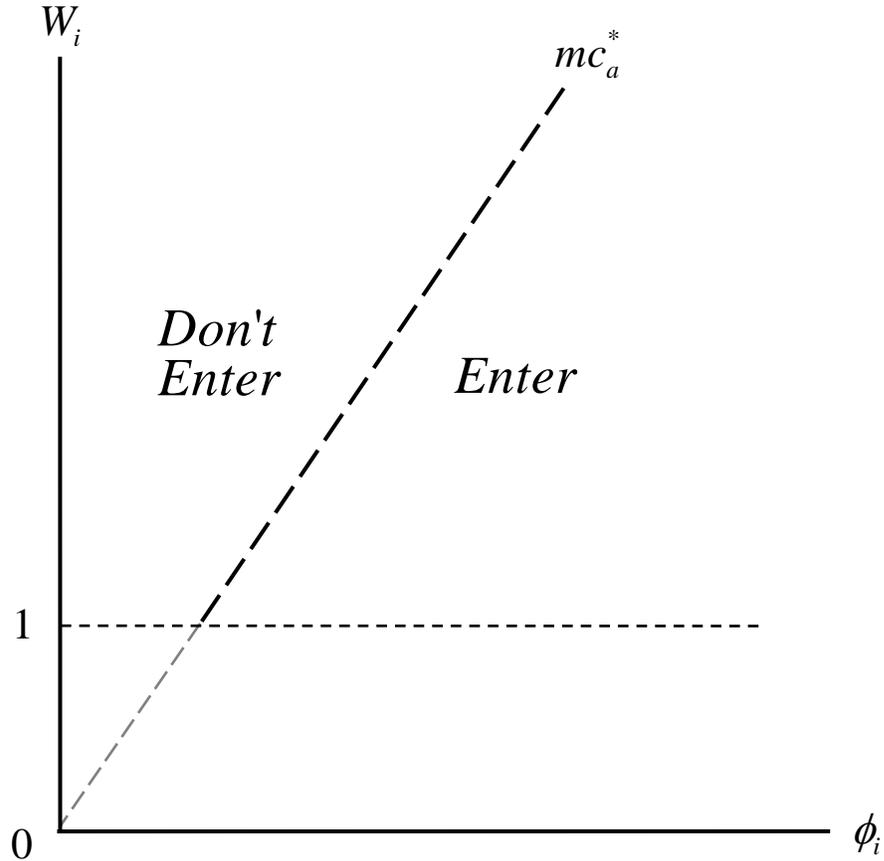
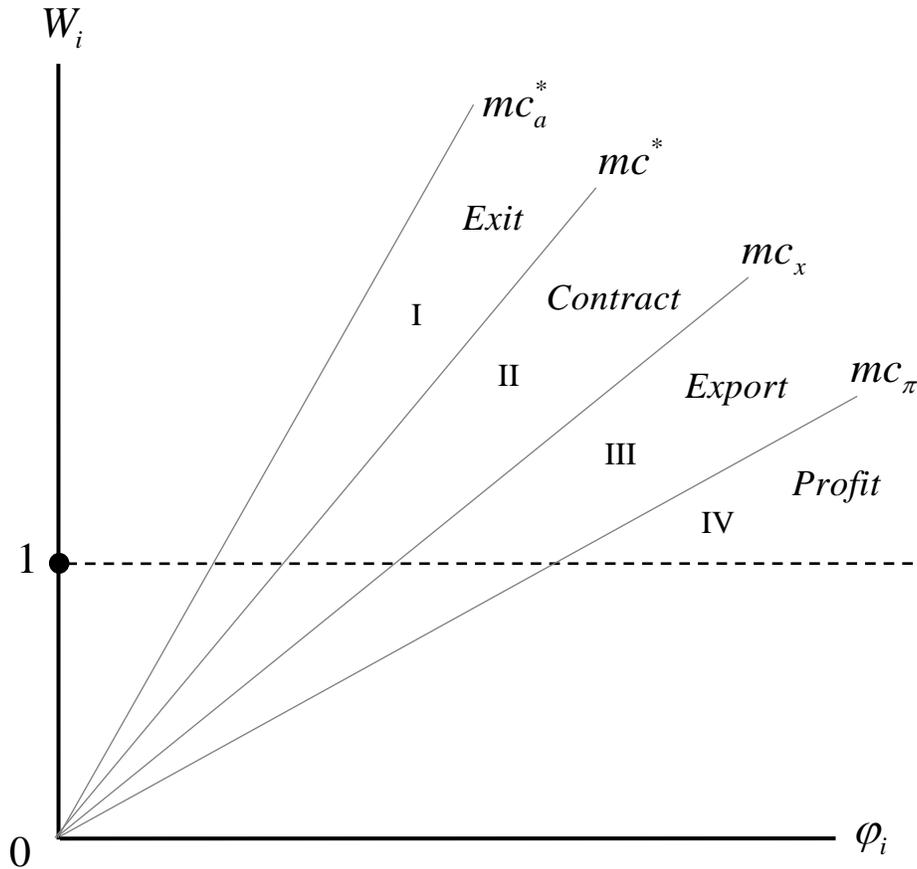


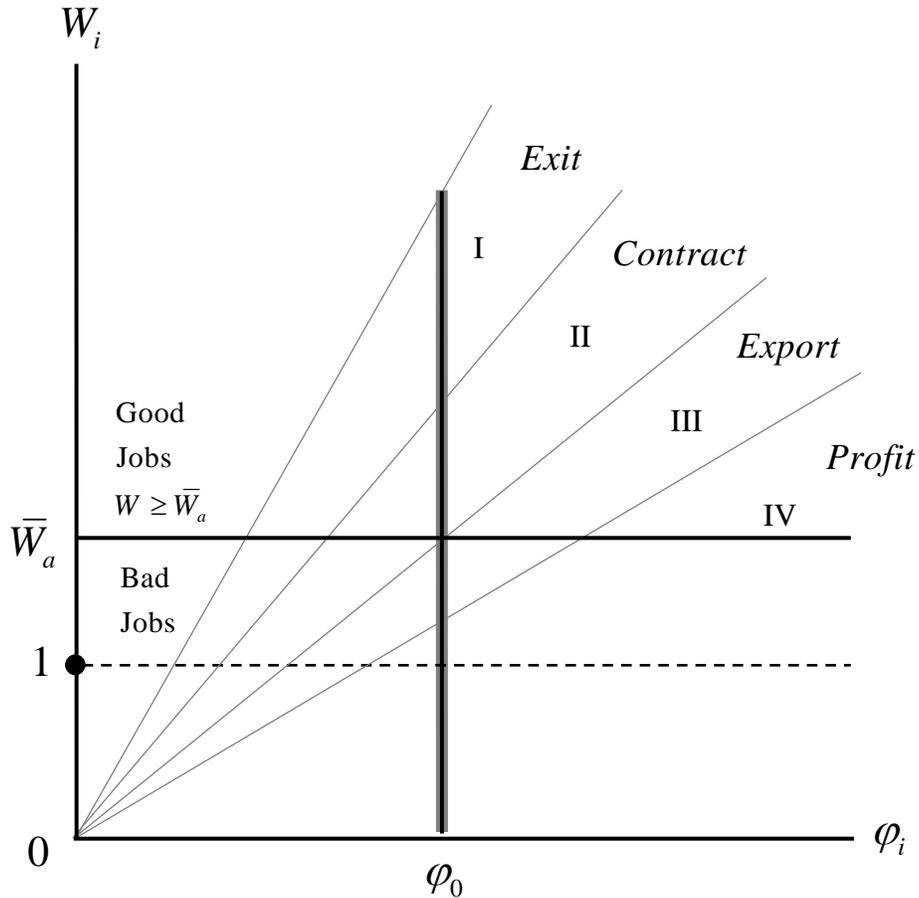
Figure 3A illustrates the autarky production entry decision for our core model. This core model is a hybrid in which marginal costs depend on firm level variation in both wages and marginal physical productivity. These marginal costs are given by  $mc_i \equiv \frac{W_i}{\phi_i} \equiv \frac{1}{z_i}$ , represented as a ray from the origin. The shaded region indicates the fact that our more general model allows for draws of any technology and monitoring that satisfies  $W_i \geq 1$ . Along any ray, firm output, prices, revenues, wage bill, and profits are constant, although firm employment varies inversely with the wage. No firm pays a wage lower than the minimum-monitoring wage, our numéraire. The marginal entrant in autarky, with marginal cost  $mc_a^* = \frac{1}{z_a^*}$ , earns zero profits. The margin of entry is determined by the underlying structure of the heterogeneous firm model.

**Figure 3B**  
**Autarky to Free Trade in the General Model**



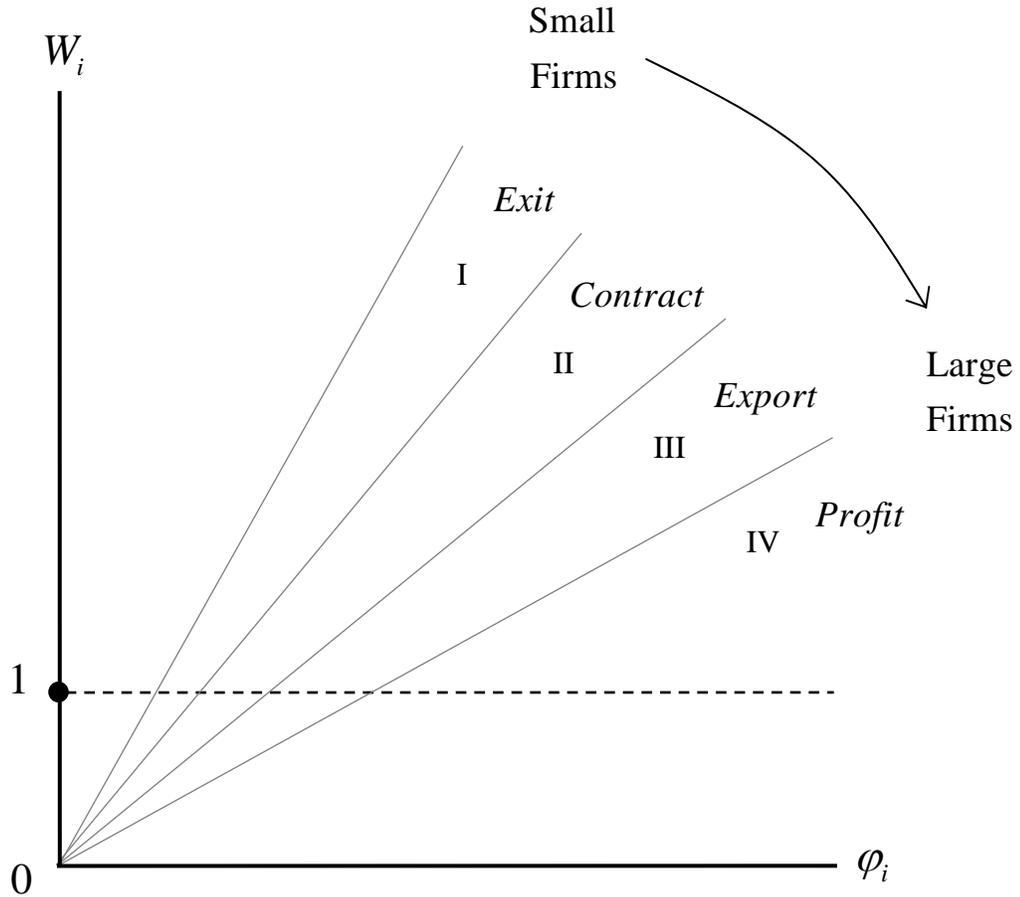
The move from autarky to free trade changes the marginal firms from those with marginal costs  $mc_a^*$  to  $mc^*$ . This leads to exit of the high marginal cost firms in Region I; contraction of the next highest marginal cost firms in Region II; and expansion of low marginal cost firms in Regions III and IV as they enter new export markets. Profits drop to zero in Region I firms and decline for firms in Regions II and III. The Region III firms experience the profit decline in spite of their success in exporting – the loss of local market share and the fixed costs of exporting are not compensated by the new profits in the foreign market. Only the super-exporting firms in Region IV experience higher profits. Job loss occurs wherever output contracts, namely in Regions I and II.

**Figure 4**  
**A Conditional Threat to “Good Jobs at Good Wages”**



A good job may be defined as one that pays more than the average wage in autarky. For illustrative purposes, consider a productivity level  $\varphi_0$  that corresponds to the point at which the average autarky wage curve crosses the boundary between Regions II and III. *Conditional* on productivity level  $\varphi_0$ , the highest wages on offer are at jobs in Region I firms; all of these good jobs are destroyed in the move from autarky to free trade. The next highest wages are on offer at jobs in Region II firms; some of these jobs are lost as output contracts. The Region III jobs expand, but these are bad jobs. The sharpest expansion of jobs occurs at the Region IV firms offering the worst jobs. These Region IV firms offering the worst jobs are also the only ones who increase profits in the move from autarky to free trade. *Conditional* on this productivity level, trade destroys only good jobs and expands only bad jobs.

**Figure 5**  
**How Trade May Raise the Average Wage**



Low marginal cost firms are both the larger firms in autarky and also the firms that expand their output most rapidly with the move from autarky to free trade. If there is a positive correlation between firm size and firm wage, then the fact that liberalization causes the exit or contraction of small firms to the benefit of expanding larger firms would be expected to raise average wages. In terms of our efficiency wage model, this would require that more productive firms have somewhat worse monitoring technologies, but not so much as to fully offset the productivity advantage (hence the positive correlation of wages and size). This might arise, for example, if larger firms require more teamwork, where individual effort may be harder to monitor.