Journal of International Economics 84 (2011) 26–36

Contents lists available at ScienceDirect

Journal of International Economics

journal homepage: www.elsevier.com/locate/jie

Good jobs, bad jobs, and trade liberalization☆

Donald R. Davis [a,*], James Harrigan [b,1]

[a] Columbia University and NBER
[b] University of Virginian and NBER

ARTICLE INFO

Article history:
Received 23 January 2009
Received in revised form 11 February 2011
Accepted 11 March 2011
Available online 21 March 2011

Keywords:
Trade liberalization
Good jobs
Firm heterogeneity
Unemployment

ABSTRACT

How do labor markets adjust to trade liberalization? Leading models of intraindustry trade (Krugman (1981), Melitz (2003)) assume homogeneous workers and full employment, and thus predict that all workers win from trade liberalization, a conclusion at odds with the public debate. Our paper develops a new model that merges Melitz (2003) with Shapiro and Stiglitz (1984), so also links product market churning to labor market churning. Workers care about their jobs because the model features aggregate unemployment and jobs that pay different wages to identical workers. Simulations show that, for reasonable parameter values, as many as one-fourth of existing "good jobs" (those with above average wage) may be destroyed in a liberalization. This is true even as the model shows minimal impact on aggregate unemployment and quite substantial aggregate gains from trade.

1. Introduction

How do labor markets adjust to trade liberalization? Three points motivate our approach to this question. The first is empirical. Most of trade is intra-industry trade and recent experience of large liberalizations suggests that the greater part of adjustment is likewise reallocation within rather than between industries. The second is a point of analysis. Recent theoretical advances that emphasize the role of firm heterogeneity and product market churning also underscore the importance of considering labor market churning in trade liberalization episodes. The third motivation is again empirical. While job rents appear to be more modest than they appeared in some early studies, they remain substantial for some workers and this could be a source of resistance to trade reform.

We develop a model that integrates these elements. Building on Melitz (2003), our model is focused on within industry reallocation, and so is relevant for the bulk of trade and the nature of the most significant trade reforms. Linking Melitz (2003) firm heterogeneity with Shapiro and Stiglitz (1984) efficiency wages at the firm level, there is equilibrium unemployment and jobs have firm specific rents attached, these rents implying that workers distinguish between good and bad jobs. Selection effects now depend both on firm physical productivities and firm wages. Since our model also features the product market churning of Melitz, it likewise features labor market churning. However, unlike in Melitz, job rents and the existence of unemployment mean that workers care about job loss, particularly the loss of good jobs.

We go on to develop a simulation of this economy, with key parameters chosen where possible to match existing empirical estimates, and study liberalization episodes that constitute transitions to Anderson and Van Wincoop's (2003) preferred estimate of actual level of trade integration as well as the case corresponding to the removal of all trade barriers. Trade raises aggregate real income substantially, and the level of unemployment is at plausible magnitudes and is little affected by liberalization. However there is considerable product and labor market churning. With the removal of all border barriers, trade leads to the gross destruction of up to one-fourth of all "good" (above average wage) jobs.

Our approach builds on a sustained dialog about the consequences of trade liberalization for labor markets. Traditional comparative advantage models highlight the potential disruptiveness of trade liberalization, which would require inter-industry reallocation of labor. Krugman–Dixit–Stiglitz type models, by contrast, emphasized that the gains from international exchange of varieties could exist with literally zero re-allocation of labor. The empirical literature is at odds with both hypotheses. Instead, actual trade liberalizations are associated with considerable labor re-allocation, but this takes place primarily within rather than between industries.

This observation accords well with the heterogeneous firm paradigm of Melitz, in which product market churning of firms has as a consequence labor market churning of jobs. However, the Melitz

☆ Much of this paper was written while Davis was visiting, and Harrigan was employed by, the Federal Reserve Bank of New York. The views expressed in this paper are those of the authors and do not necessarily reflect the position of the Federal Reserve Bank of New York or the Federal Reserve System. The authors are grateful to Elhanan Helpman and Oleg Itskhoki for very helpful comments on an early version of this paper, and to seminar participants at Columbia, Fordham, Harvard, Princeton, Yale and the NBER.

* Corresponding author at: Department of Economics, Columbia University, New York, NY 10027, United States.

E-mail addresses: drdavis@columbia.edu (D.R. Davis), james.harrigan@virginia.edu (J. Harrigan).

[1] Department of Economics, University of Virginia, Charlottesville, VA 22904, United States.

0022-1996/$ – see front matter © 2011 Elsevier B.V. All rights reserved.
doi:10.1016/j.jinteco.2011.03.005

model fares less well in another dimension. Key characteristics of the labor market in Melitz include the homogeneity of workers and jobs. All workers are the same, all jobs are the same, and there is full employment. Hence, while there is a churning of jobs, workers do not care about the churning per se, but just enjoy the gains available to all workers. This would be a world in which trade liberalization is uncontroversial, quite unlike the world in which we actually reside.

Our paper is one among a set that aim to reconsider the labor market side of trade liberalization. Related papers include Egger and Kreickemeier (2009), Helpman and Itskhoki (2010), Helpman et al. (2010), and Felbermayr, et al. (2008).

The central message of our paper is simple. The new heterogeneous firm models place essentially all of the weight of gains from trade on the efficiency effects of firm selection. The consequent product market churning has a counterpart in labor market churning. If there is unemployment and if, in addition, some jobs carry empirically relevant rents, then the presence of aggregate gains does not preclude the existence of distributional conflicts between the employed and the unemployed and between workers with good and bad jobs. In contrast to the first generation models of intra-industry exchange, in the new models such distributional conflict is to be expected.

2. Unemployment, efficiency wages, and the firm

2.1. Shapiro–Stiglitz with heterogeneous firm level monitoring and iceberg effort costs

In considering employment relations, we follow the efficiency wage model of Shapiro and Stiglitz (1984), amending this as needed to mesh with the firm-based model of Melitz (2003).

In the Shapiro and Stiglitz model, firms can monitor worker effort only imperfectly. Workers' distaste for effort tempts them to shirk, and they are deterred in equilibrium by the possibility that their shirking will be discovered and they will be fired. Unemployment persists in equilibrium because the wage that firms offer is too high to clear the labor market. Unemployment is bad news for workers, and truly involuntary, in the sense that employed workers are *ex ante* identical to the unemployed yet have higher utility. The market failure is that workers cannot credibly commit to effort at less than the going wage. Our model has all these features, with the crucial difference that firms differ in their ability to detect shirking.

There is a large literature that tests various aspects of the Shapiro–Stiglitz and other efficiency wage models, but there is no paper that directly tests the prediction that monitoring ability and high wages are substitute means to elicit effort. There are a number of papers, including Groshen and Krueger (1990), Rebitzer (1995), and Nagin et al. (2002) that use exogenous variation in monitoring intensity to confirm that effort does indeed increase in monitoring intensity.[2] There is also a literature that documents industry wage differentials (for example, Krueger and Summers (1988)). Such differentials have no direct connection to efficiency wage theory, but they are consistent with labor rents of the sort that obtain in the equilibrium of the Shapiro–Stiglitz model.

Workers are infinitely lived, risk neutral, and discount the future at rate r. Subject to an intertemporal budget constraint, they maximize:

$$E\left[\int_0^\infty U(w_t, e_t)\ \exp[-rt]dt\right]. \tag{1}$$

The real wage for a worker at firm i is $w_i = \frac{W_i}{P}$, where W_i is the nominal wage at firm i and P is the aggregate price index (developed below).

[2] We have also observed a positive relationship between monitoring intensity and homework effort by resident adolescents. We believe that such an effect is well-known to other parents.

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

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

Here the cost of effort e 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).[3]

Workers lose their job only if the firm dies or they are caught shirking. Firm death happens at an exogenous rate δ. We assume that no firm monitors effort perfectly. If workers at firm i were to shirk, they would face a hazard $m_i \in (0, \overline{m}]$ of detection, where $\overline{m}$ reflects the monitoring ability of the firm most proficient at monitoring. If detected shirking, workers face the penalty of being fired and spending time 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:

$$rV_{Ei}^N = \frac{w_i}{e} + \delta\left(V_U - V_{Ei}^N\right) \tag{2}$$

$$rV_{Ei}^S = w_i + (\delta + m_i)\left(V_U - V_{Ei}^S\right). \tag{3}$$

These consist of the flow real wage benefits, (w_i/e) or w_i respectively, plus an expected capital loss in case of a shift to unemployment, where the instantaneous probabilities differ because shirkers face a higher likelihood 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.

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:

$$V_{Ei}^N \geq V_{Ei}^S. \tag{4}$$

The firm chooses to meet this non-shirking constraint with equality (so $V_{Ei}^N = V_{Ei}^S = V_{Ei}$). We can solve this for the firm-level equivalent of the Shapiro–Stiglitz no-shirking constraint:

$$w_i = \frac{rV_U}{\hat{m}_i} \quad \text{where} \quad \hat{m}_i = \frac{m_i - (e-1)(r+\delta)}{em_i} \quad \text{and} \quad \frac{\partial \hat{m}_i}{\partial m_i} > 0. \tag{5}$$

Since V_U is independent of firm identity, wages will vary across firms only due to monitoring ability and equilibrium wages decline

[3] 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 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 Eq. (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. 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.

with improvements in monitoring. Note as well 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.[4]

These allow us to have a precise definition of the utility cost of job loss for a worker at firm i:

$$V_{Ei} - V_U = \frac{(W_i / m_i)}{P}\left[\frac{e-1}{e}\right]. \quad (6)$$

This is always positive, which means job loss is costly to workers and that unemployment is truly involuntary. Moreover, the utility cost of job loss varies across firms, being high where the wage distortion (W_i/m_i) is high.

We can also return to the firm-specific real wages in Eq. (5) and consider it for any two firms A and B. Taking ratios, we find that:

$$\frac{w_A}{w_B} = \frac{\hat{m}_B}{\hat{m}_A} = \frac{W_A}{W_B}. \quad (7)$$

That is, the firm-specific real and nominal wages are in a constant ratio that depends inversely on the firm-level relative monitoring abilities as well as common parameters. With firm level physical marginal productivities also constant (as developed below), we 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 type with the best available monitoring technology, given by $m_1 = \overline{m} < \infty$. We will choose the wage paid at the best monitoring firm as our numéraire, so that the nominal wage $W_1 \equiv 1$. Using Eq. (7), this gives rise to a notional nominal wage schedule

$$W_i = \frac{m_i[\overline{m} - (e-1)(r+\delta)]}{\overline{m}[m_i - (e-1)(r+\delta)]} \quad (8)$$

which is greater than one for $m_i \in (0, \overline{m})$ and decreasing in m_i. Firms pay a wage premium relative to that of the firm with the best monitoring technology, a premium that 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.

2.2. Aggregation

The next step is to connect wages to unemployment. For this we need an equilibrium density of the wages paid by active firms $f(W)$, to be derived later, and which will be common knowledge in the economy. Given this equilibrium density, we can 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,

$$V_E - V_U = \left[\frac{e-1}{e}\right]P^{-1}\left(\frac{W}{m}\right)^*, \quad \text{where} \quad V_E \equiv E(V_{Ei}), \quad \left(\frac{W}{m}\right)^* \equiv E\left(\frac{W_i}{m_i}\right). \quad (9)$$

The average wage distortion $\left(\frac{W}{m}\right)^*$ will play a crucial role in what follows.

[4] Eq. (5) requires the parameter restriction: $m_i/(r+\delta) > (e-1)$. The left-hand side is the hazard rate of detection relative to the discounted hazard 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.

We are now ready to consider the flow benefits of being unemployed. Since unemployed workers receive no income, the flow benefits consist entirely of the expected capital gain from re-employment. Let b be the instantaneous probability of re-employment of an unemployed worker. Then the fundamental asset equation for an unemployed worker is:

$$rV_U = b(V_E - V_U). \quad (10)$$

We can substitute Eq. (9) into Eq. (10) to get

$$rV_U = b\left(\left[\frac{e-1}{e}\right]P^{-1}\left(\frac{W}{m}\right)^*\right). \quad (11)$$

The hazard rate of re-employment of an unemployed worker, b, 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 δ. Then the steady state imposes that:

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

or, defining the unemployment rate $u \equiv U/L$,

$$b = \delta\left(\frac{1-u}{u}\right) \quad (12)$$

Substituting Eq. (12) into Eq. (11) gives

$$rV_U = \delta\left(\frac{1-u}{u}\right)\left(\left[\frac{e-1}{e}\right]P^{-1}\left(\frac{W}{m}\right)^*\right). \quad (13)$$

Substituting Eq. (13) into the individual firm's no-shirking constraint (5). We find:

$$W_i = \left[\frac{\delta(e-1)}{e\,\hat{m}_i}\right]\left(\frac{1-u}{u}\right)\left(\frac{W}{m}\right)^*. \quad (14)$$

This no-shirking constraint is a key link between the macro variables u and $(W/m)^*$.

We now focus on Eq. (14) for the best monitoring firm 1, whose nominal wage serves as numéraire. Setting $W_1 = 1$ and inserting $\hat{m}_1$ with $m_1 = \overline{m}$, this implies:

$$u = \left[\frac{A_1\left(\frac{W}{m}\right)^*}{1 + A_1\left(\frac{W}{m}\right)^*}\right] \quad \text{where} \quad A_1 \equiv \left[\frac{\delta(e-1)}{e\hat{m}_1}\right] \text{ is a constant} \quad (15)$$

so the unemployment rate is strictly between 0 and 1, as required.

Eq. (15) is central to the macro side of our model. Consider this first for a given wage distortion $(W/m)^*$. Unemployment is then increasing in both the death rate of jobs δ as well as the utility cost of effort e. Each shifts the balance of benefits against effort, the first because expected job tenure declines and the second because the utility derived from non-shirking employment declines.

We can also look at Eq. (15) for given A_1, so focusing on $(W/m)^*$. From the Shapiro–Stiglitz side of our model, the average wage distortion must be computed across all active jobs. As in Helpman et al. (2010), we abstract from wage distortions in the fixed costs, here by assuming that monitoring costs in these activities are common at all firms and for simplicity setting this equal to those of the best monitoring activity, i.e. $\overline{m}$, so the associated wage is unity. Looking inside any single firm, all fixed cost activities have a wage distortion of $(1/\overline{m})$, while marginal cost activities have a wage distortion of (W_i/m_i). As we show in the next section, in response to trade liberalization there will be two sources of changes in the average wage distortion. The first is within the firm, due to the fact that the mix of fixed and marginal activities changes. The second is the redistribution of these activities across firms, as some expand output to reach new markets, others contract and serve only the domestic market, while others exit, in addition to the fact that the steady state mass of entry will adjust. From Eq. (9), the capital gain associated with moving out of unemployment rises with the average wage distortion $(W/m)^*$. 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 Eq. (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 $r\to 0$, to be consistent with his assumption that firms do not discount the future. By inspection of Eqs. (8) and (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 model yields two key relations that carry over to the Melitz side of our model. The first is a schedule of nominal wages relative to that paid by the most proficient monitoring firm. This pins down firm marginal costs. A second key macro relation is between the no-shirking unemployment rate and the average firm distortion, defined as the employment-weighted average ratio of the nominal firm wage to its monitoring ability. That ratio emerges endogenously from the Melitz side of the model and so determines the equilibrium unemployment rate.

3. The product market

3.1. The consumer's problem

Preferences over goods are identical and homothetic. The representative consumer allocates expenditures to:

$$\text{Min}\, E = \int p(i)q(i)di$$
$$s.t.\left[\int q(i)^{\rho}di\right]^{\frac{1}{\rho}} = V.$$

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

$$P = \left[\int p(i)^{1-\sigma}di\right]^{\frac{1}{1-\sigma}}. \tag{16}$$

The associated revenues for the producer of an individual variety from this consumer are:

$$r(i) = RP^{\sigma-1}p(i)^{1-\sigma}. \tag{17}$$

These revenues depend both on aggregate values, $RP^{\sigma-1}$, as well as the firm choice of $p(i)$.

3.2. 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 (φ_i, m_i) covering both productivity and monitoring ability in variable costs. We saw above in Eq. (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 (φ_i, m_i) to a productivity-nominal-wage draw (φ_i, W_i). In Melitz (2003), it is productivity φ that determines firm performance. We show below that the determinant of performance in our model is productivity adjusted for the firm-specific wage, which we denote as $z_i=\varphi_i/W_i$. Here z_i can be thought of equivalently as the inverse marginal cost for firm i.

We consider now the problem of an individual firm that has already sunk the cost f_e to learn its inverse marginal cost z_i. Having learned its z_i, firm i will produce if its variable profits cover its per period fixed costs f; otherwise it will exit before producing. Physical labor requirements in firm z_i follow Melitz:

$$\ell(z_i,\varphi_i) = f + \frac{q(z_i)}{\varphi_i}. \tag{18}$$

Note that firm level physical labor demand requires knowledge of φ_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.

Costs also depend on the wages paid to workers in fixed cost activities. Our focus on 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 any of its fixed costs and a wage W_i for labor employed in its variable costs.[5]

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

$$\pi_i = p_i\cdot q_i - W_i\frac{q_i}{\varphi_i} - f = p_i\cdot q_i - \frac{q_i}{z_i} - f = \frac{r_i(z_i)}{\sigma} - f. \tag{19}$$

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, and employing different amounts of labor, but they charge the same price, will produce the same quantity, and have the same revenue, wage bill, and profits. Hence we will drop the subscript i henceforth except as necessary to clarify limits of integration or when it is necessary to specify physical labor demand.

3.3. The marginal firm and equilibrium structure of the economy

The combination of a primitive distribution on (φ, m) and the equilibrium nominal wage from the labor market in Eq. (8) allows us to derive the joint distribution for (φ, W). Knowledge of this joint distribution allows us as well to calculate the distribution of inverse marginal costs z with cumulative distribution function $G(z)\equiv Pr[Z\le z]$ 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:

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

[5] This asymmetry between wages paid in fixed and marginal costs is for analytical convenience only, and is directly analogous to Melitz's assumption that firms differ only in their marginal and not their fixed costs. An alternative modeling choice would be to specify a second, constant returns sector, and have fixed costs paid in units of that sector, as for example in Helpman, Itskhoki and Redding (2010).

Equilibrium structure in an autarkic Melitz economy is determined by the solution of two relations between average profits $\bar{\pi}$ and the wage-adjusted productivity 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. The FE condition is essentially identical to that of Melitz:

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

The second key relation is the Zero Cutoff Productivity (ZCP), which defines the marginal active firm:

$$\pi(z^*) = \frac{r(z^*)}{\sigma} - f = 0. \tag{ZCP}$$

As in Melitz, the intersection of the FE and the ZCP curves determines the equilibrium marginal entrant z^*. The equilibrium exists and is unique under the same conditions.

4. General equilibrium

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

4.1. Unemployment and labor market equilibrium

We showed in Eq. (15) that the unemployment rate is an increasing function of the average wage distortion $\left(\frac{W}{m}\right)^*$. In computing the average wage distortion, we account for the fact that workers in fixed cost activities are paid a wage of 1, while workers in variable cost activities are paid a wage given by Eq. (8). Employment in active firms is given by Eq. (18). Let $\psi(i|z^*)$ denote the density of active firms, where $i=(\varphi, W)$ identifies a firm type. This density depends on the primitive joint density of (φ, W) as well as the cutoff z^* determined in the previous section. The employment-weighted average wage distortion in the economy per unit mass of active firms is then

$$\left(\frac{W}{m}\right)^* = \frac{\delta}{1-G(z^*)} f_e + f + \int \frac{q(i)}{\varphi(i)} \frac{W(i)}{m(i)} \psi\left(i|z^*\right) di. \tag{20}$$

Plugging Eq. (20) into Eq. (15) delivers the equilibrium unemployment rate. With the unemployment rate determined, the equilibrium mass of firms M is determined by setting employed labor equal to labor demand,

$$(1-u)L = M\left[\frac{\delta}{1-G(z^*)} f_e + f + \int \frac{q(i)}{\varphi(i)} \psi\left(i|z^*\right) di\right]. \tag{21}$$

The mass of active firms plus their prices allows us to establish the aggregate price index P as in Melitz. Aggregate income equals total wages and likewise equals total spending.[6] This completes the specification of our model.

[6] Unlike in Melitz, nominal national income is not simply equal to the size of the labor force.

4.2. Trade and selection effects

In this section, we describe elements of the trading equilibrium that will be relevant for the discussions in subsequent sections. As before, key elements of equilibrium will be determined by the intersection of two curves. The first is the free entry curve, which is defined so that *ex ante* profits are zero, hence ties each potential cutoff z with an expected profit level $\bar{\pi}$. This curve is entirely unchanged in a move from autarky to costly trade. The second is the Zero Cutoff Productivity (ZCP) curve which lies above the autarky ZCP curve for the same reasons as in Melitz. This implies that the equilibrium cutoff z^* must rise. That is, our model will feature the same kind of selection effects as in Melitz and for exactly the same reason — i.e. the new opportunities available to exporters and the new pressures from import competition. Given z^*, the cutoff for exporting z_x is also found as in Melitz. With these cutoffs, we can calculate the new $(W/m)^*$, hence also determine the unemployment rate. With these in hand, we can return to recover all other variables in the trading equilibrium.

4.3. Monitoring, productivity, and the size-wage correlation

Unlike Melitz (2003), our model features two dimensions of random heterogeneity across firms, productivity φ and monitoring ability m, and so far we have made no assumptions about the *ex ante* correlation between them. Heterogeneity in m delivers heterogeneity in wages W through Eq. (8), which determines each firm's inverse marginal cost $z=\varphi/W$. Firm size (measured by sales) in our model is a monotonic function of z, which implies that for a given φ that high-wage firms will be smaller. This is at variance with the data, which instead shows a positive correlation between wages and firm size (see Brown and Medoff (1989), Idson and Oi (1999) and Manning (2003), among others). Since the size-wage correlation is an important empirical aspect of firm heterogeneity, here we provide some discussion of how it fits into our framework.

In our model, even if the *ex ante* correlation between φ and m is zero, the Melitz-style selection effects will tend to induce an *ex post* positive correlation between φ and W. This is because competition will force the exit of high marginal cost firms, i.e. those with high W but low φ. Thus a positive size-wage correlation is possible in our model even with no *ex ante* correlation between φ and m. However, in our numerical simulations below it turns out that a small negative *ex ante* correlation between productivity and monitoring ability is needed to get the simulated size-wage correlation to match the empirical evidence. Thus while we do not model the determinants of monitoring at the firm level, it is worth looking more closely at the issue.

Mehta (1998) provides an account of the size-wage distribution that, while not developed in the context of the Melitz model, nonetheless meshes quite naturally with it. Mehta emphasizes the crucial role of hierarchy in production, so he distinguishes managers from workers. Managers have two tasks. One is to monitor the effort of workers and the other is to engage in coordination of workers in ways that raise productivity. Large firms pair managers with increasing numbers of workers. This increased span of control for the manager leads the manager to substitute higher wages for monitoring as a way to elicit effort. While modeling of this trade-off is beyond the scope of our paper, we can easily think of the manager in the Melitz context as the residual claimant to profits at the firm. Thus, in reduced form, the approach of Mehta is captured in the assumption in some of the numerical exercises below that monitoring efficiency is inversely related to productivity.

Helpman et al. (2010) also provide a model of heterogeneous firms that in equilibrium has a positive firm size-wage correlation. While their labor market mechanism is quite different from ours, the motivation of their production structure that gives rise to the firm size-wage correlation is quite similar to Mehta's and ours: managerial time is a fixed factor, so managers supervise each worker less intensively in larger organizations.

5. Trade liberalization

This section will consider the consequences for firms and workers of trade liberalization in our model. We divide our discussion of a move from autarky to freer trade into two pieces. The first will consider the case of a liberalization that affects the structure of the economy, i.e. the equilibrium marginal cost cutoff, but not its scale, i.e. the average wage distortion, $(W/m)^*$, which determines the equilibrium unemployment rate. Depending on the primitive distribution of productivity and monitoring (φ, m), 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.

5.1. Changes in structure only

We consider here the special case in which our economies move from autarky to freer 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 Fig. 1 to think about the comparison of autarky and freer trade as it affects profits of firms and employment of workers. The lowest feasible wage is that associated with the best monitoring firm and equals one by choice of numéraire. A ray from the origin is also a

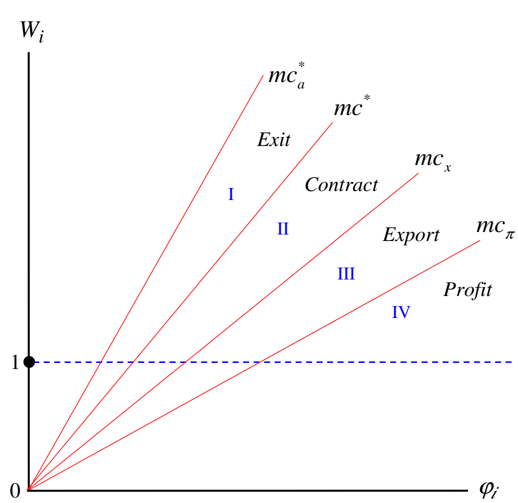

Fig. 1. Autarky to freer trade. The move from autarky to free trade changes the marginal firms from those with marginal costs mc_a* to mc*. This leads to exit of the high marginal cost firms in Region I; contraction of the next highest marginal cost firms in Region II; and expansion of low marginal cost 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.

constant marginal cost curve. The ray labeled mc_a* indicates the highest level of marginal cost consistent with zero post-entry profits in autarky, 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.

The impact of the shift in comparative steady states from autarky to trade gives rise to three additional critical values in inverse marginal costs. The first is mc*, the marginal entrant under freer trade. Next is mc_x, the marginal exporter. Finally is mc_π, the highest marginal cost for which a firm sees its profits rise with freer 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 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 freer trade. The firms there are expanding output, so should have no unusual layoffs. They also enjoy gains from lower average 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 price index 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, trade liberalization 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 analysis 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 φ, and compare what happens to different types of jobs at comparable firms defined in this way. Fig. 2 provides a simple window on this way of looking at the world. To the previous diagram, Fig. 2 adds the average wage in autarky, $\overline{W}_a$, and a specific productivity level φ_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. $W_a > \overline{W}_a$. Holding productivity fixed at φ_0, we see that trade threatens *all and only* good jobs. Controlling for firm productivity φ_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 φ_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 freer 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.

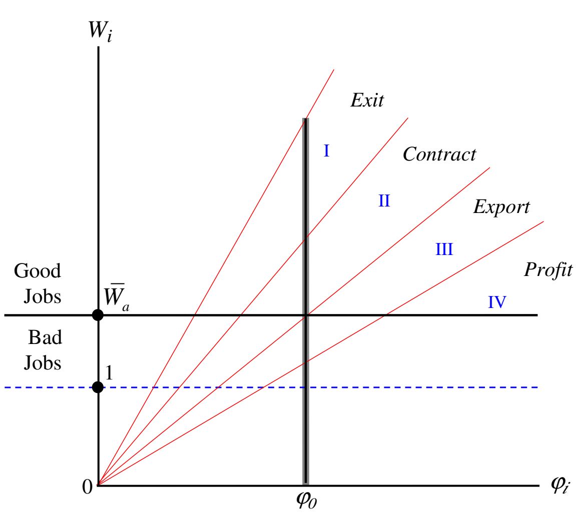

Fig. 2. A *conditional* threat to "good jobs at good wages". A good job may be defined as one that pays more than the average wage in autarky. For illustrative purposes, consider a productivity level φ_0 that corresponds to the point at which the average autarky wage curve crosses the boundary between Regions II and III. *Conditional* on productivity level φ_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.

5.2. 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 we turn to this now. The firm level wage distortion, (W_i/m_i), is a constant, and 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 different 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 (ϕ, m).[7] In short, $(W/m)^*$ is a function of z^*, but it need not be monotonic.

5.2.1. 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 distortion raises equilibrium unemployment. From Eq. (15), we recall that $u = A_1\left(\frac{W}{m}\right)^* / \left[1 + A_1\left(\frac{W}{m}\right)^*\right]$. As discussed in Section 2.2., a 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 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.

The rise in unemployment anticipated with the move from autarky to freer 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.[8]

[7] 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.

[8] 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.

5.2.2. Political economy

The main thrust of the political economy for comparative steady states from the view of firms can be understood through examination of Fig. 1. As before, the move from autarky to freer 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 freer trade. Only the largest firms, those with $mc < mc_{\pi}$ gain. Hence a move from autarky to freer 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 may 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 freer trade, which is a gain to all workers.

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, $(W/m)^*$, 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 $(W/m)^*$ 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.

6. Numerical analysis

Our model offers a rich set of predictions for how labor markets adjust to trade liberalization. In this section we simulate the model, using a calibration approach that identifies key parameters from the data and from previous estimates. The simulations establish the magnitude of effects identified in the model.[9]

Previewing our numerical results, trade liberalization leads to little change in the unemployment rate, a rise in aggregate real income, and tremendous churning in the labor market, with the gross loss of as many as one-fourth of good jobs.

The numerical version of our model requires specification of the *ex ante* joint distribution of productivity and wages, as well as values for the other model parameters such as fixed and variable trade costs, fixed and sunk entry costs, and the elasticity of substitution. The following sections explain our choices for these parameters in detail.

6.1. The wage distribution

In specifying the distribution of productivity and wages, we are guided by the large empirical literature on the firm size and wage distributions. This literature almost invariably models wages as log normal, and the firm size distribution as Pareto, so we do the same.

A key parameter in our model is the dispersion of wage rents. As discussed in our Introduction, Krueger and Summers (1988), among others, argued that large measured industry wage differentials were evidence of labor rents, while Murphy and Topel (1987) and others argued that unobserved heterogeneity in workers' marginal products was responsible for industry wage differentials. A similar dispute arises in interpreting the well-documented correlation between firm size and wages (e.g. Brown and Medoff (1989), Idson and Oi (1999), Manning (2003, Chapter 4)). To resolve this dispute requires information on worker and firm characteristics, as well as enough "job switchers" to be able to reliably identify what component of a worker's wage is due to her inherent productivity and what component is due to the firm where she works. Abowd et al. (1999) assembled data (a panel of French workers and firms from 1976 to 1987) that can answer this question. Their conclusion is that the "person" effect is much more important than the "firm effect":

> Virtually all of the inter-industry wage differential is explained by the variation in average individual heterogeneity across sectors. Person effects, and not firm effects, form the basis for most of the inter-industrial salary structure. (Abowd et al., 1999, pg. 253)

While this result can reasonably be interpreted as vindication for the view that labor rents are smaller than Krueger and Summers may have thought, "virtually all" does not mean all. In their Table IV, middle panel, Abowd et al. report their estimate of the standard deviation of the firm effect on log French wages as 0.06.[10] In our model the "firm effect" corresponds to wage variation due to variation in monitoring ability across firms, so we parameterize the marginal distribution of wages $F_w(w)$ as being log normal with a standard deviation of 0.06.

6.2. The productivity distribution and elasticity of substitution

Following many authors, we model the *ex ante* marginal distribution of unit labor requirements a (where $a = \varphi^{-1}$) as a Pareto distribution with shape parameter κ and upper bound α. The Melitz (2003) model can be solved analytically with this distribution (Baldwin 2005), a set of results that we will refer to here as the "Pareto–Melitz" model. Although our model has no analytic solution, the Pareto–Melitz model proves very useful in guiding our choices for five parameters: the Pareto shape parameter κ, the elasticity of substitution σ, the sunk cost of entry f_e, the fixed cost of production f, and the fixed cost of exporting f_x.

Solution of the Pareto–Melitz model requires that $\kappa > \sigma - 1 > 0$. In choosing κ and σ to satisfy these restrictions, we follow two strategies. The first relies on the literature on the firm size distribution, which generally finds values for κ that are not much bigger than one. For example, Corcos et al. (2009) estimate that κ ranges between 1.8 and 2.5 across industries and European countries in 2000, with the larger industries having values close to 2.[11] Taking this value for κ constrains us to a very low value of $\sigma = 2$, despite the fact that most estimates of σ exceed 2 (for example, Harrigan (1993) estimates σ to be between 5 and 12, while Broda and Weinstein (2006) find median values of σ greater than 2).

Our second approach to choosing κ and σ follows Ghironi and Melitz (2005). They use the analysis of 1992 U.S. plant level data by Bernard et al. (2003) to calibrate their version of the Pareto–Melitz

[9] All calculations were performed in *Mathematica*, and the programs are available on request.

[10] We are referring here to Abowd et al.'s parameter ψ. The estimate is 0.0685 for men, 0.0566 for women. The sample standard deviations of log wages are 0.519 and 0.480 for men and women respectively, so the ratios of the standard deviation of the firm effect to the standard deviation of log wage are 0.13 and 0.12 for men and women respectively.

[11] These numbers come from Table 7 in Corcos et al. (2009).

model, which implies $\kappa = 3.4$, $\sigma = 3.8$ (see Ghironi and Melitz (2005) for details). This choice of parameters allows for a more realistic choice of σ, although $\kappa = 3.4$ is substantially higher than what is found by Corcos et al. Thus there is an uncomfortable tension between the mathematical requirements of the model and the empirical evidence, regardless of the choice of κ and σ. We report results using both cases below.

The Pareto upper bound parameter α is a normalization, set to 10 for numerical reasons.

6.3. Variable and fixed trade costs

Our measures of variable trade costs come from the influential survey by Anderson and van Wincoop (2004). Using U.S. and other data sources, the authors report that *ad valorem* equivalent trade costs are about 74%, which reflects the combined influence of border costs of 44% and transport costs (including the time cost of goods in transit) of 21%. Thus in our simulations, we take $\tau = 1.74$ as our measure of variable trade costs in the move from autarky to trade. We also report simulations that set all border barriers to zero, which implies $\tau = 1.21$. The difference between $\tau = 1.74$ and $\tau = 1.21$ is thus a measure of the effect of the removal of all border barriers.

Turning to the choice of fixed costs, in the Pareto–Melitz model the entry and export choices depend respectively on the fixed cost ratios f/f_e and f_x/f. To calibrate f_x/f, we use the result that the share of exporting plants is $\tau^{-\kappa}[f_x/f]^{\frac{\kappa}{1-\sigma}}$. This share was 0.21 for U.S. plants in 1992, and the corresponding share for French firms in 2000 was 0.22 (see Bernard et al. and Corcos et al. respectively for these numbers). Setting $\tau = 1.74$, we back out f_x/f to match 0.215.

The Pareto–Melitz model also delivers an expression for the share of firms that enter once they have paid the sunk cost f_e, and this share depends on f/f_e. However, there is no empirical counterpart to firms that do not enter, so there is no moment which we can use to back out an estimate of f/f_e. We rather uncomfortably choose $f/f_e = 0.2$, which guarantees an interior solution given all of our other parameter values. Fortunately, wide variation in the choice of f/f_e has almost no effect on our results.

6.4. Parameters of the efficiency wage model

With wages given by draws from the distribution $F_w(w)$, the associated values of monitoring costs are given by inverting Eq. (8). To guide our choice of the remaining parameters of the efficiency wage model, we work with Eq. (15), which gives the equilibrium unemployment rate. Along with the average distortion, the determinants of the equilibrium unemployment rate are the exogenous firm death rate δ, the utility cost of effort e, and the upper bound on monitoring efficiency $\overline{m}$. Following Bernard et al. and Corcos et al., we set $\delta = 0.1$ to match the annual hazard rate for U.S. plant exit. We choose e and $\overline{m}$ together so that the equilibrium unemployment rate is reasonable for an OECD country, which leads us to $e = 1.0001$ and $\overline{m} = 2000$.

6.5. Joint distribution of wages and productivity

With the marginal distributions for wages and productivity fixed by the considerations described above, it remains to model the joint distribution. We do so using the Ali–Mikhail–Haq copula, which specifies the joint cdf of wages w and unit labor requirements a as a function of the marginal cdfs and a parameter θ,

$$F(w,a) = \frac{F_w(w)F_a(a)}{1-\theta(1-F_w(w))(1-F_a(a))}, \quad \theta \in [-1,1).$$

The degree of association between w and a is governed by θ, with independence corresponding to $\theta = 0$. We set $\theta = -0.9$, which implies a small *ex ante* correlation between productivity and wages of 0.144, and an *ex post* positive correlation between firm size and wages in equilibrium which is in line with the evidence discussed in section 6.1 above. For more on copulas and sampling from the above joint cdf, see Nelsen (2006). We also simulate our model for a zero *ex ante* correlation between wages and productivity, $\theta = 0$.

6.6. Numerical results

Table 1 provides the results of our numerical simulations. Each column compares autarky to restricted trade, covering both high ($\tau = 1.74$) and low ($\tau = 1.21$) trade cost cases. The top panel has $\sigma = \kappa = 2$, and the bottom top panel has $\sigma = 3.8$, $\kappa = 3.4$.

Focusing on the first column of numbers, the movement from autarky to current levels of trade costs ($\tau = 1.74$) raises real GDP by 12%, an effect which combines an 18% improvement in aggregate productivity with a decline in variety of 6%. The number of active firms is only 78% of the autarky level, an illustration of the powerful "survival of the fittest" mechanism in the Melitz model. Turning to the elements that are new to our model, the unemployment rate of 7% doesn't budge when the economy opens up. Workers who maintain their old jobs see their real wages increase by 11% due to the fall in the price level, but many workers do lose their jobs: 15% of "good jobs" (jobs with above average wages in autarky) are lost, while 19% of "bad jobs" are eliminated. Thus while the average worker is much better off than under autarky, there is a substantial reallocation of job rents. The effects of further reductions in trade costs are even larger: real GDP is 24% higher than under autarky, but more than a fifth of autarky good jobs are eliminated.

Our baseline parameterization includes a small *ex ante* correlation of 0.144 between wages and productivity, which leads to a size-wage correlation of 0.05 with current levels of trade costs, in line with the evidence reported in Manning (2003) discussed above.[12] We modify this assumption in the second two columns of Panel A, and with the exception of the size wage correlation which is now very small and negative, our results about the aggregate and distributional effects of trade liberalization are virtually unchanged. The only notable difference is that job losses are now a bit more heavily concentrated in "good jobs", since these high-wage jobs are less likely to be at highly productive firms than in the baseline parameterization.

The second panel of the table tells much the same story, except that all the effects of liberalization are quite a bit smaller. For example, in the move from autarky to current levels of trade costs, only 5% of "good jobs" are lost as opposed to 15% in our baseline. Unemployment in this panel is 10 or 11%, which is somewhat high by U.S. standards but very much in line with levels in France and elsewhere in Europe (recall that many of our parameters are drawn from French and other European data). The intuition for why larger values of σ and κ lead to smaller effects of liberalization is that firms have both less market power (larger σ) and a more skewed productivity distribution (larger κ) than when σ and κ are small, so that there are fewer small, inefficient firms in autarky. Thus the selection effects of trade liberalization that are at the heart of the Melitz model are less powerful.

Fig. 3 illustrates the employment effects of liberalization in our simulation. For the purpose of understanding Fig. 3 it is useful to think of each dot as representing an active firm in autarky, although strictly speaking the dots are draws from a continuous joint distribution.[13] The firms that expand employment are exporters, and the dispersion

[12] We refer here to Manning's Table 4.2, pg. 87, which reports that the estimated elasticity of wages with respect to employer size is anywhere between 0.013 and 0.145. An estimate of 0.04 seems to be preferred.

[13] For aesthetic reasons, Fig. 3 is constructed by drawing 5000 times from $F(w,a)$, rather than the more numerically accurate sample of 20,000 draws used to construct Table 1. Parameters are those used in the first column in Table 1.

Table 1
Simulations of the model for high and low trade costs.

Panel A: $\sigma=2$, $\kappa=2$

	High trade costs	Low trade costs	High trade costs	Low trade costs
	Ex ante ρ(productivity,wage) > 0		*Ex ante* ρ(productivity,wage) = 0	
Trade relative to autarky values				
Real GDP	1.12	1.24	1.12	1.24
Productivity	1.18	1.34	1.17	1.34
Active local firms	0.78	0.64	0.79	0.64
Price index	0.89	0.81	0.89	0.80
Unemployment rate	1.00	1.01	1.00	1.00
Levels				
Share of exporters	0.21	0.43	0.21	0.44
Autarky unemploy.	0.07	0.07	0.07	0.07
Trade unemployment	0.07	0.07	0.07	0.07
Autarky ρ(Size,Wage)	0.07	0.07	0.00	0.00
Trade ρ(Size,Wage)	0.05	0.03	−0.02	−0.02
Share of jobs lost in move to trade				
Good jobs	0.15	0.22	0.16	0.25
Bad jobs	0.19	0.29	0.17	0.26

Panel B: $\sigma=3.8$, $\kappa=3.4$

	High trade costs	Low trade costs	High trade costs	Low trade costs
	Ex ante ρ(productivity,wage) > 0		*Ex ante* ρ(productivity,wage) = 0	
Trade relative to autarky values				
Real GDP	1.04	1.13	1.04	1.13
Productivity	1.01	1.07	1.01	1.07
Active local firms	0.88	0.67	0.88	0.66
Price index	0.96	0.89	0.96	0.89
Unemployment rate	1.01	1.01	1.01	1.01
Levels				
Share of exporters	0.22	0.75	0.23	0.75
Autarky unemploy.	0.11	0.11	0.10	0.10
Trade unemployment	0.11	0.11	0.10	0.10
Autarky ρ(Size,Wage)	0.00	0.00	−0.02	−0.02
Trade ρ(Size,Wage)	0.00	0.01	−0.01	−0.01
Share of jobs lost in move to trade				
Good jobs	0.05	0.10	0.05	0.10
Bad jobs	0.06	0.11	0.06	0.11

The high and low trade costs respectively are $\tau=1.74$ and $\tau=1.21$. The notation ρ(.,.) indicates the correlation coefficient. The *ex ante* correlation between productivity and the wage is 0.144 in columns 1 and 2 (the two cases correspond to $\theta=-0.9$ and $\theta=0$ respectively). All other parameters identical across cases, with the exception of the export fixed cost f_X, which is chosen to generate a share of exporters = 0.215 when $\tau=1.74$ (resulting in $f_X=1.24$ in Panel A and $f_X=0.75$ in Panel B). Simulation computed using 20,000 draws from *ex ante* joint distribution of wages and productivity. Common parameter values are

Ex ante standard deviation of log wages	σ_W	0.06
Scale parameter on Pareto distribution	α	10
Utility cost of effort	e	1.0001
Upper bound monitoring hazard rate	$\overline{m}$	2000
Exogenous firm death hazard rate	δ	0.1
Fixed entry cost	f_e	5
Fixed production cost	f	1

of this cloud reflects the long, thin upper tail of the Pareto productivity distribution. The cluster of firms just to the left of the vertical axis are firms that survive the opening to trade but do not export: instead, they shed workers in the face of import competition. Finally, the cluster of firms to the far left shut down and layoff their labor force when trade opens up. The key message illustrated by the figure is that workers with the same wages can suffer very dissimilar fates: their firm can shut down, contract, or expand (possibly a lot) when the economy opens to trade. A related message is that among the three categories of firms (those that exit, import competing, and exporters) there is great heterogeneity in wages.

7. Conclusions

How do labor markets adjust to trade liberalization? The experience of major trade liberalizations underscores the importance of intra-industry reallocations. First generation models of intra-industry liberalization, based on Krugman (1981), emphasize that such integration will be smooth: no firm goes out of business, no worker loses a job, and welfare rises for everyone as the price index falls owing to variety gains. In such a world, liberalization should command universal approval. Of course, trade liberalization in reality remains highly controversial, with overwhelming majorities in the United States saying that it costs jobs and lowers wages.

Fig. 3. Each dot represents a firm active in autarky, its' wage, and the employment response when trade costs fall from $\tau = \infty$ to $\tau = 1.74$ for $\sigma = \kappa = 2$, $\theta = -0.09$ (the case corresponding to the first column of Panel A in Table 1). The set of points to the far left are firms that shut down when trade opens up, the set of firms just left of the vertical axis are firms that survive but do not export, while the dots to the right represent exporters. The scale on the horizontal axis is arbitrary, but the relative magnitudes are meaningful.

A new generation of intra-industry trade models, based on Melitz (2003), provides an opening to make sense of these facts. In a benchmark case for the new models, the Krugman variety gains disappear entirely, even though consumers value variety. All of the gains come through the product market churning that expands output at high productivity firms and leads low productivity firms to contract or exit.

Our innovation is to link this product market churning to labor market churning, while giving workers a reason to care about their jobs. We do this by merging the Melitz model with a variant of the Shapiro–Stiglitz model of efficiency wages. In this model, workers care about job loss for two reasons. First, and in contrast to Melitz, there is involuntary unemployment, so job loss may give rise to a spell without work or wages. Second, different jobs pay different wages to identical workers, so that a worker with a particularly good job (high wage) may reasonably fear that displacement from that job will result in eventual re-employment only at a lower wage. Of course, idiosyncratically high wages at a job, all else equal, also make that job more vulnerable in the face of liberalization. Hence this also helps us to make sense of public concerns of trade costing jobs and lowering wages.

We develop a simulation of our model based on the best available parameter estimates. We find quite substantial aggregate gains in our simulations. While unemployment exists in our model, it is little affected by liberalization. However, there is a tremendous amount of labor market churning. In one experiment, up to one-fourth of all “good” (above average wage) jobs are destroyed. Given best estimates of the magnitude of the firm-specific component of wages, this could lead many to lose as a result of liberalization.

In short, we have developed a model of intra-industry exchange in which the combination of labor market churning and job specific rents can make sense of public concerns that trade costs jobs and lowers wages. The model explains this in a context that continues to feature large aggregate gains common in intra-industry models.

References

Abowd, J.M., Kramarz, F., Margolis, D.N., 1999. High wage workers and high wage firms. Econometrica 67, 251–333 (March.

Anderson, James E., van Wincoop, Eric, 2004. Trade costs. Journal of Economic Literature XLII, 691–751 (September).

Anderson, James E., van Wincoop, Eric, 2003. Gravity with Gravitas: A Solution to the Border Puzzle. The American Economic Review 93 (1), 170–192 March.

Baldwin, Richard E., 2005. Heterogeneous firms and trade: testable and untestable properties of the Melitz model. *NBER Working Paper* No. W11471. July.

Bernard, Andrew B., Jonathan Eaton, J., Jensen, Bradford, Kortum, Samuel, 2003. Plants and productivity in international trade. American Economic Review 93, 1268–1290.

Broda, Christian, Weinstein, David, 2006. Globalization and the gains from variety. The Quarterly Journal of Economics 541–585 May).

Brown, C., Medoff, J., 1989. The employer size-wage effect. Journal of Political Economy 97, 1027–1059.

Corcos, Gregory, Gatto Del, Massimo, Mion, Giordano, Ottaviano, Gianmarco I.P., 2009. Productivity and firm selection: quantifying the ‘new’ gains from trade. FEEM Working Paper 379 and KITeS Working Paper 02/2009, dated March 27 2009.

Egger, Hartmut, Kreickemeier, Udo, 2009. Firm heterogeneity and the labour market effects of trade liberalisation. International Economic Review 50 (1), 187–216 (February).

Felbermayr, G., Prat, J., Schmerer, H.-J., 2008. Globalization and labor market outcomes: wage bargaining, search frictions, and firm heterogeneity. IZA Discussion Paper No. 3363 (February).

Ghironi, Fabio, Melitz, Marc, 2005. International trade and macroeconomic dynamics with heterogeneous firms. Quarterly Journal of Economics 120 (3), 865–915.

Groshen, Erica, Krueger, Alan B., 1990. The structure of supervision and pay in hospitals. Industrial and Labor Relations Review 43, 134S–146S.

Harrigan, James, 1993. OECD imports and trade barriers in 1983. Journal of International Economics 35, 91–112.

Helpman, Elhanan, Itskhoki, Oleg, 2010. Labor market rigidities, trade and unemployment. Review of Economic Studies 77 (3), 1100–1137 July.

Helpman, Elhanan, Itskhoki, Oleg, Redding, Stephen, 2010. Inequality and unemployment in a global economy. Econometrica 78 (4), 1239–1283 July.

Idson, Todd L., Oi, Walter, 1999. Workers are more productive in large firms. American Economic Review Papers and Proceedings 89 (2), 104–108.

Krueger, Alan, Summers, Lawrence, 1988. Efficiency wages and the inter-industry wage structure. Econometrica 56 (2), 259–293.

Krugman, Paul R., 1981. Intraindustry specialization and the gains from trade. Journal of Political Economy 89, 959–973.

Manning, Alan, 2003. Monopsony in Motion: Imperfect Competition in Labor Markets. Princeton U. Press, Princeton.

Matusz, Steven J., 1996. International trade, the division of labor, and unemployment. International Economic Review 37, 71–84.

Mehta, Shailendra Raj, 1998. The law of one price and a theory of the firm: a Ricardian perspective on interindustry wages. RAND Journal of Economics 29, 137–156.

Melitz, Marc J., 2003. The impact of trade on intra-industry reallocations and aggregate industry productivity. Econometrica 71 (6), 1695–1725.

Murphy, Kevin M., Topel, Robert H., 1987. Unemployment, risk, and earnings: testing for equalizing wage differences in the labor market. In: Lang, Kevin, Leonard, Jonathan S. (Eds.), Unemployment and the Structure of Labor Markets. Basil Blackwell, London.

Nagin, Daniel S., Rebitzer, James B., Sanders, Seth, Taylor, Lowell J., 2002. Monitoring, motivation, and management: the determinants of opportunistic behavior in a field experiment. The American Economic Review 92 (No. 4), 850–873 Sept).

Nelsen, Roger B., 2006. An Introduction *to Copulas*, 2nd Ed. Springer, New York.

Rebitzer, James, 1995. Is there a trade-off between supervision and wages? An empirical test of efficiency wage theory. Journal of Economic Behavior and Organization 28, 107–129.

Romer, David, 2006. Advanced Macroeconomics. McGraw Hill, New York.

Shapiro, Carl, Stiglitz, Joseph E., 1984. Equilibrium unemployment as a worker discipline device. American Economic Review 74 (3), 433–444.