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Employment Protection, Labor Market Turnover, and the Effects of Globalization

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Abstract

A parsimonious search and matching model of the labor market with endogenous separation is embedded in a North-North intermediate goods trade framework. International product market integration leads to redistribution of market shares from 'weak' to 'strong' firms within an industry, implying chances and threats for them, as firms are ex-ante unaware of their relative advantage over the competitor. Opening the economy will therefore increase the dispersion of potential revenues and consequently lead to higher labor market turnover, higher welfare and increased wage inequality, while the effect on employment is ambiguous. Ceteris paribus, the effects are qualitatively similar to decreasing employment protection in form of costly firing restrictions which prevent the economy from reaching a first best allocation. The positive welfare effects of opening to trade are decreasing in the level of firing costs. This can therefore lead to a substantial failure in reaping the benefits from economic integration.

Keywords

Employment protection, firing margin, trade in intermediate goods, labor market turnover, revenue risk

JEL Classification

F15, F16, J63, J65

Comments

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Contents

1 Introduction

Recent work has emphasized the need for understanding the role of the welfare state and social protection in a world of increasing economic integration. So far these papers have predominantly focused on unemployment insurance (see e.g. Keuschnigg and Ribi, 2009). This work extends the analysis by looking at the role of employment protection (EP) in an open economy. A parsimonious static version of the Diamond-Mortensen-Pissarides (DMP) model with one-shot worker-firm matching, bilateral wage bargaining and endogenous separation is enriched to capture effects of trade through changes in marginal revenues which are usually assumed to be exogenous and constant in the canonical DMP model. While most studies that integrate modern trade models (e.g. Melitz, 2003) with theories of frictional labor markets focus on unemployment levels, the developed model is especially equipped to analyze labor market turnover as an important channel connecting EP and trade. This is important as the same level of unemployment can be generated by different compositions of job creation and destruction. The specific question the paper seeks to answer is how the effects of EP are altered after arrival of a trade liberalization shock in a North-North trade setting. In addition the optimal implementation of EP is discussed.

In principle, the causal relationship of labor market institutions and trade patterns can be two-fold. Papers, like Cuñat and Melitz (2007) and Helpman and Itskhoki (2010) describe how a flexible labor market implies a comparative advantage in producing in high-volatility sectors. Closely related, Davidson et al. (1999) explain how country-specific differences in sectoral labor turnover rates determine trade. This paper is related to another stream of the literature that analyzes how trade patterns shape labor market institutions and social protection. Most attention concerning the role of social protection in an open economy was put on unemployment insurance (UI). EP, as another pillar of the welfare state, and its interaction with globalization shocks has received comparatively little attention so far. But what is a potential role of EP on top of UI? Blanchard and Tirole (2008) argue that existing UI creates a firing externality that can be undone by introducing EP in form of a firing tax. It is well understood that EP reduces both job destruction as well as job creation (see for example Messina and Vallanti (2007) for empirical support). While the effect on employment of locally increasing EP from a small level is ambiguous, it is clear that ever increasing EP will eventually lead to a reduction in employment, which characterizes the downside of EP. Hence, an optimally chosen EP efficiently trades off the positive effect of correcting the firing externality and the negative effect of a reduction in the level of employment. This trade-off will be picked up in the normative part of the paper. This study also features a positive part dealing with the effects on welfare for a given level of firing restrictions.

That increased international integration should lead to more volatility in employment has been widely argued in the literature (see for example Rodrik, 1997, or Bhagwati and Dehejia, 1994) although there are hardly any formalizations of this idea. A typical argument is that increased opportunities to trade in intermediate goods make labor demand of domestic final good producers more elastic as they can more easily switch suppliers and source from abroad. I explicitly model a channel which implies that whenever opening to trade leads to an increase in 'chances' and 'threats' for domestic firms, job creation and destruction will rise. Chances can be thought of as new export markets while threats can come from import competition. I will make use of a production technology similar to the idea of trade in tasks by Grossman and Rossi-Hansberg (2008). While there is limited substitability between domestic tasks or intermediate goods, i.e. final output cannot be increased by simply repeating same task, a domestic variety[1] could be perfectly replaced by a foreign one from the same industry. Imagine assembling a car and how a German car engine cannot be substituted by adding a second German steering wheel but by a French car engine. In contrast to their framework I do not apply the technology assumption in an off-shoring- or North-South-context, where one country has a persistent cost advantage in which case, given the additional option of cheap sourcing from the South, Northern firms unambiguously profit and generate a clear positive productivity effect. As already hinted by the car example, I will focus on a perfectly symmetric North-North set-up where the production advantage is stochastic and driven by idiosyncratic shocks that are uncorrelated between sectors. Hence, in one sector a firm can steal business from the corresponding competitor in the other country, while this pattern could be reversed in another sector. As a domestic firm is ex-ante unaware of whether it can gain revenues, or if it will lose market shares, the distribution of potential revenues and hence profitability widens which will be the key determinant for a trade-induced rise in labor turnover. This kind of spread is also present in new trade theory models à la Melitz (2003) that predict a reallocation of market shares from low- to high-productivity firms[2] while the link to flows between the pools of employed and unemployed workers is absent in those frameworks. The idea that openness to trade can amplify the 'winner-loser'-pattern within an industry is well established empirically (see for example Pavcnik, 2002, Tybout, 2003, Bernard, 2004, and Baggs, 2005).

[1]The terms 'task', 'intermediate good', and 'variety' have the same meaning in this context and are used interchangeably.

[2]Note that the mechanism in Melitz (2003) works quite differently. In contrast to my framework, less productive firms do not suffer directly from increased competition as this channel is not present in the Melitz set-up given his assumptions on preferences. Instead, less productive firms are hurt by the increased labor demand of new entrants that bid up the wage on a competitive labor market, which is absent in my framework.

In the parsimonious model developed in this paper job creation is directly linked to expected profits of firms. If expected profits increase, more firms will enter the labor market pushing up the probability of a worker to find a job. Job destruction is driven by match-specific shocks to productivity and revenues and therefore consequently to profitability. Hence, there is a cut-off for the value of production below which a firm will destroy a job and lay off the involved worker. If trade liberalization lowers profitability in bad matches as argued above, it is clear that the mass of revenues below the cut-off increases, which consequently implies a rise in the job destruction rate. At the same time trade liberalization is supposed to increase profitability in good matches, boosting expected profits and therefore job creation because firms just care about values of production above the cut-off, i.e. profits that are actually realized. This argument makes clear how openness to trade affects job flows and labor turnover, while the effect on the level of employment, which is at the heart of the analysis in many other studies, might be much less accentuated. The interaction of trade and EP follows directly as EP, as argued before, is a policy instrument that works exactly at the labor turnover margin.

The model delivers the following results. Ceteris paribus, EP and openness to trade have opposing effects along many dimensions. EP unambiguously decreases job creation and destruction, while the opposite is true for a trade openness shock. While both entail ambiguous effects on the employment level, the output effects are clear cut. EP will always lead to less total and average net output per worker. An openness to trade shock will imply the opposite. Both 'shocks' make the wage distribution unambiguously more disperse which increases income inequality. But the spreads in the wage distribution are of completely different nature. In case of EP the wage distribution increases on both tails as (a) all wages are pushed up by a constant fraction generated in the process of wage bargaining and (b) more low paying jobs are operated because of decreased job destruction. Hence, the effect on the average wage is ambiguous. In case of a trade shock, the wage distribution it widened on the right tail as a direct consequence of increased volatility in potential revenues, while the cut-off on the left side is unaffected. Consequently, the average wage increases unambiguously. In the welfare analysis I first consider a benchmark environment with risk-neutral workers such that welfare and net output coincide. The normative question of optimal EP is therefore trivialized as there are no externalities present[3] that justify firing restrictions. Concerning the positive part where I look at the effects of given firing costs, the parsimonious model set-up allows to derive a simple solution for the second best. It is shown that, for a reasonable parameterization, the

[3] The typical search externalities in the labor market are assumed to be balanced (Hosios (1990)-condition) throughout the paper.

welfare loss due to firing restrictions is increasing in job turnover, i.e. openness to trade. That means that while an open economy will always enjoy higher welfare, the distance to a possible first best is also increasing, i.e. open economies suffer relatively more from EP. As an extension, I introduce risk-aversion of the workers to create a firing externality in the spirit of Blanchard and Tirole (2008). Workers demand unemployment insurance which creates a fiscal externality as firms do not take into account that an UI-system has to be financed when they decide to lay off a worker. Blanchard and Tirole (2008) find that an optimal firing tax has to be positive in that case. My results differ because I explicitly model endogenous job creation. It is still true that firms do not internalize the social costs of firing, but they also do not internalize the social benefit from hiring.[4] Therefore whether an optimal firing tax should be positive or not is tightly linked to the effect on the tax base and therefore on the level of unemployment[5]. A short numerical example reveals that employment is likely to decrease in the present set-up and that a firing tax should be set to 0, as in the case of risk-neutral workers.

The paper further relates to other strands of the literature. Helpman et al. (2010) and Felbermayr et al. (2011) integrate frictional labor markets of DMP style into the Melitz (2003)-framework in order to analyze the effect of trade liberalization on inequality and the level of unemployment. Both develop thorough dynamic models incorporating firm self-selection into exporter/non-exporter-status, multi-worker firms, etc. - features that are missing in the present paper. On the other hand they do not allow for trade effects along the job destruction margin which is at the heart of this study. In addition, the parsimonious set-up allows for a more comprehensive welfare analysis. Probably the most closely related analysis was done by Jansen and Turrini (2004) which also features endogenous job destruction. They consider two 'globalization scenarios'. First, an economy is allowed to move from autarky to symmetric two-country trade. Given their technology assumptions integration is followed by increased demand for intermediate goods which inflates prices as supply is fixed. The effect is comparable to a positive shock to total factor productivity and shifts the whole distribution of potential revenues to the right, leading to a reduction in job destruction. In a second scenario, they assume an exogenous increase in the volatility of cost-price mark-ups, as in Mortensen and Pissarides (1994), which results in an increase in job destruction. The contribution of this paper is to bring both scenarios together by showing that using a Grossman and Rossi-Hansberg (2008)-

[4]This has been argued before in the literature. See e.g. Coles (2008) for a similar argumentation in a model that solely focuses on the job creation margin.

[5]Empirical evidence on the effect of EP on employment levels - mostly drawn from cross-country analyses - is mixed. Some papers, including the seminal work of Lazear (1990), or Nickell (1997), Heckman and Pagés (2000), and Kahn (2007) find a significant negative effect. Other studies like OECD (1999) and Addison et al. (2000) report no significant effects. Addison and Teixeira (2003) and, more recently, Skedinger (2011) provide extensive summaries of the empirical literature.

technology implies that market integration of two symmetric countries leads to a spread in potential revenues, which is more consistent with the 'winner-loser' pattern present in new trade theory. The model predicts an increase in job destruction and job creation, hence in job turnover. The link of openness to trade and job turnover has received moderate attention in the empirical literature, probably because suitable data on worker flows is rather limited compared to employment level data. A positive effect of openness to trade on job turnover is empirically supported by Haltiwanger et al. (2003) and Faggio and Konings (2003) for transitions economies, Haltiwanger et al. (2004) and Ribeiro et al. (2004) for trade liberalization in South America, by Groizard et al. (2010) and Kletzer (2000) for US manufacturing and Beaulieu et al. (2004) for Canada. In contrast, Klein et al. (2002) find no evidence that the establishment of NAFTA had an influence on worker flows. Brülhart et al. (1998) use Irish data to show that exposure to trade has no effect on between industry labor reallocation but a small positive effect on within industry job turnover. However, one should be careful when linking empirical results relying on industry or firm level data to the model in this paper which rather presents a theory of production plants. To a great extent international trade is carried out by multinationals and worker flows within a multinational company might not be recorded accurately, which could underestimate job turnover compared to the predictions of the model.

The remainder of the paper is organized as follows. Section 2 presents a simple labor market model featuring endogenous job creation and separation where the distribution of before-wage profits is taken as given. In section 3 I will discuss the effects of an increase in the risk of profitability on job flows. Section 4 presents a simple intermediate goods trade model that delivers a microfoundation for a rise in volatility of the form that was assumed in the previous section. The welfare implications of openness to trade and EP are derived in section 5 before section 6 concludes.

2 Labor market model

First, I analyze the labor market assuming that production is just characterized by an exogenous distribution of possible production values. This assumption will be motivated and interpreted in section 4. The set-up of the labor market model is static and can be summarized by the following sequence of events:

Stage 1. A mass 1 of workers starts out as unemployed.

Stage 2. Firms enter the labor market according to a free entry condition by posting one vacancy each at cost c.

Stage 3. Workers are hired according to a matching technology $\mathcal{M}$.

Stage 4. A value of production y, i.e. a realization of a given random variable Y, is revealed to each firm leading to firing of the most unprofitable workers.

Stage 5. In case of separation firms have to pay firing costs F. Laid-off workers receive $z \equiv h + b$ like the workers who were never hired, where h denotes home production and b is unemployment compensation. Production is started with the remaining workers, who receive a bargained wage w.

Before solving the model by backward induction I will specify the matching technology and preferences. The labor market is characterized by a typical matching function assumed to fulfilled the following conditions. The matching function $\mathcal{M}(u, v)$ is homogeneous of degree one and increasing in its two arguments: number of initially unemployed u and number of vacancies v. Define labor market tightness as the vacancy-unemployment ratio, i.e. $\theta \equiv \frac{v}{u} = \frac{v}{1}$. The firm's probability of matching can be expressed as $m^f = \frac{\mathcal{M}}{v}$ with an elasticity of m^f w.r.t. of $-\eta \in (-1, 0)$ which is assumed to be constant. A worker's probability of being matched is $m = \frac{\mathcal{M}}{u} = \theta m^f$ with $\frac{dm}{d\theta} = (1-\eta)m^f > 0$. Hence, m is referred to as the job finding or job creation rate[6] and let G be the separation or job destruction rate. Employment[7] is given as the number of workers that are matched and not subsequently laid off

$$e = m(1 - G), \tag{2.1}$$

which evolves as follows

$$de = (1 - G)\, dm - m\, dG. \tag{2.2}$$

Clearly employment is increasing the job creation rate and decreasing in the job destruction rate. Workers' utility functions are strictly increasing, $u'(\cdot) > 0$. Expected utility of a worker i is given as

$$V_i = \underbrace{m(1 - G)}_{e} \cdot u(w_i) + \underbrace{(1 - m(1 - G))}_{1-e} \cdot u(z). \tag{2.3}$$

Wages will differ for workers because worker-firm pairs may have different values of production y. Integrating this expression over all individuals gives total utilitarian welfare $\Omega = \int_0^1 V_i\, di$ as firms make zero profits in equilibrium. For the moment, I will focus on

[6]As the initial unemployment rate is equal to 1, the job finding rate m and the number of matches $\mathcal{M}$ give the same number.

[7]Using mass 1 of workers implies that e also denotes the probability of being employed for a specific worker due to the law of large numbers.

risk-neutral[8] workers, i.e. $u(x) = x$.

The last decision stage of the agents is the firing or separation decision. Firms will lay off workers whenever the realized value of production[9] y minus labor costs $w(y)$ is lower than the firing costs F, i.e.

$$y - w(y) < -F \Rightarrow \underline{y} = w(\underline{y}) - F, \tag{2.4}$$

where $\underline{y}$ denotes the value of production at which a firm is indifferent between firing and keeping the worker. y is the realization of an i.i.d. draw from the known distribution $G_Y(\cdot)$. Recall that $G_Y(\cdot)$ is an endogenous object that will depend on the current trade regime. As the model is set up in a way such that equilibrium is recursive one can solve the labor market taking $G_Y(\cdot)$ as given for the moment. $G_Y(\underline{y})$, or in short G, gives the probability that a worker-firm pair is insufficiently profitable and will therefore be referred to as firing or job destruction rate. To specify G it is necessary to know the reservation wage $w(\underline{y})$. Wages are determined using a standard bilateral Nash bargaining game

$$w(y) = \text{argmax} \left[u(w) - u(z)\right]^{\omega} \left[y - w + F\right]^{1-\omega}, \tag{2.5}$$

where ω denotes the worker's bargaining power. After using the assumption of risk-neutrality the first-order condition reads

$$\frac{\omega}{w - z} = \frac{1 - \omega}{y - w + F}. \tag{2.6}$$

Hence, the wage schedule is given by

$$w(y) = (1 - \omega)z + \omega \left[y + F\right]. \tag{2.7}$$

Substitute the reservation wage out of the cut-off condition (2.4) to get

$$\underline{y} = z - F. \tag{2.8}$$

Equation (2.8) is the first central equilibrium condition and will be referred to as the job destruction condition. The intuition is that at the cut-off the surplus of forming a worker-firm pair is 0, hence the wage is pushed down to the outside option z. Consequently, there

[8] This assumption is relaxed in section 5.3.

[9] Readers should think of the market value of production y as 'before-wage profits' that capture productivity as well as the demand structure, i.e. the price and revenue that can be generated, in reduced form. The paper will be more explicit about how y is derived in section 4. As the distribution of match-specific productivity will be constant all changes in the distribution of Y can be interpreted as changes in the distribution of revenues.

will be no inefficient firing[10] that could be prevented by bilateral trade between the firm and the worker. The job destruction rate G is just

$$G = G_Y(z - F). \tag{2.9}$$

After solving for the firing decision one can analyze the preceding job creation decision which is driven by the profit a firm can anticipate to make. The expected profit conditional on being matched with a worker is denoted

$$\pi^e = [y^e - w^e](1 - G) - GF, \tag{2.10}$$

where y^e and w^e denote conditional expectations of y, i.e. $y^e = E(Y|y > \underline{y}) = \int_{\underline{y}}^{\infty} y\, dG_Y(y)/(1-G)$, and $w(y)$, i.e. $w(y^e)$. Substitute the wage schedule (2.7) into the expected per-worker profits π^e and rearrange to get

$$\pi^e = (1 - \omega)\left[y^e - \underline{y}\right](1 - G) - F. \tag{2.11}$$

Expected profits are decreasing in the outside option, the bargaining power of the worker and the firing costs. Latter can eventually lead to negative expected profits. Firms are assumed to have an outside option of 0 and will therefore enter the labor market as long as $m^f \pi^e - c \geq 0$ where $c > 0$ are costs of entering. I assume the parameters in a range such that $\pi^e > 0$ is guaranteed to avoid the uninteresting case of zero entry. As more firms enter, the tightness of the market increases which drives down the probability of being matched with a worker. In equilibrium firms will enter up to the point where there is no more gain from doing so. The free entry condition therefore states that $m^f \pi^e = c$ or[11]

$$(1 - \omega)[y^e - z + F](1 - G) - F = \frac{c}{m^f}. \tag{2.12}$$

This pins down the job creation rate which is given as[12]

$$m \equiv m(\theta) = m\left(\left[m^f\right]^{-1}\left(\frac{c}{\pi^e}\right)\right), \tag{2.13}$$

where $\left[m^f\right]^{-1}(\cdot)$ denotes the inverse function of $m^f(\cdot)$. It is easy to see that the job creation rate is increasing in π^e and decreasing in c. Equilibrium in the labor market

[10] The terms 'firing' and 'separation' can therefore be used interchangeably.

[11] An alternative representation of (2.12) often used for calculations is $e(1-\omega)[y^e - z] - mGF - e\omega F = c\theta$.

[12] For an explicit relationship one could consider a typical Cobb-Douglas specification, e.g. $m^f = \mathcal{M}_0\theta^{-\eta}$ and consequently $m = \theta m^f = \mathcal{M}_0\theta^{1-\eta}$. Then labor market tightness is given as $\theta = \mathcal{M}_0^{1/\eta}\left[{\pi^e}/{c}\right]^{1/\eta}$ and the job creation rate would be $m = \mathcal{M}_0^{1/\eta}\left[{\pi^e}/{c}\right]^{(1-\eta)/\eta}$.

is given by the vector $\langle \theta, \underline{y} \rangle$ that solves the job destruction (2.8) and the job creation condition (2.12). These conditions resemble the equilibrium conditions of a fully dynamic version of the model (e.g. Pissarides, 2000) except that expected profits are not discounted and the job destruction condition does not incorporate possible future shocks to y. A first result is given by the following proposition.

Proposition 2.1. *An increase in firing costs leads to a reduction in both, the job creation rate (through lower labor market tightness) as well as the job destruction rate. The effect on the employment level is ambiguous.*

The proof is provided in appendix A. This result is well understood and intuitive. An increase in F pushes the cut-off value of production $\underline{y}$ up and consequently the job destruction rate falls. At the same time firing costs reduce expected profits as stated in (2.11). Clearly, firms will create less vacancies and the workers' job finding rates fall. The effect on wages is summarized in the next proposition.

Proposition 2.2. *An increase in firing costs leads to an increase in the spread of the wage distribution. Whether the average wage falls or rises is solely determined by the nature of the underlying distribution of Y.*

The proof is provided in appendix A. The first part is intuitive as firing costs prevent firms from destructing jobs with low profitability which pay low wages. Consequently, the wage distribution is widened on the left tail. The result that this does not automatically imply a decrease in the average wage stems from the fact that all wage rise by the constant term ω that workers can snatch in the bargain for every unit of F.

3 Increase in the risk of profitability

This section discusses how an increase in the riskiness of the value of production changes the equilibrium allocation. This increase could in principle have very different motivations, like what happens in an environment where firms are forced to engage in more risky projects. Another story, told by this paper, explains how international market integration can imply increased chances as well as increased threats to local firms, hence spreading out the distribution of potential revenues of firms after integration. I will be more explicit about this in section 4 where a simple two-country model is used to show that international market integration implies a spread in the distribution of revenues and therefore profitability of the form that will be analyzed in a general and abstract manner in what follows now.

For simplicity and tractability I assume that the increase in volatility takes place in the simple form of a mean preserving single crossing spread from Y to Y'.

Definition 3.1. *A mean preserving single crossing spread (MPSCS) from Y to Y' is given if the following two conditions hold*

a) Mean preservation (MP):

$$E(Y) = E(Y') = \int_{-\infty}^{\infty} y\, dG_Y(y) = \int_{-\infty}^{\infty} y\, dG_{Y'}(y) = \mu_Y,$$

b) Single crossing spread (SCS):

$$\exists \hat{y} : G_Y(y) \geq G_{Y'}(y), \forall y \geq \hat{y} \quad and \quad G_Y(y) \leq G_{Y'}(y), \forall y \leq \hat{y}.$$

The notion of MP is self-explanatory while the SCS characteristic just implies that the cumulative distribution function (cdf) of the spread random variable Y' crosses the cdf of Y just once from above at the intersection point[13] $\hat{y}$ as illustrated in figure F.1 in appendix F. Assuming this, one can analyze how job flows are affected but such a volatility increase.

Lemma 3.1. *The job destruction rate G is weakly increasing for any kind of SCS of Y if $\underline{y} \leq \hat{y}$.*

Proof. This follows directly from the SCS definition. ∎

The intuition for this result is clear and also illustrated in figure F.1. While the cut-off $\underline{y}$ is unaffected, a bigger mass is now located below it, leading to a higher probability of separation. Let me address the effect on job creation now.

Lemma 3.2. *The job creation rate m is weakly increasing for any kind of MPSCS of Y.*

The proof is provided in appendix A. The basic intuition is again simple to grasp and best understood by looking at figure F.2. While the unconditional expectations of both distributions are the same, only the revenues above the cut-off $\underline{y}$ are actually realized. This means that the increase in the mass of low profitability does not hurt the firm because those jobs would not have been operated anyways while the firm profits from a higher probability of drawing a high revenue. This pushes up expected profits and consequently the job creation rate m. Hence, labor turnover is accelerated. Note the analogy to the effect of EP just with opposite direction. As in the case of EP the effect of a revenue spread on employment is undetermined while effects on welfare are clear cut as will be shown in section 5. The following corollary gives some supplement results.

Corollary 3.1. *Average output y^e, average wage w^e and the wage dispersion are weakly increasing for any kind of MPSCS of Y if $\underline{y} \leq \hat{y}$.*

[13]Note that the single intersection point $\hat{y}$ coincides with the mean μ_Y if the distribution is symmetric.

The proof is provided in appendix A. If one wants to compute the exact changes in G and m, e.g. to be able to sign the change in employment, one has to be more specific about the nature of the MPSCS. The next section develops a microfoundation that characterizes the relation between openness to intermediate goods trade and the spread of potential values of production which is explicitly derived.

4 Market integration and revenue risk

The effect of an increase in the risk of revenues and therefore profitability was discussed in the last section. This part of the paper presents a simple stylized extension to the labor market model described in section 2 that explicitly models a channel through which openness to trade affects the distribution of firms' revenues. So far the random variable Y, summarizing the distribution of potential values of production, was taken as given. More model structure will be put on the production side of the economy now. First, I will discuss this for the closed economy before allowing for free trade in intermediates with a symmetric second country. Motivation for increasing product market integration is obviously manifold. One could think of it as a result of increased standardization of intermediate goods or a removal of or reduction in prohibitive non-tariff trade barriers and so forth.

4.1 Closed economy

While the value of production was simply denoted y and followed a given distribution so far, I am more explicit about this now. Production in the economy occurs in a continuum of intermediate good sectors and a final good sector. Every worker-firm pair from before produces a *different* intermediate good or variety. Hence, due to the identity: 1 worker, 1 firm, 1 variety, one can index them all with $i \in [0, 1]$. As every firm represents a whole domestic industry and revenues across domestic industries will not be correlated, the assumption in the reduced model from before that every firm receives an i.i.d. draw of y will not be violated. Further, one can discuss the demand structure in one industry in isolation and I will therefore drop the index i if appropriate. In a nutshell the decision structure looks as follows. The representative final good producer takes prices as given and chooses the amount of input of every variety, q_i^d. An intermediate good producer i has monopoly power in market i and sets price p_i and picks the optimal quantity q_i^s from the demand correspondence q_i^d. In equilibrium demand has to equal supply in every intermediate goods market, hence $\exists q_i : q_i \in q_i^d \cap q_i^s, \ \forall i$. Further, demand has to equal supply in the final good market, i.e. $Q^d = Q^s$. The final good is an all-purpose good that is used for consumption of the workers and for covering the firms' costs and will serve as numéraire, hence $P = 1$. Technologies and optimal decisions are explained in more detail now.

The final good sector is characterized by a representative competitive firm that uses no labor but only the varieties as inputs to assemble them using a simple 1:1 technology. The production function is non-homothetic and given by

$$Q^s = \int_0^1 \min\left\{1, q_i^d\right\} \, di. \tag{4.1}$$

The production technology captures 'love of variety'. In principle varieties are perfect substitutes but as technology is characterized by decreasing marginal productivity the final good producer will never want to source all inputs from just one variety producer. This technology assumption deviates from the typical homothetic, constant elasticity of substitution production/utility functions used by Melitz (2003) and others. The technology choice relates to Grossman and Rossi-Hansberg (2008)'s idea of production in tasks, where every task has to be done exactly once[14] to produce output. It is also closely related to frameworks with non-homothetic preferences where consumers simply decide whether to buy or not to buy a differentiated good. This type of 0-1-preferences are for example discussed in Murphy et al. (1989), Matsuyama (2000), and Foellmi and Zweimller (2006). The optimization problem of the final good producer is given as

$$\max_{q_i^d \in [0,1]} \Pi = \max_{q_i^d \in [0,1]} P \cdot \int_0^1 q_i^d \, di - \int_0^1 p_i \cdot q_i^d \, di. \tag{4.2}$$

As long as $p_i \leq P$ the final good producer will demand any amount up to 1. Hence, the demand or willingness to pay for every variety is a step function horizontal at P up to $q_i = 1$ and then dropping to zero. As the intermediate good producers have monopoly power in every intermediates good market they will set $p_i = P$ and seize all the rents leaving the final good producer with zero profits. The optimal output is the maximum output that still finds demand, i.e. $q_i^s = 1$, which gives revenues of $r_i = p_i q_i = 1$.

I will now illustrate the decision problem of the intermediate good producer in more detail. As the problem is the same for all intermediate good firms I will drop the firm index. An intermediate firm produces output by using the production factors labor and capital. Labor input is discrete. Either a worker is employed or not. The hiring decision

[14] Note that in my framework not every single 'task' has to be done, or in this framework's interpretation: not every single 'variety' has to be produced, to get positive output of the final good. This assumption is obviously necessary as some of the intermediate firms will not produce at all which automatically implies that $q_i^s = 0$.

is made *before* any revenue or cost/productivity shock materializes. Once hired a firm cannot adjust its labor input, except for the possibility of completely laying off its worker again, and is therefore more or less profitable.[15] Capital goods, which are expressed in terms of the final good, can be thought of as machines that can be flexibly scaled up and down at constant marginal costs k. The more machines are used the more output is produced although in any case only a single worker is required to supervise or handle the machines.[16] Hence, the marginal productivity of a worker is increasing and total factor costs are decreasing in output size. The production function is given as

$$q^s = \begin{cases} 0 & \text{if no worker is employed,} \\ x \cdot n & \text{if a worker is employed,} \end{cases} \tag{4.3}$$

where n denotes the quality of production which is an i.i.d. draw from $G_N(\cdot)$ with support bounded from below by k.[17] x are the units of capital goods that are needed to produce q^s units of the intermediate good with quality n. Hence, for a low quality the intermediate good firm has to use more machines[18] to get the same quality-adjusted output. The revenue is $r \equiv p \cdot x \cdot n$ and before-wage profits are $y = r - x \cdot k$. Hence, there are clear opportunities costs of scaling up production as marginal costs of producing an additional unit of q are k/n. Observe that the quality shock is inversely related to the marginal costs and could be alternatively modeled as a stochastic cost shock.[19] Before-wage profits y are therefore

$$y = p \cdot x \cdot n - x \cdot k = q^s \left(p - \frac{k}{n}\right) = q^s \cdot \phi, \tag{4.4}$$

where the mark-up on capital costs is denoted $\phi \equiv p - \frac{k}{n}$. Recall that conditional profits including wages are $y - w(y)$. Given the assumption that wages are bargained it is easy to see that maximizing $y - w(y)$ is equivalent to maximizing y. Hence, the optimization problem of the intermediate firm is

$$\max_{p, q^s} q^s \left(p - \frac{k}{n}\right) \tag{4.5}$$

[15] See Caballero (2007) for a discussion of specificity of inputs.

[16] Importantly, although I assume that a single workers can operate more than one machine she can do so only within her firm or industry. She cannot handle different machines producing two or more varieties at the same time.

[17] This is just a simplifying assumption which guarantees that in equilibrium all mark-ups will be non-negative. This simplifies the analytic treatment but is of no qualitative importance.

[18] Another interpretation would be that the quality parameter gives the amount of malfunctioning or sub-standard goods that will not be accepted by the final good producer.

[19] In principle, the match-specific shock could be arbitrarily interpreted as quality, cost, mark-up, or productivity shock without any consequences for the analytical treatment.

$$\text{subject to } q^s \in q^d \text{ where } q^d = \begin{cases} [0,1] & \text{if } p \leq P, \\ 0 & \text{otherwise.} \end{cases} \tag{4.6}$$

As explained before the optimal choice[20] is $p = q^s = 1$. Therefore the mark-up is given by $\phi = 1 - \frac{k}{n}$ and distributed according to G_Φ which is a simple transformation[21] of G_N. As q is always 1, before-wage profits are simply given by the random variable $Y = \Phi$, with $E(Y) = E(\Phi) \equiv \mu_\Phi$ and $Var(Y) = Var(\Phi) \equiv \sigma^2_\Phi$, such that density and distribution are just

$$g_Y(y) = g_\Phi(y) \qquad \text{and} \qquad G_Y(y) = G_\Phi(y). \tag{4.7}$$

As before one can solve the labor market model just by inserting (4.7) in *Stage 4*.

4.2 Open economy

I will now allow international exposure to have an effect on the labor market. The effect is propagated through the product markets, namely through the potential revenues firms can make. Assume that there are a 'home' and 'foreign' country indexed by H and F. Both are symmetric in every aspect[22]. In contrast to typical new trade models the integration of both countries does not imply that the number of potential varieties doubles. As before the technology in the final good sector is such that a home variety i cannot be substituted by a second unit of home variety j, but I assumed that it is a perfect substitute for foreign variety i. This is very similar to the trade in tasks framework of Grossman and Rossi-Hansberg (2008) with the difference that instead of North-South trade where the South has a systematic price advantage, this paper tells a North-North trade story where the advantage is stochastic. In one sector the domestic variety producer is the 'strong' firm and able to receive a higher market share by stealing business from the foreign producer, called the 'weak' firm, while the pattern might be reversed in another sector.

[20] Recall that maximized profits are only realized if in addition the non-negative profit condition is fulfilled, i.e. $y \geq \underline{y}$. Otherwise the worker is laid off at firing costs F.

[21] For simplicity I directly assume a distribution for Φ with finite support on $[0, \bar{\phi}]$ with $\bar{\phi} \leq 1$. Clearly, one could first define a distribution for N with support $[k, k/(1-\bar{\phi})]$ and then link the distributions according to

$$g_\Phi(\phi) = g_N\left(\frac{k}{1-\phi}\right)\frac{k}{(1-\phi)^2} \qquad \text{and} \qquad G_\Phi(\phi) = G_N\left(\frac{k}{1-\phi}\right).$$

See appendix E.2 for mathematical details.

[22] A strong but very convenient assumption is that job matching is perfectly correlated in both countries. Hence, one does not have to consider the case that a variety producer is matched with a worker while the corresponding firm in the other country is not matched. One can therefore ignore that firms have to form expectations about how likely it is that this event will occur. Consequently, one can directly compare all potential revenues conditional on both firms in this industry being matched with a worker. Relaxing this assumption would not change the results qualitatively and simply constitute a mixture of the closed and open economy model presented here, as some firms face additional competition and some do not. As firms are ex-ante unaware of which of those two cases will occur they would still face a higher revenue risk.

I focus on the stylized limiting case of perfect international product market integration with zero transportation or market entry costs such that both final good producers can freely choose whether to source variety i from the home or the foreign country. Hence, a variety producer might end up supplying both countries or none at all. Which case prevails[23] will depend on the outcome of a contest both firms enter. On one hand, the idea that two firms split the market in form of contest is an approximation to a more complex mechanism like Bertrand competition which would imply the same market share pattern but also would entail price effects[24] which would considerably complicate the welfare analysis and comparisons with the closed economy solution.[25] On the other hand, contests have been used to model competition for market shares in the literature[26] before, see e.g. Friedman (1958), Bell et al. (1975), or Schmalensee (1976). In this context, contests are often interpreted as games of persuasive marketing or lobbying, etc. I follow this motivation and assume that firms compete in a contest in order to try and differentiate otherwise completely identical products. I will interpret the contest success function in a probabilistic way, i.e. the firm that is more successful in convincing the buyers of the ostensible superiority of its output will be able to steal market shares from the other firm. I will now explain this mechanism in more detail. The sequence of events in the redefined labor market game looks as follows.

Stages 1–3. As before.

Stage 4a. A contest decides which firm will receive a higher or lower share of the market.

Stage 4b. Idiosyncratic mark-ups ϕ_H and ϕ_F (two i.i.d. draws from $G_\Phi(\cdot)$) are revealed to the home and the foreign producer of a variety. This implies values of production y_H and y_F. The most unprofitable matches are destroyed and the workers are laid off.

Stage 5. As before.

[23]The result of this section generalizes to any other mechanism that leads to a situation where product market integration implies said 'strong firm'-'weak firm' patterns that are uncorrelated between industries.

[24]With Bertrand competition firms cannot set monopoly prices $p_i = P$ anymore. As mark-ups differ, the firm with the better shock will set a price that reduces the mark-up of the opponent to zero and will produce for both countries. As final good production is competitive this would also have an effect on the final good's price.

[25]Note that all welfare effects will therefore stem from a more efficient allocation of resources by exploiting increasing marginal products of single workers and opportunities of specialization. Bertrand competition would add an additional positive selection effect as only the firm with the lower marginal costs within an industry will survive.

[26]Konrad (2009) provides a recent comprehensive survey of the contest and tournament literature.

The extensions are now described in more detail. The final good production technology is the same as before,

$$Q_H^s = Q_F^s = \int_0^1 \min\left\{1, q_{H,i}^d + q_{F,i}^d\right\} \, di. \tag{4.8}$$

Hence, in the open economy world demand[27], i.e. $Q^s = Q_H^s + Q_F^s$, for every variety is now $[0, 2]$. Two firms in every sector fight for the whole market and do so in form of a contest where the winning probability ξ is given by the following simple, standard Tullock (1980) contest success function

$$\xi = \begin{cases} \frac{\kappa_H}{\kappa_H + \kappa_F} & \text{if } \max\{\kappa_H, \kappa_F\} > 0, \\ 1/2 & \text{otherwise,} \end{cases} \tag{4.9}$$

where κ_H denotes effort of the home firm and κ_F of the foreign firm. Both players can exert only two levels of effort, namely $\kappa_\ell \in \{0, \bar{\kappa}\}$, $\ell = H, F$. Unused effort cannot be spent on another activity.[28] As the mark-up shocks have not materialized yet the prize of the contest is the profit of winning given the expected mark-up which is the same for both players. There is a unique Nash-equilibrium in pure strategies where both players exert full effort. Hence the probability of winning is $\xi = 1/2$ in which case one firm gets the whole market and the other gets nothing.[29] As the winning firm is now again monopolist and serves the whole market it would again set $p_i = P$ but simply produce $q_i^s = 2$ leaving it with revenue of 2 while the other firm receives nothing. Once, the result of the contest is known and taking the optimal response of the intermediate producer into account, q is the realization of the following distribution conditional on employing a worker, Q,

$$q = \begin{cases} 2 & \text{with probability } \frac{1}{2}, \\ 0 & \text{with probability } \frac{1}{2}. \end{cases} \tag{4.10}$$

Before-wage profits are again computed according to (4.4). In the open economy they are therefore given by the random variable Y' which is the product of the two independent random variables Q and Φ, i.e. $Y' = Q \cdot \Phi$. While in the closed economy before-wage earnings[30] y are always equal to ϕ, they will now be higher or lower with probability $1/2$

[27]As both final good producers face exactly the same problem one can alternatively think of one big assembling firm with the production function $Q^s = \int_0^1 \min\left\{2, q_{H,i}^d + q_{F,i}^d\right\} di$ generating world demand for intermediate goods.

[28]In principle it would make no difference in the open economy setting whether firms are endowed with effort or whether effort is costly in terms of the final good. The former option was chosen to isolate welfare effects that purely stem from reallocation of resources and specialization when moving from the closed to the open economy case.

[29]Appendix D discusses a generalization where firms can only steal parts of the other firm's market.

[30]In the closed economy Q is degenerate and has a single mass point at 1.

each. A domestic firm has a potential of stealing business from a the foreign firm and raise its market share, while also the opposite could happen. As firms are ex-ante unaware of whether they will be the 'strong' or the 'weak' firm this implies an increase in revenue risk for a variety producer.

Lemma 4.1. *The integration of both product markets implies that the mean of Y' is preserved while $Var(Y') > Var(Y)$. It further implies a MPSCS from Y to Y' if the probability density function (pdf) of Φ, $g_\Phi(\cdot)$, is non-decreasing.*

The proof is provided in appendix A. Again, the random variable Y' is just a simple transformation of Φ, with $E(Y') = E(\Phi) = Var(Y) = \mu_\Phi$, $Var(Y') = 2Var(\Phi) + E(\Phi)^2 = 2Var(Y) + \mu_\Phi^2$ and the following distribution and density functions

$$g_{Y'}(y) = \frac{g_\Phi\left(y/2\right)}{4} \qquad \text{and} \qquad G_{Y'}(y) = \frac{1 + G_\Phi\left(y/2\right)}{2}. \tag{4.11}$$

The assumption that $g_\Phi(\cdot)$ is non-decreasing is a sufficient, but by no means necessary, condition for the intersection of $G_Y(\cdot)$ and $G_{Y'}(\cdot)$ to be unique[31]. Lemma 4.1 hints at the main result that international integration, as described above, indeed increases the spread of before-wage profits Y with all the discussed consequences in a way that was taken as given in the labor market analysis so far. The following proposition summarizes the main implications.

Proposition 4.1. *Assume that $g_\Phi(\cdot)$ is non-decreasing. Then the integration of both product markets leads to higher labor turnover and has ambiguous employment effects. Average and total net output, the average wage and the wage dispersion increase.*

Proof. This follows directly from combining lemma 4.1 with lemmata 3.1 and 3.2 and corollary 3.1. ∎

Increased job creation and destruction as well as the ambiguous effect on employment are direct results of the fact that market integration leads to a spread in revenues and before-wage profits as discussed in the previous section. While gross output, given my assumptions, only varies with employment, average costs decrease due to specialization. Consequently, average net output increases. The next section will reveal that also total net output has to rise unambiguously. As wages contain an element proportional to firms' before-wage profits it is clear that the average wage goes up while the wage distribution becomes more dispersed.

[31] Appendix A shows that the considerably weaker condition $g_\Phi\left(y/2\right) < 4g_\Phi\left(y\right)$ is also sufficient for single crossing.

5 Welfare analysis

This section presents the welfare analysis of the described model. First, I continue to assume that workers are risk-neutral. This gives a trivial first best implementation with no government intervention in the case of 'balanced' search externalities. In a second step it is analyzed how EP implies welfare losses and how these losses are amplified in open economies with increased necessity for labor reallocation while opening the economy in principle boosts welfare in absolute terms. In the last part of this section I check the robustness of these results by introducing risk-aversion and UI. The firing externality created by UI gives a motive for using EP as argued by Blanchard and Tirole (2008). It is shown that if endogenous job creation is taken into account the results derived in a risk-neutral framework are not very likely to change qualitatively.

5.1 First best allocation

Recall that all workers are ex-ante identical w.r.t. abilities and are assumed to always have the same value of home production. They are indexed by $i \in [0,1]$. The social planner is subject to the search frictions and the idiosyncratic shocks in the values of production. He has to choose a sequence of wages w_i and unemployment benefits b_i, labor market tightness θ and the cut-off $\underline{y}$ in order to maximize utilitarian welfare subject to a resource constraint. Given risk-neutrality the social planner's problem reads

$$\max_{\{w_i\},\{b_i\},\theta,\underline{y}} \int_0^1 [ew_i + (1-e)z_i] \; di, \tag{5.1}$$

subject to equilibrium employment (2.1) and the following resource constraint

$$\int_0^1 [ew_i + (1-e)b_i] \; di = ey^e - c\theta. \tag{5.2}$$

This implies

$$(1-\eta)\left[y^e - h\right](1-G) = \frac{c}{m^f}, \tag{5.3}$$

$$\underline{y} = h. \tag{5.4}$$

Let us compare these conditions with the decentralized equilibrium conditions

$$(1-\omega)\left[y^e - z + F\right](1-G) - F = \frac{c}{m^f}, \tag{5.5}$$

$$\underline{y} = z - F. \tag{5.6}$$

First note that because of risk-neutrality the optimal UI is zero, i.e. $b = 0$. Second, it is clear that one requires $F = 0$ for implementation of the first best, given that the Hosios (1990)-condition ($\eta = \omega$) holds which I will assume. Hence, one can work with the welfare generated in a laissez-faire economy as the first best benchmark.

5.2 Second best allocation

Denote the welfare of a laissez-faire economy as $\Omega(0)$ while the welfare in an economy with positive firing costs, $F > 0$ is denoted $\Omega(F)$. Defined in the equivalent (net) output terms representation[32] this is

$$\Omega(F) \equiv ey^e + (1-m)z + mG\left[z - F\right] - c\theta, \tag{5.7}$$

which is maximized subject to the equilibrium values of $\theta, \underline{y}, m, G, e$.

Proposition 5.1. *Welfare is decreasing in firing costs for any non-negative level of firing costs, i.e.* $\frac{d\Omega(F)}{dF} < 0$ *for all* $F \geq 0$.

The proof is provided in appendix A. This comes at no surprise as there is no inefficiency present that could justify $F > 0$ as already argued in the derivation of the first best allocation. Proposition 5.1 extends this result by showing that welfare is monotonically decreasing for all non-negative values of F. I will analyze the effect of F on welfare in an environment that is characterized by additional inefficiencies in section 5.3.

Proposition 5.2. *Welfare is weakly increasing for any MPSCS of* Y.

The proof is provided in appendix A. Note that proposition 5.2 even holds if a MPSCS leads to a fall in employment which is always overcompensated by the increase in average output.

Proposition 5.3. *The welfare loss due to firing costs is weakly increasing in job turnover if* $\eta = \omega \leq 1/2$.

The proof is provided in appendix A. The key message is that the welfare loss of EP is particularly severe for economies with high firing costs in combination with a high matching elasticity i.e. if the number of matches is more responsive to an increase in vacancies (small η). Note that proposition 5.3 states a weak condition for the welfare loss to increase in job turnover. The same can be true for considerably higher levels of η and ω. Given the results of the previous section this implies that an integrated or open economy suffers relatively more in efficiency terms from firing restrictions. It still

[32]Both, utility and output maximization coincide in the case of risk-neutrality as shown in appendix B.

enjoys higher welfare than a closed or less open economy in absolute terms, while the distance to a possible first best rises. Firing restrictions can hence lead to a substantial failure in reaping the possible welfare gains that could result from economic integration by preventing necessary labor reallocation. Or put differently, while closed economies will suffer from firing costs, the problem becomes even more severe for open economies.

5.3 Risk-aversion, unemployment insurance, and firing externalities

In this section I relax the assumption of risk-neutrality and impose risk-aversion. This implies that UI should be positive which creates a firing externality as described in Blanchard and Tirole (2008). Firms do not internalize the costs created by an UI system when they decide to lay off a worker. This externality can be counteracted by EP in form of a firing tax. Before the welfare analysis is presented it is discussed how equilibrium is affected by the introduction of risk-aversion, implying $u'(x) > 0$ and $u''(x) < 0$. Note that the wage bargaining condition changes as follows

$$\frac{\omega}{u(w) - u(z)} u'(w) = \frac{1 - \omega}{y - w + F}. \tag{5.8}$$

One can first-order Taylor approximate $u(x)$ around w and evaluate the function at $x = z$ which gives

$$u(w) - u(z) \approx u'(w)(w - z). \tag{5.9}$$

Using this handy approximation results in the same wage schedule as before

$$w(y) = (1 - \omega)z + \omega \left[y + F \right]. \tag{5.10}$$

Hence, the equilibrium allocation is again determined by

$$(1 - \omega) \left[y^e - z + F \right] (1 - G) - F = \frac{c}{m^f}, \tag{5.11}$$

$$\underline{y} = z - F. \tag{5.12}$$

This conveniently implies that the employment and output level is independent of the degree of risk-aversion. Consequently, propositions 5.1 to 5.3 are also true in the environment with risk-aversion if the terms 'welfare', defined as the sum of workers' utilities, is replaced by 'output'. This distinction is important as the tasks of output and welfare maximization do not coincide anymore. Hence, in contrast to output, welfare will depend on the degree of risk-aversion. The subsequent part of this section discusses the optimization of welfare.

5.3.1 First best allocation

In case of risk-aversion the social planner's problem reads

$$\max_{\{w_i\},\{b_i\},\theta,\underline{y}} \int_0^1 [eu(w_i) + (1-e)u(z_i)] \; di, \tag{5.13}$$

subject to equilibrium employment (2.1) and the resource constraint (5.2). The first-order conditions for w_i and b_i state that

$$u'(w_i) = \lambda = u'(z_i), \tag{5.14}$$

where λ is the Lagrange multiplier. (5.14) has two implications. First every employed worker receives the same wage, i.e. $w_i = w$, and every unemployed receives the same benefits $b_i = b$. Second, there is full insurance, i.e. $w = z = b + h$. Inserting the full insurance result in the first-order conditions for θ and $\underline{y}$ results in

$$(1-\eta)\,[y^e - h]\,(1-G) = \frac{c}{m^f}, \tag{5.15}$$

$$\underline{y} = h. \tag{5.16}$$

Let us consider a possible first best implementation now. Note by comparing (5.12) and (5.16) that optimal job destruction requires $b = F$ (as in Blanchard and Tirole (2008)). But observe how $b = F > 0$ will always lead to inefficiently low job creation which is not present in Blanchard and Tirole (2008). The only first best allocation would be given by $b = F = 0$ and $w = h$. This raises one problem. $w = h$ is incompatible with Nash bargained wages[33]. Hence, there does not exist a decentralized implementation of the first best allocation.

5.3.2 Second best allocation

Let us look for a second best allocation, i.e. the market solution that maximizes welfare, now. To allow for more flexibility an additional financing instrument in form of simple lump-sum taxes[34] T is introduced. Note that in the Blanchard and Tirole (2008) framework without endogenous job creation this would not change the result that a firing tax should be used to internalize the firing externality which otherwise leads firms to destruct jobs excessively. The problem changes as follows

$$\Omega(F) \equiv \max_b m \int_{\underline{y}}^{\infty} u(w(y) - T)\, dG_Y(y) + (1-e)u(z - T), \tag{5.17}$$

[33] See Michau (2011) for a detailed discussion of this issue in a dynamic setting.

[34] This implies that the gross wage $w(y)$ is independent of T and is still given by 2.7.

subject to the equilibrium values of θ, $\underline{y}$, $w(y)$, m, G, and e and the budget constraint where I assume that F can be collected as a firing tax at a share $\psi \in [0, 1]$

$$T = b(1 - e) - mGF\psi. \tag{5.18}$$

I will investigate the effect of introducing EP, i.e. by checking how $\frac{d\Omega(F)}{dF}$ is signed at $F = 0$ which simplifies (A.20). There are two cases: (a) if $d\Omega/dF > 0$ at $F = 0$ then $F^* > 0$ or if $d\Omega/dF < 0$ at $F = 0$ then $F^* = 0$. The results are summarized by the following proposition.

Proposition 5.4. *Let the following condition be fulfilled*

$$\Gamma \equiv \omega u'(\tilde{w})^e + (1 - e)u'(\tilde{z})mG\psi - mg(\underline{y})\left[u(\tilde{w})^e - u(\tilde{z})\right] > 0.$$

Then $\frac{de}{dF} > (<)\ 0$ *is a sufficient (necessary) condition for* $F^* > (=)\ 0$. *Otherwise it is a necessary (sufficient) condition for* $F^* > (=)\ 0$.

The proof is provided in appendix A. Observe how tightly related the effect on welfare is to the effect on employment $\frac{de}{dF}$. The proposition states that the effect of marginally raising F on total welfare is in principle ambiguous, even at $F = 0$. Why is this result different from Blanchard and Tirole (2008) where one would have $\frac{d\Omega}{dF}_{|F=0} > 0$? The main difference is the endogenous job creation margin. It is still true that firms do not internalize the social costs of firing, but they also do not internalize the social benefit from hiring. The intuition is that it is the total amount of benefits that matters, which is proportional to $1 - e$. The externality is created by the UI system that has to be financed which is not taken into account by the firms. Intuitively the externality is getting more severe if F leads to an increase in unemployment, which explains the tight link of the effect on welfare and the effect on employment. Whether firing taxes should be used at all hence depends on whether the condition in proposition 5.4 is fulfilled and especially on the effect on employment.

I will address this ambiguity with a small numerical example[35] to get a hint which of both cases seems to be more plausible. The functional forms and parameters were chosen in accordance with the literature and to replicate an unemployment rate of $1 - e = 0.1$. The choice of UI $b = 0.1$ was determined by welfare maximization according to (5.17) and represents a gross replacement rate of $\frac{b}{w^e} = 0.3$. The parameters and results are shown in table F.1. Starting from $F = 0$ the model suggests that employment is decreasing in F

[35] The results of this calibrated static model should be interpreted with great care, as the model was mainly designed to derive qualitative results. For a more realistic assessment concerning the magnitude of the featured effects one should employ a full dynamic version of the model, which is left for future research.

for the chosen calibration.[36] Although $\Gamma > 0$ the numerical example suggests that welfare is decreasing in F and consequently optimal EP is equal to zero. Hence, the result that EP leads to a welfare loss is likely to hold also in the case of risk-aversion as before when workers were risk-neutral.

6 Conclusion

A parsimonious static version of the Diamond-Mortensen-Pissarides (DMP) model with endogenous job creation and job destruction is combined with a North-North intermediate goods trade framework. The effects of openness to trade are propagated to the labor market through changes in marginal revenues which are normally assumed to be constant in the canonical DMP model. The final good production technology is such that an intermediate from a different industry has to be used to add additional value to the output, while a foreign variety is a perfect substitute for a home variety within the same industry. International product market integration implies that within an industry, consisting now of a home and foreign intermediate good producer, market shares and revenues are redistributed from the less to the more successful firm. As a firm is ex-ante unaware of its relative advantage over its competitor, openness to intermediate goods trade increases the spread of the distribution of revenues and profits it can expect. The intuition is that a domestic firm has to form expectations not only about its own productivity as in the closed economy benchmark but also about the relative advantage over the competing rival firm abroad and the consequences for market shares. The increased risk in profitability leads to more job creation, more job destruction, higher output, welfare, and wage inequality while the effect on employment is ambiguous. It is shown that the effects of international market integration are qualitatively identical to a reduction in employment protection in form of costly firing restrictions, except for wage inequality which would decrease. Further, the positive welfare effects of opening to trade are decreasing in the level of firing costs which render firing restrictions more severe for open economies by preventing necessary labor reallocation.

Some further concluding comments are in order. First, the trade shock was analyzed by comparing the limiting cases of a closed versus a trade-friction-free open economy. Hence, the presented model is ignorant about in-between cases of gradual trade liberalization. Although not formalized, an according extension could look as follows. Suppose that trade costs entered the model. The price in the integrated market stays the same but the mark-ups differ between producing for the final good firm in the home or the foreign

[36] This is in line with the literature as discussed in section 1, as the studies that find a significant effect almost exclusively report it to be negative.

country as variety producers in addition have to pay trade costs. Depending on the size of these costs it might happen that the mark-up for exports is negative while it is positive for the variety supplied to the domestic market. Hence, for some industries trade costs can prevent single-location sourcing from both final good producers. A specialization pattern might therefore only occur in some industries. A reduction in trade costs would lead to a higher probability of a single variety producer to find itself in a situation of international competition and would therefore in principle have the same qualitative effects as the scenario of opening to trade without restrictions studied in this paper. One could also assume that due to an implicit home bias effect a firm cannot steal the complete market but only a fixed fraction.[37] This fraction can be changed smoothly to mimic effects of gradual market integration. Second, the model was set up in a simple static framework. Suppose that mark-up and market share shocks only arrive from time to time, say with constant probabilities. The decision making of the firms is hardly affected and openness to trade would again simply imply increased uncertainty about future profitability. Hence, the main results would immediately carry over to such a dynamic setting. Third, I used the term 'market integration' hinting at a merging of two markets into one, which is not entirely the case. In contrast to many trade models the amount of varieties does not double, but stays constant inducing more competition within every variety sector. But there is no reason to rule out that in the long run variety producers can adapt their production techniques and that a persistent specialization pattern evolves. Hence, one should interpret the present model rather in a medium run perspective. Fourth, the model was designed in a very stylized way in order to analyze the effects of openness to trade and employment protection in a qualitative way. For quantitative exercises such as a cross-country welfare evaluation of existing firing restriction legislations given the observed openness to trade, one would have to employ a dynamic version of the model. This is left for future research.

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Appendix

A Derivations and proofs

Comparative statics w.r.t. F and proof of proposition 2.1.

$$\frac{d\theta}{d\pi^e} > 0, \quad \frac{d\theta}{d\mathcal{M}_0} > 0, \quad \frac{d\theta}{dc} < 0, \quad \frac{d\theta}{d\eta} < 0. \tag{A.1}$$

$$\frac{d\underline{y}}{dF} = -1, \quad \frac{dy^e}{d\underline{y}} = \frac{g_Y(\underline{y})(y^e - \underline{y})}{1 - G} > 0. \tag{A.2}$$

$$\frac{d\pi^e}{d\underline{y}} = -(1-\omega)(1-G) < 0. \tag{A.3}$$

$$\frac{d\pi^e}{dF} = -\left[1 - (1-\omega)(1-G)\right] < 0. \tag{A.4}$$

$$\frac{dm}{dF} = \frac{1-\eta}{\eta}\frac{m}{\pi^e} \cdot \frac{d\pi^e}{dF} = \frac{1-\eta}{\eta}\frac{m^2}{c\theta} \cdot \frac{d\pi^e}{dF} < 0. \tag{A.5}$$

$$\frac{dG}{dF} = -g_Y(\underline{y}) < 0. \tag{A.6}$$

$$\frac{de}{dF} = (1-G) \cdot \frac{dm}{dF} - m \cdot \frac{dG}{dF}. \tag{A.7}$$

$$\frac{de}{dF} = -(1-G)\frac{1-\eta}{\eta}\frac{m^2}{c\theta}\left[1-(1-\omega)(1-G)\right] + m g_Y(\underline{y}) \overset{?}{\gtreqless} 0. \tag{A.8}$$

■

Proof of proposition 2.2. The first part follows directly from the drop in the cut-off value $\underline{y}$, according to equation (2.8). For the second part write the marginal change of the average wage $w^e = (1-\omega) + \omega(y^e + F)$ as

$$\frac{dw^e}{dF} = \omega\left(1 - \underbrace{\frac{g_Y(\underline{y})(y^e - \underline{y})}{1 - G_Y(\underline{y})}}_{\chi}\right).$$

Whether the term χ is smaller or greater than 1 depends on the underlying distribution. For many distributions like uniform, normal, log-normal (with sufficiently small variance), beta (in the range used in this paper) etc. χ is bound between 0 and 1 for all $\underline{y}$ which consequently implies that F increases the average wage. ■

Proof of lemma 3.2. First, rewrite the MP condition. By the definition of MP one knows that $\int_{-\infty}^{\infty} y\, dG_{Y'}(y) - \int_{-\infty}^{\infty} y\, dG_Y(y) = 0$. Integrate by parts to get

$$\lim_{y\to\infty} \{y\,[G_{Y'}(y) - G_Y(y)]\} - \lim_{y\to-\infty} \{y\,[G_{Y'}(y) - G_Y(y)]\}$$
$$- \int_{-\infty}^{\infty} [G_{Y'}(y) - G_Y(y)]\; dy = 0.$$

As both limits tend to zero because of the definition of $G_Y(\cdot)$ and $G_{Y'}(\cdot)$ as cdfs it can be established that

$$\int_{-\infty}^{\infty} [G_{Y'}(y) - G_Y(y)]\; dy = 0. \tag{A.9}$$

Split the integral such that

$$\int_{-\infty}^{\underline{y}} [G_{Y'}(y) - G_Y(y)]\; dy + \int_{\underline{y}}^{\infty} [G_{Y'}(y) - G_Y(y)]\; dy = 0, \quad \forall \underline{y} \in \mathbb{R}. \tag{A.10}$$

I will now establish that the first term in (A.10) is non-negative while the second term is non-positive. Consider two cases, first $\underline{y} \geq \hat{y}$. Integrate the SCS condition from above to get

$$\int_{\underline{y}}^{\infty} G_Y(y)\, dy \geq \int_{\underline{y}}^{\infty} G_{Y'}(y)\, dy. \tag{A.11}$$

Note that the same is true in the second case $\underline{y} \leq \hat{y}$: Integrate the SCS condition from below and use (A.10) to arrive at (A.11) which now consequently holds $\forall \underline{y} \in \mathbb{R}$. To show that job creation is increasing it suffices to prove that the term $\Lambda \equiv \left[y^e - \underline{y}\right](1 - G_Y(\underline{y})) = \int_{\underline{y}}^{\infty} (y - \underline{y})\, dG_Y(y)$ is increasing as a result of a MPSCS. Hence, one has to show that $\Lambda' - \Lambda \equiv \Xi$ is non-negative, i.e.

$$\Xi = \left[\int_{\underline{y}}^{\infty} y\, dG_{Y'}(y) - \big(1 - G_{Y'}(\underline{y})\big)\, \underline{y}\right] - \left[\int_{\underline{y}}^{\infty} y\, dG_Y(y) - \big(1 - G_Y(\underline{y})\big)\, \underline{y}\right] \geq 0. \tag{A.12}$$

Integrate this expression by parts and take the limits to get

$$\Xi = -\,\underline{y}\,\left[G_{Y'}(\underline{y}) - G_Y(\underline{y})\right] - \int_{\underline{y}}^{\infty} [G_{Y'}(y) - G_Y(y)]\; dy$$
$$- \big(1 - G_{Y'}(\underline{y})\big)\, \underline{y} + \big(1 - G_Y(\underline{y})\big)\, \underline{y}.$$

Terms cancel, leaving $\Xi = -\int_{\underline{y}}^{\infty} [G_{Y'}(y) - G_Y(y)]\, dy$ which, as has been established before, has to be non-negative. ∎

Proof of corollary 3.1. Recall that in the proof of lemma 3.2 it was established that $\Lambda \equiv (1-G)(y^e - \underline{y})$ is increasing for any kind of MPSCS. Lemma 3.1 states that G is increasing for any kind of SCS if $\underline{y} \leq \hat{y}$. Both results can only be true at the same time if y^e is also increasing. Inserting in the wage equation (2.7) automatically reveals that the average wage w^e has to rise as well. The increase in the wage dispersion is a direct result of the MPSCS of Y. ∎

Proof of lemma 4.1. See appendix E for a short summary of the used mathematical concepts that are used in this proof. First, note that $Q = 2B$, where B is Bernoulli-distributed with probability parameter $1/2$. Consequently, $E(Q) = Var(Q) = 1$. One can therefore establish that $E(Y) = E(Y') = E(Q)E(\Phi) = E(\Phi)$, hence we have mean preservation. Second, due to independence the variance of Y' is given as $Var(Y') = E(Q)^2 Var(\Phi) + E(\Phi)^2 Var(Q) + Var(Q)Var(\Phi) = 2Var(\Phi) + E(\Phi)^2$ which is clearly bigger than the variance of Y, i.e. $Var(Y) = Var(\Phi)$. The density and distributions of Y and Y' are given as

$$g_Y(y) = g_\Phi(y) \quad \text{and} \quad g_{Y'}(y) = g_\Phi\left(\frac{y/2}{4}\right), \tag{A.13}$$

$$G_Y(y) = G_\Phi(y) \quad \text{and} \quad G_{Y'}(y) = \frac{1 + G_\Phi(y/2)}{2}, \tag{A.14}$$

where $g_{Y'}(y)$ is derived by using the density formula for product distributions and $G_{Y'}(y)$ simply stems from integration. Third, I show that $G_Y(\cdot)$ and $G_{Y'}(\cdot)$ fulfill the SCS condition. Recall that Φ is bounded between 0 and $\bar{\phi}$. If the cdfs above are evaluated at these boundaries it is clear to see that

$$G_Y(0) < G_{Y'}(0) \quad \text{and} \quad G_Y(\bar{\phi}) > G_{Y'}(\bar{\phi}). \tag{A.15}$$

Consequently, because of continuity there has to be an intersection point $\hat{y}$ such that $0 < \hat{y} < \bar{\phi}$. It is not clear that this intersection point is unique which is required for the SCS condition. A sufficient condition is that $g_\Phi(y/2) < 4g_\Phi(y)$. Note that the number of crossings is uneven. If there was more than one crossing $\hat{y}$ then at least one of the intersection points would be characterize by $g_Y(\hat{y}) < g_{Y'}(\hat{y})$, i.e. $G_{Y'}$ intersects G_Y from below. Given the condition from above this cannot be true. A stronger condition that is sufficient for uniqueness is that $g_\Phi(\cdot)$ is non-decreasing. ∎

Proof of proposition 5.1. The derivative of 5.7 w.r.t. F reads

$$\begin{aligned}\frac{d\Omega(F)}{dF} =& \frac{dm}{dF}\int_{\underline{y}}^{\infty} y\, dG_Y(y) + mg(\underline{y})(z-F) \\ & - \frac{dm}{dF}z + \frac{dm}{dF}G(z-F) - mG - mg(\underline{y})(z-F) - c\frac{d\theta}{dF}.\end{aligned} \tag{A.16}$$

Use $\frac{dm}{dF} = (1-\eta)m^f \cdot \frac{d\theta}{dF}$ and rewrite this equation as

$$\frac{d\Omega(F)}{dF} = \left(m^f\left[(1-\eta)(y^e - z + F)(1-G) - F\right] - c\right)\frac{d\theta}{dF} + m^f\eta F\frac{d\theta}{dF} - mG. \tag{A.17}$$

Given that the Hosios-condition holds the first term is zero because of the free entry condition (5.5). Using $\frac{d\theta}{dF} = -\frac{m}{\eta c}\left[\omega + (1-\omega)G\right]$ leaves

$$\frac{d\Omega(F)}{dF} = -\frac{m^2}{\theta}\left[\omega + (1-\omega)G\right]\frac{F}{c} - mG < 0. \tag{A.18}$$

■

Proof of proposition 5.2. Note that the welfare function (5.7) can be rewritten as

$$\Omega(F) = e\omega\left[y^e - z + F\right] + z = \omega m\Lambda + z \tag{A.19}$$

as explained in appendix B. Given the assumptions, Λ and m are both non-decreasing as a result of a MPSCS as established in the proof of lemma 3.2. ■

Proof of proposition 5.3. It has to be established under which conditions (A.18) is decreasing in job turnover, i.e. m and G. The condition $\eta \leq 1/2$ guarantees that the term $\frac{m^2}{\theta}$ in (A.18) is increasing in θ. In that case $\frac{d\Omega(F)}{dF}$ is decreasing for any increase in m and/or G.

■

Proof of proposition 5.4. First note that the budget solving lump-sum tax rate (5.18) changes with F according to

$$\frac{dT}{dF} = -b\frac{de}{dF} - \frac{dm}{dF}GF\psi - \frac{dG}{dF}mF\psi - mG\psi. \tag{A.20}$$

Let me define $\tilde{w} = w(y) - T$ and $\tilde{z} = z - T$. Use the envelope theorem, insert for $\frac{dm}{dF} = \frac{de}{dF}\frac{1}{1-G} - mg(\underline{y})\frac{1}{1-G}$, expand and rewrite the expression as

$$\begin{aligned}\frac{d\Omega(F)}{dF}_{|F=0} =& \frac{de}{dF}\cdot\left[u(\tilde{w})^e - u(\tilde{z})\right] + \frac{de}{dF}\cdot b\left[eu'(\tilde{w})^e + (1-e)u'(\tilde{z})\right] \\ & - mg(\underline{y})\left[u(\tilde{w})^e - u(\tilde{z})\right] + e\omega u'(\tilde{w})^e + (1-e)u'(\tilde{z})mG\psi,\end{aligned} \tag{A.21}$$

where superscript ^{e} again indicates the conditional expectation. All terms in brackets are positive. The first is so because $w(y) \geq z, \forall y \geq \underline{y}$. The condition stated in proposition 5.4 can then be directly derived from (A.21). ■

B Utility and output maximization

Both concepts, utility and output maximization, coincide in case of risk-neutral workers. Consider the second best welfare function for utility maximization

$$\Omega^{util} = m \int_{\underline{y}}^{\infty} w(y)\, dG_Y(y) + (1-e)z, \tag{B.1}$$

subject to the equilibrium conditions. Insert the wage schedule (2.5) and rearrange to get

$$\Omega^{util} = e(1-\omega)z + e\omega y^e + e\omega F + (1-e)z. \tag{B.2}$$

Rewrite the free entry condition (5.5) as $e(1-\omega)\left[y^e - z + F\right] - mF - c\theta = 0$ and add it to (B.2) to get

$$\Omega^{util} = ey^e + (1-e)z - mGF - c\theta = \Omega^{output}, \tag{B.3}$$

which is identical to the output maximizing objective function (5.7).

C Goods markets clearing

This section briefly describes goods markets clearing in the closed economy. The intermediate goods markets are completely supply-driven and therefore clear trivially. Supply of an intermediate good is either 1 or 0 depending on whether or not a worker is kept. The demand correspondence of the final good firm for every variety is $[0, 1]$, hence all intermediate goods markets clear. I now address the final good market. The final good production function states that given that e intermediate goods firms survive also the amount of the final good output is e. In addition, an unemployed person produces h units in terms of the final good as home production[38]. Hence, equating supply and demand

[38]UI b is set to 0 in what follows. If UI is financed through taxes as in section (5.3) the inclusion is trivial as it just implies a redistribution of final goods but does not change the market clearing condition.

gives

$$e + (1-e)h = ew^e + (1-e)h + mGF + c\theta + e(1-\phi^e),$$

$$\text{where } \; w^e = \frac{\int_{\underline{y}}^{\bar{y}} w(y)\, dG_Y(y)}{1 - G_Y(\underline{y})} \quad \text{and} \quad \phi^e = \frac{\int_{\underline{\phi}}^{\bar{\phi}} \phi\, dG_\Phi(\phi)}{1 - G_\Phi(\underline{\phi})}, \tag{C.1}$$

denote the average wage and the average mark-up which enter because $1 - \phi\frac{k}{n}$ in (C.1) are marginal costs for the usage of the capital good. The right hand side of equation (C.1) describes demand for the final good which consists of consumption of the employed workers using their wage income, consumption of the home production of unemployed workers, and all costs of the intermediate goods firms for firing, vacancy posting and production. Insert the wage schedule (2.5) to get

$$e = e(1-\omega)h + e\omega y^e + e\omega F + mGF + c\theta + e - e\phi^e. \tag{C.2}$$

Use the free entry condition (5.5) to insert for $c\theta = e(1-\omega)\left[y^e - h\right] - mGF - e\omega F$ to arrive at

$$e = ey^e + e - e\phi^e \quad \Leftrightarrow \quad y^e = \phi^e. \tag{C.3}$$

As $q = 1$ is true for all producing matches it follows that $y = \phi$ above the cut-off and hence $y^e = \phi^e$ has to hold which completes the proof.

D Intermediate market shares

Suppose that the result of the contest is not a 'winner-takes-all' solution. Instead suppose that

$$q = \begin{cases} 2(1-s) & \text{with probability } \frac{1}{2}, \\ 2s & \text{with probability } \frac{1}{2}, \end{cases} \tag{D.1}$$

where $s \in (1/2, 1]$. $s = 1$ represents the extreme case from before, while $s \to 1/2$ mimics the closed economy case where every firm just supplies half of the world market. Hence, before-wage profits Y are given by $Y = Q \cdot \Phi$, where $Q = 2\left[s + (1-2s)B\right]$ and B is again Bernoulli-distributed with probability parameter $1/2$. Clearly, $E(Q) = 1$ and $Var(Q) = (1-2s)^2$. It is easy to see that $E(Y) = \mu_\Phi$ and $Var(Y) = \sigma_\Phi^2 + \mu_\Phi^2(1-2s)^2 + \sigma_\Phi^2(1-2s)^2$. Hence, the variance increases in s while the expectation is unchanged. Density and distributions are given by

$$g_Y(z) = \frac{1}{2}\left[\frac{1}{2s} g_\Phi\left(\frac{z}{2s}\right) + \frac{1}{2(1-s)} g_\Phi\left(\frac{z}{2(1-s)}\right)\right], \tag{D.2}$$

$$G_Y(z) = \frac{1}{2}\left[G_\Phi\left(\frac{z}{2s}\right) + G_\Phi\left(\frac{z}{2(1-s)}\right)\right]. \tag{D.3}$$

Observe how the closed and the open economy setting described in the paper are nested as limiting cases $s \to 1/2$ and $s = 1$. The parameter s therefore captures the strength of the effect of market integration on the revenue risk.

E Math sheet

This section summarizes general mathematical concepts that have been heavily used in this paper for easier reference.

E.1 Change of variables

Let X be a univariate continuous random variable with cdf $G_X(\cdot)$ and pdf $g_X(\cdot)$. Let f be a monotone transformation such that $Y = f(X)$. Then the cdf and pdf of Y are defined as follows

a) if $f(\cdot)$ is increasing

$$G_Y(y) = G_X(f^{-1}(y)) \quad \text{and} \quad g_Y(y) = g_X(f^{-1}(y))\frac{1}{f'(f^{-1}(y))},$$

b) if $f(\cdot)$ is decreasing

$$G_Y(y) = 1 - G_X(f^{-1}(y)) \quad \text{and} \quad g_Y(y) = -g_X(f^{-1}(y))\frac{1}{f'(f^{-1}(y))}.$$

E.2 Random variables algebra

Let X and Y be two independent univariate continuous random variables with the according cdfs and pdfs. Define $Z = X + Y$. Then $G_Z(\cdot)$ is the convolution

$$G_Z(x) = (G_X * G_Y)(x) = \int_{-\infty}^{\infty} G_X(x-y)\, dG_Y(y) = \int_{-\infty}^{\infty} G_Y(x-y)\, dG_X(y),$$

$$g_Z(x) = (g_X * g_Y)(x) = \int_{-\infty}^{\infty} g_X(x-y) g_Y(y)\, dy = \int_{-\infty}^{\infty} g_Y(x-y) g_X(y)\, dy.$$

Now define $Z = X - Y$. Then $G_Z(\cdot)$ is the cross-convolution

$$G_Z(x) = (G_X \star G_Y)(x) = \int_{-\infty}^{\infty} [1 - G_Y(y-x)]\, dG_X(y) = \int_{-\infty}^{\infty} G_X(x+y)\, dG_Y(y),$$

$$g_Z(x) = (g_X \star g_Y)(x) = \int_{-\infty}^{\infty} g_Y(y-x) g_X(y)\, dy = \int_{-\infty}^{\infty} g_X(x+y) g_Y(y)\, dy.$$

All values were assumed to be real-valued. Now define $Z = X \cdot Y$. $g_Z(\cdot)$ and $G_Z(\cdot)$ are then given by

$$g_Z(z) = \int_{-\infty}^{\infty} \frac{1}{|x|} g_X(x)\, g_Y(z/x)\, dx,$$

$$G_Z(z) = \int_{-\infty}^{z} g_Z(x)\, dx.$$

Expectation and variance can be computed as

$$E(Z) = E(Z)E(X),$$

$$Var(Z) = E(X)^2 Var(Y) + E(Y)^2 Var(X) + Var(X)Var(Y).$$

F Tables and figures

Table F.1: Numerical example

Parameters	Results
$u(x) = \frac{x^{1-\psi}-1}{1-\psi}$	$\theta = 2.81$
$m = \mathcal{M}_0 \theta^{1-\eta}$	$\underline{y} = 0.15$
$Y \sim beta(\alpha, \beta)$	$e = 0.9$
$b = 0.1$	$m = 0.96$
$F = 0$	$m^f = 0.34$
$\psi = 3$	$G = 0.06$
$\eta = 0.5$	$\frac{w^e}{b} = 0.3$
$\omega = 0.5$	$T = 0.01$
$\psi = 1$	$\Gamma = 16.72$
$\alpha = 2$	$\frac{de}{dF} = -1.97$
$\beta = 2$	$\frac{dm}{dF} = -2.87$
$h = 0.05$	$\frac{dG}{dF} = -0.77$
$c = 0.06$	$\frac{dT}{dF} = 0.14$
$\mathcal{M}_0 = 0.57$	$\frac{d\Omega}{dF} = -28.33$

Figure F.1: Cumulative distribution functions - mean preserving single crossing spread

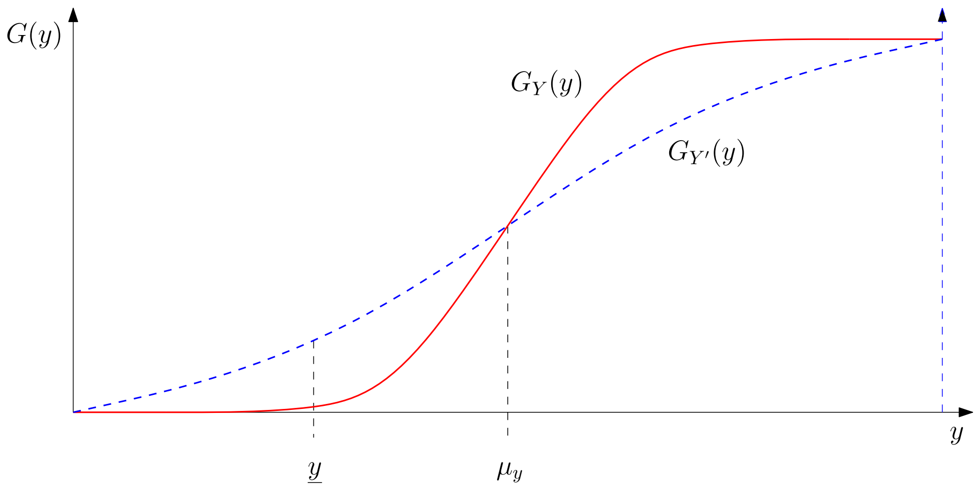
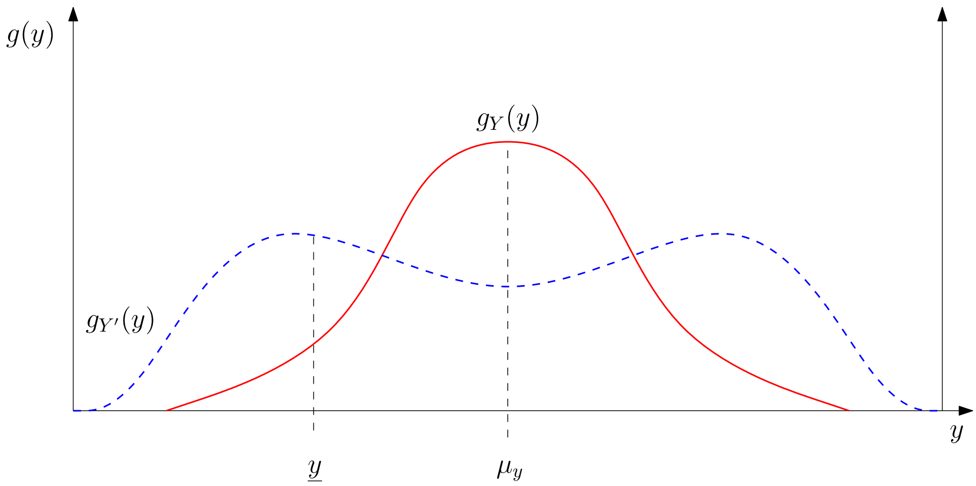


Figure F.2: Probability density functions - mean preserving single crossing spread



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