Labor Market Flexibility and Comparative Advantage*

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Abstract

International differences in the flexibility with which labor market regulation enables firms to adjust to idiosyncratic shocks are a source of comparative advantage if the within-industry dispersion of shocks is different across industries. Other things equal, countries with more flexible labor markets specialize in high-dispersion industries. Empirical evidence for a sample of OECD countries supports our theory: the exports of countries with more flexible labor markets are biased towards high-dispersion industries.

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1 Introduction

Comparative advantage is usually attributed to international differences in production capabilities strictly understood. The Ricardian model, for example, stresses the importance of technology for explaining why countries trade, whereas the Heckscher-Ohlin model emphasizes international differences in relative factor endowments. This paper argues that institutional differences can give way to comparative advantage, too, even when technologies and relative factor endowments are identical across countries. In particular, we show that international differences in the flexibility with which economies can reallocate labor between firms are a source of comparative advantage if the within-industry dispersion of firm-idiosyncratic shocks (both on the production and the demand side) is different across industries. Other things equal, countries with more flexible labor markets specialize in high-dispersion (or high-volatility) industries.

For simplicity, let us frame the intuition of our model in 'Ricardian' terms. If firms within an industry experience no productivity shocks at all, there is no need to reallocate labor across firms. Therefore that industry's average productivity will be equal across countries regardless of international differences in flexibility/rigidity. If firms within some other industry are subject to different productivity shocks, countries that can reallocate labor across firms more easily will achieve a higher average productivity in that industry. Hence, international differences in the ability of markets to reallocate labor combined with different within-industry dispersions of shocks lead to cross-country differences in autarky relative prices.

The following stylized facts highlight the potential relevance of this source of comparative advantage:

Table 1 reports two indices of labor market flexibility constructed by the World Bank upon the basis of related work by Botero *et al.* (2004). The indices increase with the rigidity of the corresponding country's labor market. One of them (rigidity of employment) is an average of three indices that capture labor market regulation affecting the difficulty with which firms can hire, fire, or change the hours worked by their employees. The other index (rigidity of hours) measures the latter dimension of labor market rigidities exclusively. North-America, the British Isles and Oceania have got more flexible labor market institutions than most of continental Europe.

These institutional differences are associated to important cross-country differences in the flows of workers both between employment and unemployment, and, more importantly for our purposes, across jobs. Table 2, based on Ridder and van den Berg (2003), provides information on international differences in labor market performance. Notice that job flows are remarkably higher in the US, a country with a flexible labor market, than in France and Germany, where labor market rigidities are far more important. Table 3, taken from Blanchard and Portugal (2001), compares job flows in the US and Portugal, a very 'rigid' country.[1] Although the American and Portuguese unemployment rates were similar during the early 90s, the Portuguese labor market exhibited much smaller flows of workers across different jobs.

Finally, Table 4, taken from Davis *et al.* (1997), displays average annual excess job reallocation rates (as a percentage of employment) by four-digit (SIC) manufacturing industry in the US. The high average rates of excess job reallocation, which represents the part of job reallocation over and above the amount required to accomodate net employment changes, indicate that this pattern largely reflects simultaneous job creation and destruction within industries. Table 4 also shows that the within-industry reallocation process exhibits a remarkable degree of cross-industry variation.

Provided one can link the cross-industry variation in job reallocation rates and volatility, all the elements required for our theory to work are present in reality. Our model does indeed provide such a theoretical link, which enables us to take the theory to the data. In fact, empirical evidence for a sample of 21 OECD countries and roughly 260 industries supports our intuition: countries with more flexible labor markets concentrate their exports relatively more intensively in sectors with higher volatility.

The link between labor market rigidities and comparative advantage has been present in the literature since the mid 90s. Saint-Paul (1997) establishes a link between firing costs and international specialization according to the life-cycle of goods: countries with flexible labor markets have got a comparative advantage in 'new'-good industries subject to higher aggregate demand volatility than 'mature'-good industries. Davidson, Martin and Matusz (1999) preset an equilibrium unemployment model in which the country with a more efficient search technology has a comparative advantage in the good produced in high-unemployment/high-vacancy sectors. This is due to the differences in prices required to induce factors to search for matches in sectors with different break-up rates. Galdón (2002) shows that labor market rigidities cal also affect specialization through lon-term unemployment, which reduces the skills workers might need in 'new-economy' sectors. Finally, Brügemann (2003) analyses the political-economy between labor market regulation choice

[1] Job creation at time t equals employment gains summed over all plants that expand or start up between $t-1$ and t. Job destruction at time t equals employment losses summed over all plants that contract or shut down between $t-1$ and t. Net employment growth equals the job creation rate minus the job destruction rate. Job reallocation at time t is the sum of job creation and job destruction. Excess job reallocation equals the difference between job reallocation and the absolute value of net employment change.

and trade liberalization in a model in which labor market rigidities give rise to comparative advantage. In comparison with these references, we try to add ‘empirical contents’ to the theory so as to take it to the data.

Our paper is also related to a growing literature that studies the effects of international differences in ‘institutions’ trade patterns. See, among others, Levchenko (2004), who shows that the quality of institutions (*e.g.*, property rights, the quality of contract enforcement, shareholder protection) affects both trade flows and the distribution of the gains from trade between rich and poor countries; and Costinot (2005) and Nunn (2005), who provide theories of international trade in the presence of imperfect contract enforcement, in which countries with better institutions should have a comparative advantage in more complex industries, or where the relation-specificity of investments is more relevant.

The rest of the paper is structured as follows. Sections 2 formalizes the paper's basic intuition in a one-factor model. Section 3 extends the model to a two-factor setup, and discusses how to obtain a proxy for the within-industry dispersion of shocks from information on excess job reallocation rates. In section 4, we present the empirical evidence. Section 5 concludes.

2 The Model

There are two countries, denoted by $c = F, H$. Each country has got one unit of internationally immobile labor, which is supplied inelastically: $L_c = 1$. Preferences are identical across countries: agents maximize $u(Q)$, where Q denotes consumption of a composite good, which is made from a continuum of final goods aggregated in a Cobb-Douglas fashion:

$$Q = \exp\left\{\int_0^1 \ln q(i)\, di\right\}. \tag{1}$$

$q(i)$ denotes consumption of final good i. We think of each industry i as an aggregate of intermediate goods:

$$y(i) = \left[\int_0^1 y(i,z)^{\frac{\varepsilon-1}{\varepsilon}}\, dz\right]^{\frac{\varepsilon}{\varepsilon-1}}, \tag{2}$$

We assume that the elasticity of substitution between intermediate goods ε is higher than between industries: $\varepsilon > 1$. Each intermediate good is produced with labor only:

$$y(i,z) = e^{\pi} L(i,z), \tag{3}$$

where π is a stochastic term. Within each industry, the π's are iid draws from a common distribution, identical across countries, but different across industries, with mean 0 and variance $\sigma^2(i)$. (We will sometimes refer to $\sigma^2(i)$ as industry i's 'volatility'.) This formulation emphasizes shocks for intermediate good producers on the production side, but allowing instead for demand shocks in equation (2) would yield results similar to the ones we discuss below.

All markets are competitive. We assume two different institutional scenarios. In country F, the determination of all prices and the allocation of all resources take place after the realization of π. This captures the idea of a flexible economy that can reallocate resources towards their more efficient uses costlessly. In country H, the wage and the allocation of labor are decided before the realization of π; no adjustment is allowed thereafter. After the realization of π, production and commodity market clearing take place. This corresponds to the idea that rigidities prevent firms from adjusting to changing circumstances.

Autarky in the Flexible Country

The zero-profit conditions for final good and intermediate good producers imply, respectively,

$$p_F(i) = \left[\int_{-\infty}^{\infty} p_F(i,\pi)^{1-\varepsilon}\, dF(\pi)\right]^{\frac{1}{1-\varepsilon}}, \tag{4}$$

$$p_F(i,\pi) = e^{-\pi} w_F, \tag{5}$$

where $F(\pi)$ denotes π's cumulative distribution function. This yields

$$p_F(i) = \frac{w_F}{\left[\int_{-\infty}^{\infty} e^{(\varepsilon-1)\pi} dF(\pi)\right]^{\frac{1}{\varepsilon-1}}}. \tag{6}$$

Autarky in the Rigid Country

Notice that the law of large numbers ensures there is no aggregate uncertainty. This implies that expectations on all variables before the realization of π equal their ex-post counterparts except for, of course, the individual firm's realization. We assume that agents hold a diversified portfolio and that firms maximize expected profits.

Given that all firms in industry i are ex-ante identical, $L_H(i,z) = L_H(i)$ for all z. Zero-profit conditions and market clearing imply

$$p_H(i) = \left[\int_{-\infty}^{\infty} p_H(i,\pi)^{1-\varepsilon}\, dF(\pi)\right]^{\frac{1}{1-\varepsilon}}, \tag{7}$$

$$w_H L_H(i) = \int_{-\infty}^{\infty} p_H(i,\pi)\, y_H(i,\pi)\, dF(\pi), \tag{8}$$

$$e^{\pi} L_H(i) = \left[\frac{p_H(i,\pi)}{p_H(i)}\right]^{-\varepsilon} y_H(i). \tag{9}$$

Equation (7) sets the price of final good i equal to its unit cost; equation (8) sets the labor cost of any intermediate good producer in industry i equal to expected revenue; equation (9) describes market clearing for any intermediate good in industry i. Some manipulation yields

$$p_H(i) = \frac{w_H}{\left[\int_{-\infty}^{\infty} e^{\frac{(\varepsilon-1)}{\varepsilon}\pi} dF(\pi)\right]^{\frac{\varepsilon}{\varepsilon-1}}}. \tag{10}$$

One can show that the flexible country has got an absolute advantage over the rigid country, due to the former's ability to reallocate labor across firms with different productivities.[2]

Free Trade

Assume $\pi(i) \sim N\left[0, \sigma^2(i)\right]$. In this case, equations (6) and (10) can be written, respectively, as

$$p_F(i) = \exp\left\{-\frac{\sigma^2(i)}{2}(\varepsilon-1)\right\} w_F, \tag{11}$$

$$p_H(i) = \exp\left\{-\frac{\sigma^2(i)}{2}\frac{(\varepsilon-1)}{\varepsilon}\right\} w_H. \tag{12}$$

Assuming free trade in final goods,[3] the model can be solved as in Dornbusch *et al.* (1977). Let us rank industries according to the variance of productivity, so that $\sigma(i)$ rises with i. Define

$$A(i) \equiv \frac{\exp\left\{-\frac{\sigma^2(i)}{2}(\varepsilon-1)\right\}}{\exp\left\{-\frac{\sigma^2(i)}{2}\frac{(\varepsilon-1)}{\varepsilon}\right\}} = \exp\left\{-\frac{\sigma^2(i)}{2}\frac{(\varepsilon-1)^2}{\varepsilon}\right\}.$$

[2] Jensen's inequality implies

$$\left[\int_{-\infty}^{\infty} e^{(\varepsilon-1)\pi} dF(\pi)\right]^{\frac{1}{\varepsilon-1}} \geq \left[\int_{-\infty}^{\infty} e^{\frac{(\varepsilon-1)}{\varepsilon}\pi} dF(\pi)\right]^{\frac{\varepsilon}{\varepsilon-1}}.$$

[3] Intermediate goods remain nontraded.

Notice $dA(i)/di < 0$: the larger i, the larger the productivity difference between flexible and rigid countries. That is, the flexible country has got a comparative advantage in high-volatility industries, as these are the industries where its ability to reallocate resources pays off more in terms of productivity gains. The free-trade equilibrium is characterized by the wage ratio w_H/w_F and a marginal commodity $\bar{\imath}$. For $i \leq \bar{\imath}$, $w_H/w_F \leq A(i)$, and good i is produced by country H. For $i > \bar{\imath}$, $w_H/w_F > A(i)$, and good i is produced by country F.

In equilibrium, the value of world consumption must equal the value of world output, which equals world labor income: $P(Q_F + Q_H) = w_F + w_H$. The value of country H's output, equal to country H's labor income, must also equal what the world spends on it.[4] If H produces in the range $[0, i]$, $w_H = iP(Q_F + Q_H) = i(w_F + w_H)$. Therefore we can write

$$\frac{w_H}{w_F} = \frac{i}{1-i} \equiv B(i). \tag{13}$$

The intersection of $A(i)$ and $B(i)$ determines the free-trade equilibrium. (See Figure 1.) Any overall increase in variance such that $\sigma'(i) > \sigma(i)$ $\forall i$ causes $A(i)$ to shift down as $B(i)$ remains unchanged. (See Figure 1.) This leads to a decrease in the range of sectors produced in H (*i.e.* a lower $\bar{\imath}$) and a lower relative wage w_H/w_F.

3 Two Factors

We now turn to a two-factor version of our model. Our interest here is twofold. First, we want to understand how the intuitions of our one-factor model are modified when there are production factors that are not subject to international differences in flexibility. Secondly, we need to impose some additional structure so as to take our model to the data.

Assume countries have got capital and labor, and that industries not only differ in the variance of productivity shocks, but also in their capital intensities. Q is now defined as

$$Q = \exp\left\{\int_0^1 \int_0^1 \ln q(i,j)\, di dj\right\}. \tag{14}$$

[4] Given our assumption on Q, expenditure on any interval $[i_1, i_2] \subset [0,1]$ is given by $\int_{i_1}^{i_2} p(i)\, q(i)\, di = (i_2 - i_1) PQ$, where $P = \exp\left\{\int_0^1 \ln p(i)\, di\right\}$.

We keep on thinking of an industry (i, j) as an aggregate of intermediate goods:

$$y(i,j) = \left[\int_0^1 y(i,j,z)^{\frac{\varepsilon-1}{\varepsilon}} dz\right]^{\frac{\varepsilon}{\varepsilon-1}}, \tag{15}$$

where $\varepsilon > 1$. Intermediate goods are produced with capital and labor:

$$y(i,j,z) = e^{\pi} K(i,j,z)^{\alpha(j)} L(i,j,z)^{1-\alpha(j)}, \tag{16}$$

$\alpha(j) \in [0,1]$. As in the one-good model, the π's are iid draws from a common distribution, identical across countries, but different across industries: $\pi(i) \sim N\left[0, \sigma^2(i)\right]$. Labor flexibility still varies across countries as above. As for capital, we assume that in both countries the rental rate and the allocation of capital to each firm are agreed before the realization of π; no adjustment is allowed thereafter. Implicit in this assumption is the idea that adjustment costs for capital are higher than for labor.

Autarky in the Flexible Country

The appendix shows

$$p_F(i,j) = \exp\left\{-\frac{\sigma^2(i)}{2} \frac{(\varepsilon-1)}{[1-\alpha(j)] + \alpha(j)\varepsilon}\right\} \mu(j)\, r_F^{\alpha(j)} w_F^{1-\alpha(j)}, \tag{17}$$

where $\mu = \alpha^{-\alpha}(1-\alpha)^{\alpha-1}$. Notice that for $\alpha(j) = 0$, this expression is equivalent to equation (11). *Ceteris paribus*, the higher the capital intensity of an industry, the lower the productivity gains associated to the reallocation of labor from low-π to high-π firms.

For future reference, we also work out the pattern of labor reallocation within each industry in the flexible country. Davis, Haltiwanger, and Schuh (1997) define excess job reallocation within an industry i between any two time periods t and t' as the amount of labor that is reallocated within the industry over and above the amount required to accomodate net aggregate employment changes. In terms of our notation,

$$v(i,j) \equiv \frac{1}{L(i,j)} \left[\int_0^1 |\Delta L(i,j,z)|\, dz - \Delta L(i,j)\right], \tag{18}$$

where ΔL denotes the change in employment between t and t'. The appendix shows that in our model an industry's excess job reallocation rate between any two time periods[5] is

$$v_F(i,j) = 2\left[2\Phi\left[\frac{(\varepsilon-1)\,\sigma(i)}{\sqrt{2}\,[[1-\alpha(j)]+\alpha(j)\,\varepsilon]}\right]-1\right], \tag{19}$$

where $\Phi(\cdot)$ denotes the standard normal distribution function. Notice σ has got a positive effect on excess reallocation: the higher the dispersion of the productivity shocks firms experience, the larger the within-industry reallocation of labor from low-π firms to high-π firms. The effect of α on v is negative instead:[6] the higher α, the lower the labor reallocation needed to equalize the value of the marginal productivity of labor between firms facing different realizations of π. This result is instrumental for our empirical strategy. In the absence of comprehensive cross-industry measures of the variance of productivity (and demand), v can be used to proxy for volatility (after controlling for α). This is very convenient for our purposes, as we have data for v at a very disaggregated level for the manufacturing industry.

Autarky in the Rigid Country

Since factor prices and the allocation of factors to each firm are agreed before the realization of π, all intermediate good producers hire the same amount of capital and labor. The analysis here is an immediate extension of the one-factor rigid-country case:

$$p_H(i,j) = \exp\left\{-\frac{\sigma^2(i)}{2}\frac{(\varepsilon-1)}{\varepsilon}\right\}\mu(j)\,r_H^{\alpha(j)}w_H^{1-\alpha(j)}. \tag{20}$$

Notice that

$$\frac{\sigma^2(i)}{2}\left[\frac{(\varepsilon-1)}{[1-\alpha(j)]+\alpha(j)\,\varepsilon}-\frac{(\varepsilon-1)}{\varepsilon}\right] > 0.$$

Again, the flexible country has got an absolute advantage over the rigid country, due to the former's ability to reallocate labor across firms.

Free Trade

Let us rank sectors by their respective capital intensities and variance levels. Assume $\alpha(j)$ and $\sigma(i)$ are continuous differentiable functions such that $d\sigma(i)/di > 0$, $d\alpha(j)/dj > 0$. As in the one-factor model, country F's productivity advantage increases with i for given j. But it decreases with j:

[5] One can think of our static set-up as a steady-state equilibrium; the law of large numbers ensures that aggregate outcomes are invariant over time.

[6] As we discuss below, this is the case in the data. It is worth remarking that both in the one-factor model and in the two-factor model with capital mobile across industries after the realization of π, $v = 2\left[2\Phi\left[(\varepsilon-1)\,\sigma/\sqrt{2}\right]-1\right]$.

the higher the capital intensity of an industry, the less relevant a country's ability to reallocate production factors from low- to high-productivity firms. Hence, *ceteris paribus*, F (H) will tend to specialize in high-volatility/labor-intensive sectors (low-volatility/capital-intensive sectors).

Assuming free trade in final goods, the model leads to complete specialization. Abusing notation, for given factor prices there is a set of goods F and a set of goods H, such that for all $(i,j) \in F$, $b_F(i,j) < b_H(i,j)$; and for all $(i,j) \in H$, $b_F(i,j) \geq b_H(i,j)$, where $b(i,j)$ denotes the industry's unit cost function (which has got the same form as the industry's autarky price). Consider the set of marginal commodities given by $b_F(i,j) = b_F(i,j)$, which can be rewritten as

$$\ln \frac{w_F}{w_H} + \frac{\alpha(j)}{1-\alpha(j)} \ln \frac{r_F}{r_H} = \frac{\sigma(i)^2}{2} \frac{(\varepsilon-1)^2}{\varepsilon\left[\left[1-\alpha(j)\right]+\alpha(j)\varepsilon\right]}. \tag{21}$$

Let us assume $r_F = r_H$.[7] In this case, $di/dj > 0$ by the Implicit Function Theorem. With i and j, respectively, on the vertical and horizontal axes, the set F (H) is to the North-West (South-East) of $i(j)$.[8]

4 Empirical Evidence

We focus our empirical analysis on the pattern of comparative advantage and trade of OECD countries. This is where most of world trade takes place, and where the assumption of identical technologies across countries can be defended best. Moreover, since our proxies for labor market flexibility are based on the contents of labor laws, we find it convenient to focus on a sample of countries where law enforcement problems are not that important.

In the spirit of Romalis (2004), we test the predictions of our model on the pattern of country-level exports across sectors. We thus test whether countries with more flexible labor markets concentrate their exports relatively more intensively in sectors with higher volatility. Naturally, we also control for other determinants of comparative advantage such as the interactions between country-level factor abundance and sector-level factor intensities. Instead of measuring each country's exports into the U.S. across sectors (which neglects the within OECD exports outside the U.S.), we follow the approach of Nunn (2005) and measure each country's aggregate exports across sectors.

[7] This might be due to international capital mobility or to the steady states of both countries being determined by the interest rate equalling the same rate of time preference.

[8] This result is again specific to the assumption of 'rigid' capital. If we assume capital is 'flexible', $di/dj < 0$. Hence, there is an ambiguity as to the two-factor model's predictions in this respect.

Data Construction and Description

Dependent Variable

The aggregate country exports across sectors come from the World Trade Flows Database (see Feenstra *et al.* (2005)). This data is classified at the 4-digit SITC rev. 2 level. We use the concordance from SITC to U.S. 4-digit SIC that is described in Nunn (2005).[9] This data is available yearly from 1962-2000. We use the export data from 1990 to match the sector level data described below, but have also expertimented using trades averages across a span of years centered around this date. After the sector concordance, we are left with manufacturing export data across 259 U.S. 4-digit SICs.

Country-Level Data

Following the work of Botero, Djankov, La Porta, López-de-Silanes, and Shleifer (2004), the World Bank has collected measures of the rigidity of employment laws across countries.[10] The measures cover three broad employment areas: hiring costs, firing costs, and restrictions on changing the number of working hours (coded on a 6 point scale). We feel that the latter is most closely related to the measure of volatility our theoretical model is intended to capture. We also use an overall measure of the rigidity of employment (which is a continuous index that averages the indices across these 3 broad categories). Both measures are coded from 0 to 100, with 0 being the most flexible. Since we recognize that the indices may capture many features of labor markets that are not relevant for our model, we construct a coarser dummy variable separating countries between "flexible" and "rigid". With either of these 2 indices, separating countries at the median country produces the same split between countries. Thus, our main labor flexibility index (FLEXIBILITY_c) is a 0-1 variable with the following country grouping: (flexible) Australia, Belgium, Canada, Denmark, Ireland, Japan, Norway, New Zealand, United Kingdom, United States; (rigid) Austria, Finland, France, Germany, Greece, Italy, Netherlands, Portugal, Spain, Sweden, Turkey.

Our remaining country level variables come from standard sources. We measure capital abundance (K_c) as the log of physical capital stock per worker (from the Penn World Tables). Human skill abundance (S_c) is calculated as the log average years of schooling in a country with Mincerian non-linear returns to education. Both these measures, obtained from Caselli (2003),[11] are available

[9] We thank Nathan Nunn for graciously sharing this data.

[10] This data, along with more detailed descriptions on its collection, is available online at http://www.doingbusiness.org/ExploreTopics/HiringFiringWorkers/

[11] We also tried alternate measures of skill abundance, such as the fraction of workers that completed high school,

over time; we use their values for 1990 to match the sector-level data described below.

Sector-Level Data

Our empirical approach requires a measure of volatility across sectors, which is not directly observable. However, our theoretical model suggests that, in an economy with flexible labor markets, the volatility of a sector is positively reflected in a larger level of excess job reallocation within that sector. Data for the latter is available across sectors for the U.S., an economy with one of the most flexible labor markets among OECD countries. These measures are available at yearly and quarterly frequencies for all U.S. 4-digit SICs, based on the work by Davis *et al.* (1997).[12] These data are available for years spanning 1973-1993. We pick 1990 as our benchmark year.[13]

We use the measures at quarterly frequencies, as our theory is also meant to capture the adjustment needed to respond to seasonal fluctuations. As predicted by our model and noted in Davis *et al.* (1997), we expect that these measures of excess job reallocations will be negatively correlated with capital intensity. Indeed, this correlation is quite strong, as indicated by figures 1 and 2, which show this relationship in both levels and in logs (weighted by employment in the sector), using capital per worker (from the NBER-CES Manufacturing Industry Database) as our measure of capital intensity.[14] Since capital intensity is another driver of comparative advantage, we do not directly use the measure of excess job reallocation as a proxy for sector volatility. Instead, we recover a more direct measure of volatility by purging the effects of capital intensity on excess job reallocation. As figures 1 and 2 make clear, a linear relationship between these two variables in logs is a reasonably good fit. We thus regress the log of excess reallocation on the log of capital per worker, and use the residual from this regression as our measure of volatility (VOLATILITY_s) across sectors.[15]

We also construct measures of factor intensities for capital and skill across sectors using the

or attained higher education (from Barro and Lee – NBER WP – 2000). These measures were clearly dominated by the one based on average years of schooling in explaining the pattern of comparative advantage across skill intensive sectors.

[12] The data has been graciously posted online by the authors, and is available at http://www.bsos.umd.edu/econ/haltiwanger/download.htm

[13] We would like to use data that is as recent as possible since our measures of labor market flexibility are only available for recent years. We use 1990 instead of 1993, the latest year available, so that we can run a robustness check by averaging out the measures across a 5 year interval centered on 1990. Unfortunately, there is a problem with the online data for 1988, so we use averages for 1989-1993 instead of 1988-1992.

[14] The measure of capital intensity used is capital per worker. We tried alternate measures for capital intensity, but the fit was clearly best for this former measure.

[15] We have also computed volatility using a high order polynomial in capital intensity to capture non-linear effects. The resulting volatility measure is very highly correlated with our preferred measure, and leads to similar results.

NBER-CES Manufacturing Industry Database. Several different functional forms have been used to measure both capital and skill intensity. We use the log of capital per worker (K_s) as our measure of capital intensity and the log of the ratio of non-production wages to total wages as our measure of skill intensity (S_s). We have experimented using many other functional forms: the same variables in levels, and the functional forms used by (Romalis 2004) based on a 3-factor model (also experimenting with logs and levels). In all these cases, we found that these latter functional forms had much less explanatory power for the pattern of comparative advantage than our preferred functional forms.[16] Again, we use data for 1990, but also experiment with a 5-year average centered around 1990.

Estimation and Results

Our baseline specification is:

$$X_{sc} = \beta_0 + \beta_{vf}\,(\text{VOLATILITY\_s*FLEXIBILITY\_c}) + \beta_{kk}\,(\text{K\_s*K\_c}) + \beta_{ss}\,(\text{S\_s*S\_c}) + \chi_s + \chi_c + \varepsilon_{sc}, \tag{22}$$

where X_{sc} is measured as the log of exports of country c in sector s, and χ_s and χ_c are sector and country level fixed effects. Given these fixed effects, our specification is equivalent to one where exports are measured as a share or as a ratio relative to the exports of a given reference country. Similarly, the specification is also equivalent to one where the country characteristics are measured as differences relative to a reference country. Our model predicts $\beta_{vf} > 0$: countries with more flexible labor markets export relatively more in relatively more volatile sectors. The similar traditional comparative advantage predictions, based on factor abundance and factor intensity, are $\beta_{kk} > 0$ and $\beta_{ss} > 0$.

The results from an OLS regression of equation (22) are listed in Table 5.[17] We find strong confirmation both for the predictions of our model and the traditional forces of specialization according to comparative advantage. The table lists the standardized beta coefficients, which captures the effects of raising the independent variables by one standard deviation (measured in standard deviations of the dependent variable). The magnitude of the coefficient on the volatility-flexibility interaction is of the same magnitude as those reported by Nunn (2005) and Levchenko

[16] Another commonly used measure of skill intensity is the ratio of non-production workers to total workers (whereas we use the ratio of the payments to these factors). These measures have a correlation coefficient of .94, and yield nearly identical results.

[17] Although we potentially have 21 countries x 259 sectors = 5439 observations, not all countries report exporting in all sectors. We are left with 5300 observations.

(2004) for the effects of institutional quality on the pattern of comparative advantage.

We next confirm that our results are not driven by other country characteristics outside of our model. In particular, we want to make sure that our measure of country level flexibility is not picking up the effects of other correlated country level attributes. We control both for the level of real GDP per capita (from the Penn World Tables) and an overall measure of the quality of legal institutions from López de Silanes, La Porta, Shleifer and Vishny (1998).[18] As expected, both of these measures are significantly correlated with our measure of labor market flexibility (even within the OECD, richer countries have more flexible labor markets and better measures of the rule of law). However, the results in Table 6 show that the pattern of comparative advantage is driven by the independent variation in labor market flexibility relative to these other two country level measures (the interaction terms with either of these two measures also do not enter significantly when they are included one at a time). We also extend these robustness checks to the interactions of factor abundance with factor intensity, by including interactions with GDP per capita (again, the latter is very significantly correlated with both measures of factor abundance). The results in Table 6 show that our measure of capital abundance still picks up important independent variation from GDP per capita that explains the pattern of comparative advantage towards capital intensive goods. However, we also see that our measure of human capital abundance no longer exhibits any important variation not captured in GDP per capita.

We have also checked to make sure that our results are not driven by the inclusion of countries with the lowest levels of GDP per capita. We have excluded together, and one at a time, Turkey, Greece, and Portugal from our sample, and always obtain a positive coefficient on the volatility-flexibility interaction that is significant at the 1% level. Lastly, we have also checked for the influence of outlier observations by removing all observations with studentized standard errors greater than 2.0. Again, our results are not substantially affected.

5 Concluding Remarks

Comparative advantage can arise even when the genuine production capabilities (resources and technologies) of countries are identical, provided they differ in labor market institutions. The empirical evidence presented above supports the validity of our intuitions within a sample of relatively homogeneous countries regarding their technologies.

This result has a number of interesting policy implications. First, labor market reform is likely

[18] We use their overall index for the rule of law.

to have asymmetric effects across industries. Secondly, a rigid economy has an alternative to the liberalization of its labor market to improve its welfare: it can always liberalize trade and ‘import flexibility’ from a more flexible trading partner.

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6 Appendix

Two-Factor Model: Autarky in the Flexible Country

Since the rental rate and the allocation of capital to each firm are agreed before the realization of π, all intermediate good producers of an industry hire the same amount of capital: $K_F(i,\pi) = K_F(i)$

for all π, where $K_F(i)$ is also the total amount of capital hired in the industry (since there is a unit mass of intermediate good producers).[19] Hence:

$$\frac{y(\pi)}{y(0)} = e^{\pi} \left[\frac{L(\pi)}{L(0)} \right]^{1-\alpha}. \tag{23}$$

Market clearing for each firm's output $y(\pi)$ and price $p(\pi)$ implies:

$$\frac{y(\pi)}{y(0)} = \left[\frac{p(\pi)}{p(0)} \right]^{-\varepsilon}. \tag{24}$$

Firms hire labor until the value of its marginal product is equal to the common wage:

$$w = p(\pi)\,(1-\alpha)\,e^{\pi} K(i)^{\alpha} L\,(\pi)^{-\alpha}. \tag{25}$$

Equations (23), (24) and (25) yield:

$$\frac{p(\pi)}{p(0)} = \exp\left\{ \frac{-\pi}{(1-\alpha)+\alpha\varepsilon} \right\}, \tag{26}$$

and

$$\frac{L(\pi)}{L(0)} = \exp\left\{ \frac{(\varepsilon-1)}{(1-\alpha)+\alpha\varepsilon}\pi \right\}. \tag{27}$$

In our model, an industry's excess job reallocation rate between any two time periods can be expressed as

$$v \equiv \frac{1}{L} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \left| L\left(\pi'\right) - L\left(\pi\right) \right| dF\left(\pi'\right) dF\left(\pi\right). \tag{28}$$

Equation (27) and Theorem 2.7 in Aitchison and Brown (1957) yield

$$v = 2\left[2\Phi\left[\frac{(\varepsilon-1)\,\sigma}{\sqrt{2}\,[1+\alpha\,(\varepsilon-1)]} \right] - 1 \right]. \tag{29}$$

Equations (24) and (26) imply:

$$\frac{p(\pi)y(\pi)}{p(0)y(0)} = \exp\left\{ \frac{(\varepsilon-1)}{(1-\alpha)+\alpha\varepsilon}\pi \right\} = \frac{L(\pi)}{L(0)}. \tag{30}$$

Since labor is paid the value of its marginal product, the Cobb-Douglas production form (and zero profit condition) implies that each firm pays a share $(1-\alpha)$ of its revenue $p(\pi)y(\pi)$ to labor:

[19] In what follows, country and industry notation is suppressed for simplicity wherever unnecessary. It is understood that α and σ will vary across industries.

$wL(\pi) = (1-\alpha)\, p(\pi)y(\pi)$. This relationship also holds in the aggregate for the industry: $wL = (1-\alpha)\, py$. As there are no ex-ante profits, wages are determined so that aggregate capital cost rK equals the remaining α share of revenue:

$$rK = \alpha \int_{-\infty}^{\infty} p(\pi)y(\pi)dF(\pi) = \alpha p(0)y(0) \exp\left\{ \frac{\sigma^2}{2} \left[\frac{(\varepsilon - 1)}{(1-\alpha) + \alpha\varepsilon} \right]^2 \right\}. \tag{31}$$

Using expressions $w = (1-\alpha)\, p(0) \left[K/L\,(0)\right]^{\alpha}$ and $wL(0) = (1-\alpha)\, p(0)y(0)$, which imply that $p(0)y(0) = \left[w/\left(1-\alpha\right)\right]^{(\alpha-1)/\alpha} p(0)^{1/\alpha}K$, equation (31) can be written as

$$\mu r^{\alpha} w^{1-\alpha} = p(0) \exp\left\{ \frac{\sigma^2}{2} \left[\frac{(\varepsilon - 1)}{(1-\alpha) + \alpha\varepsilon} \right]^2 \alpha \right\}, \tag{32}$$

where $\mu = \alpha^{-\alpha} \left(1-\alpha\right)^{\alpha-1}$. Finally, note that (26) implies that the price index for the final good is given by

$$p = p(0) \exp\left\{ -\frac{\sigma^2}{2} \left[\frac{(\varepsilon - 1)}{(1-\alpha) + \alpha\varepsilon} \right]^2 \frac{1}{\varepsilon - 1} \right\}. \tag{33}$$

Solving out for $p(0)$ using equation (32) yields

$$p = \exp\left\{ -\frac{\sigma^2}{2} \frac{(\varepsilon - 1)}{(1-\alpha) + \alpha\varepsilon} \right\} \mu r_F^{\alpha} w_F^{1-\alpha}. \tag{34}$$

Degrees of Flexibility/Rigidity

A simple way of introducing different degrees of labor market flexibility/rigidity is by assuming that each country has got both flexible and rigid sectors. This can be done easily by introducing one additional layer of aggregation into the model. For simplicity, we will work out the one-factor case. Extensions to the two-factor case are immediate.

Most of our assumptions above remain the same. We now think of each industry i as an aggregate of nontraded sectors s:

$$y\left(i\right) = \exp\left\{ \int_0^1 \ln y\left(i,s\right) ds \right\}, \tag{35}$$

where $y\left(i\right)$ denotes production of final good i. Each good s is produced with a continuum of nontraded intermediate goods:

$$y\left(i,s\right) = \left[\int_0^1 y\left(i,s,z\right)^{\frac{\varepsilon-1}{\varepsilon}} dz \right]^{\frac{\varepsilon}{\varepsilon-1}}. \tag{36}$$

Each intermediate good is produced with labor $y(i,s,z) = e^{\pi} L(i,s,z)$. All markets are perfectly competitive. Within each industry, there are 'flexible' and 'rigid' sectors, denoted respectively by ϕ and ρ. In a flexible sector, the allocation of labor takes place as in the flexible-country case discussed above. Rigid sectors are as industries were modeled in the rigid-country case. We assume that a measure $\lambda \in [0,1]$ of sectors in industry i are flexible, whereas a measure $(1-\lambda)$ are rigid. Labor is ex-ante perfectly mobile across sectors and industries.

Autarky

It is easy to see that for $s \in [0,\lambda]$,

$$p_{\phi}(i,s) = \frac{w}{\left[\int_{-\infty}^{\infty} e^{(\varepsilon-1)\pi} dF(\pi)\right]^{\frac{1}{\varepsilon-1}}}. \tag{37}$$

For $s \in (\lambda,1]$,

$$p_{\rho}(i,s) = \frac{w}{\left[\int_{-\infty}^{\infty} e^{\frac{(\varepsilon-1)}{\varepsilon}\pi} dF(\pi)\right]^{\frac{\varepsilon}{\varepsilon-1}}} \tag{38}$$

Since $p_{\phi}(s) < p_{\rho}(s)$, an industry's price index is a negative function of λ. Assuming $\pi \sim N\left(0,\sigma^2\right)$, the industry's price index is

$$p(i) = \exp\left\{-\frac{\sigma^2(i)}{2}\left[\frac{(\varepsilon-1)^2}{\varepsilon}\lambda + \frac{(\varepsilon-1)}{\varepsilon}\right]\right\} w. \tag{39}$$

Free Trade

Assume $\lambda_F > \lambda_H$. Define

$$A(i) \equiv \exp\left\{\frac{(\lambda_H - \lambda_F)\,\sigma^2(i)}{2}\frac{(\varepsilon-1)^2}{\varepsilon}\right\}, \tag{40}$$

and let us rank sectors according to this variable, so that $A'(i) < 0$. As in the one-factor model above, the free-trade equilibrium can be characterized by the intersection of $A(i)$ and $B(i)$. Notice that an increase in λ_F will have effects similar to an increase in $\sigma^2(i)$ for all i.

Labor Market Rigidity Indices

(Source: Botero et al.(2004))

	Rigidity of Hours Index	Rigidity of Employment Index
Australia	40	17
Austria	80	44
Belgium	40	20
Canada	0	14
Denmark	40	20
Finland	60	48
France	80	66
Germany	80	55
Greece	80	66
Ireland	40	33
Italy	80	57
Japan	40	19
Netherlands	60	49
New Zealand	0	7
Norway	40	38
Portugal	80	58
Spain	80	66
Sweden	60	43
Turkey	80	55
United Kingdom	20	14
United States	0	3

Table 1

Labor Market Performance (Source: Ridder and van den Berg (2003))

	W. Germany	France	UK	USA
Monthly Flow out of Unemployment % of Unempl. (Average over 1985-1993)	7.6	3.6	7.7	39.4
Monthly Flow into Unemployment % of Empl. (Average over 1985-1993)	0.41	0.33	0.59	2.26
Monthly Flow of Hires % of Empl. (Average over various years)	2.63	2.42	NA	5.38

Table 2

Quarterly job creation and destruction, all manufacturing sectors

(Source: Blanchard and Portugal (2001))

	Job Creation	Job Destruction	Job Reallocation
Portugal (1991:1-1995:4)	4	3.9	7.9
US (1972:2-1993:4)	6.8	7.3	14

Table 3

Average annual excess job reallocation rates,
US manufacturing sectors

(Source: Davis, Haltiwanger, and Schuh (1997))

Percentile	Excess Job Reallocation
1%	4.1
5%	6.2
10%	7.4
25%	9.9
50%	12.9
75%	15.8
90%	19.4
95%	21.7
99%	25.6
Size-Weighted Mean	13.2
Industry Observations	514

Table 4

VOLATILITY_s*FLEXIBILITY_c	0.203
	(3.919)**
K_s*K_c	1.629
	(8.641)**
S_s*S_c	1.043
	(11.038)**
Observations	5300
R-squared	0.5879

Notes:
Beta coefficients are reported
Absolute value of t statistics in parentheses
* significant at 5%; ** significant at 1%

Table 5

VOLATILITY_s*FLEXIBILITY_c	0.197
	(3.457)**
VOLATILITY_s*GDPPC_c	-0.166
	(0.352)
VOLATILITY_s*RULELAW_c	0.118
	(0.770)
K_s*K_c	1.357
	(3.495)**
S_s*S_c	0.059
	(0.388)
K_s*GDPPC_c	0.320
	(0.728)
S_s*GDPPC_c	3.010
	(8.096)**
Observations	5300
Number of sic	259
R-squared	0.5937

Notes:
Beta coefficients are reported
Absolute value of t statistics in parentheses
* significant at 5%; ** significant at 1%

Table 6

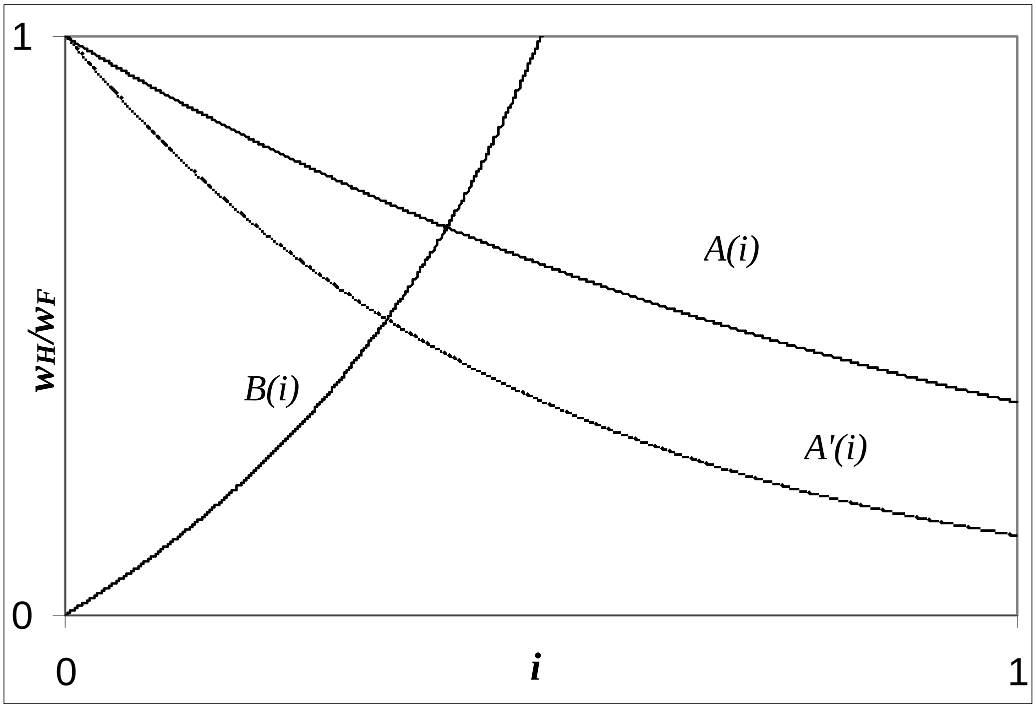

Figure 1: Equilibrium and comparative statics

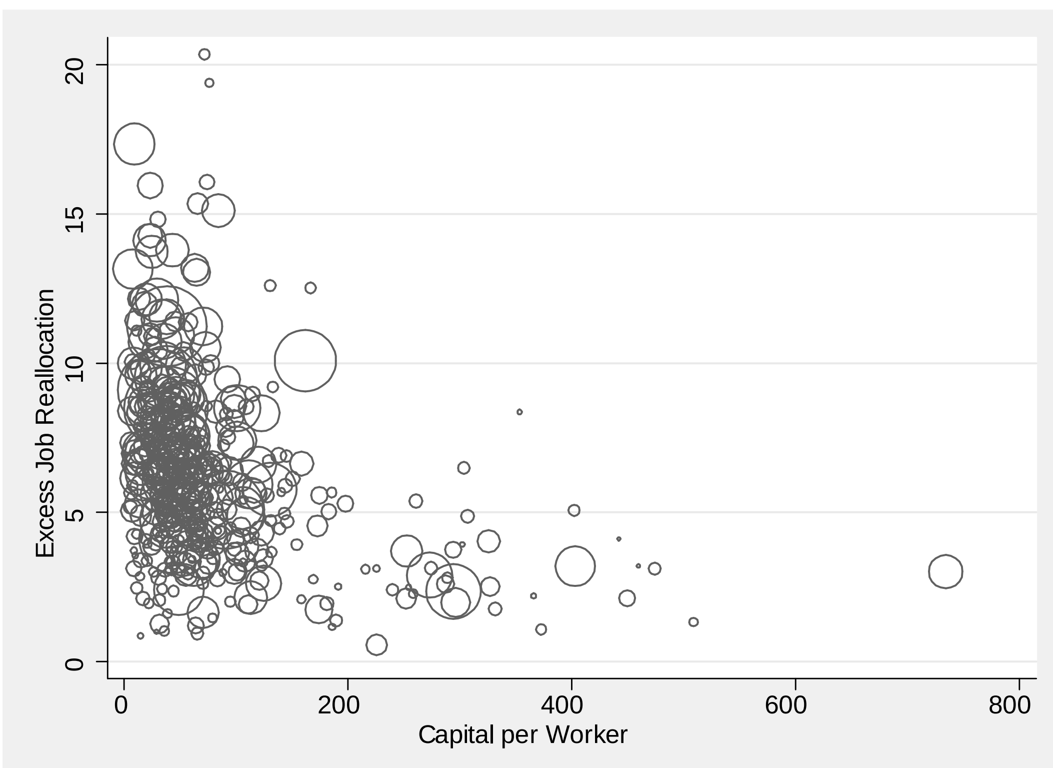

Figure 2: Excess Job Reallocation and Capital Intensity

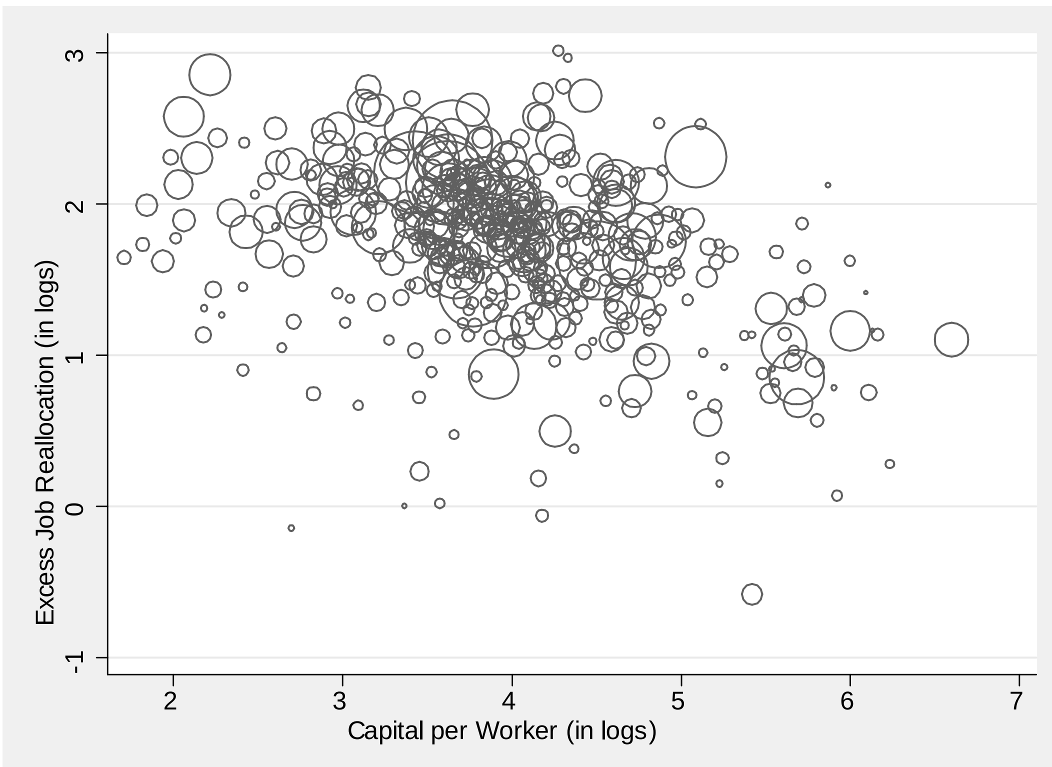

Figure 3: Excess Job Reallocation and Capital Intensity