The University of
Nottingham

research paper series

Globalisation and Labour Markets

Research Paper 2008/10

International Competition, Returns to Skill and Labor Market Adjustment

by

Rod Falvay, David Greenaway and Joana Silva

GEP
Leverhulme Centre
for Research on Globalisation and Economic Policy

The Authors

Rod Falvey is a Professor of International Economics in the Leverhulme Centre for Research on Globalisation and Economic Policy (GEP), University of Nottingham; David Greenaway is a Professor of Economics and Director of GEP; Joana Silva is a Young Professional at the World Bank and a GEP External Policy Associate.

International Competition, Returns to Skill and Labor Market Adjustment

by

Rod Falvey, David Greenaway and Joana Silva

Abstract

This paper examines whether increased import competition induces domestic workers to skill upgrade and/or switch industries. The analysis makes use of a large unique longitudinal matched employer-employee dataset that covers virtually all workers and firms in Portugal over the 1986-2000 period. Our identification strategy uses two exogenous changes in the degree of international competition. First, we exploit the strong appreciation of the Portuguese currency in 1989-1992 and pre-existing differences in trade exposure across industries in a differences-in-differences estimation. Second, we make use of changes in industry-specific (source-weighted) real exchange rates. A bivariate probit model is used to analyse the impact of increased international competition on skill-upgrading and/or industry switching. Based on both empirical strategies, and on two different skill definitions, we find strong confirmation for the hypothesis that increased international competition increases the returns to skill and induces skill upgrading.

Outline

Non-Technical Summary

The increased integration of national product markets has stimulated interest in identifying and explaining its labour market consequences, particularly with regard to the market returns to different skills/occupations and workers' skill-acquisition choices. While the drivers of the relative wage effects have been studied extensively, recent research has identified a new driver - changes in the degree of product market competition. The argument proceeds as follows. If product markets are imperfectly competitive, greater competition increases the sensitivity of profits to production costs. Provided that skilled workers are more productive than unskilled workers, an increase in competition raises the sensitivity of profits to the proportion of skilled workers hired. This induces a rise in demand for skills, which translates into higher returns. Empirical support for this hypothesis has been found in UK data.

Our aim here is to make two contributions. First we provide further evidence on the impact of within industry changes in international competition on returns to skill. We do this using a large longitudinal matched employer-employee dataset for Portugal that covers almost all workers and firms in the Portuguese private sector over the 1986-2000 period. This data is merged with very detailed trade data disaggregated at the industry level by both country of origin of imports and destination of exports. We employ two exogenous measures of changes in international competition - the strong appreciation of the Portuguese currency in 1989-1992 (over 25%); and industry-specific real exchange rates, for which we have data for a later period (1991-2000). Using two different skill definitions, we show that returns to skill within an industry increase with international competition.

By affecting returns to skill, increasing international competition influences workers' incentives to acquire skills. Our second, and perhaps most important, contribution is to investigate whether changes in competition also impact on skill upgrading. Specifically, we analyse whether a within industry increase in foreign competition causes skill upgrading and industry switching among workers. This reallocation may result from workers' reactions or firms' decisions. Using the same dataset and identification strategies, we estimate transition probabilities between skills and/or industries (controlling for worker, firm and sector characteristics) in a bivariate probit specification. Our empirical results strongly support the view that labour market adjustment to globalisation involves significant worker movements across sectors and skills. We find that increased international competition induces skill acquisition and decreases skill downgrading. Policy attention to the consequences of increased competition for human capital accumulation seems merited.

1. Introduction

In recent decades the increased integration of national product markets has stimulated a large literature aiming to identify and explain its labour market consequences. Among the consequences of particular interest are adjustments in the market returns to different skills/occupations and changes in workers skill-acquisition decisions. The former were the early focus of this literature, in particular whether trade liberalisation was an important driver of the increased wage inequality between skilled and unskilled workers observed in many high income countries. The general consensus from this seems to be that it may have contributed to a rise in the skill premium but played a small role relative to skilled biased technological change (Slaughter 2000, Acemoglu 2002, Machin 2003).[1] Other recent contributions argue that organisational change (Caroli and Van Reenen, 2001; Black and Lynch, 2004; Garicano and Rossi-Hansberg, 2006) and declining unionisation (Machin, 1997; Card, 2001) have also played an important role.

A recent paper by Guadalupe (2007) reports a previously unnoticed driver of the increase in returns to skill: changes in the degree of product market competition. Guadalupe identifies a mechanism whereby an increase in competition within an industry induces a rise in returns to skill. If product markets are imperfectly competitive, greater competition increases the sensitivity of profits to production costs. Provided that skilled workers are more productive than unskilled workers, an increase in competition raises the sensitivity of profits to the proportion of skilled workers hired. This induces a rise in demand for skills, which translates into higher returns. Using a panel of UK workers, she finds empirical support for this hypothesis. Exploiting two quasi-natural experiments which affected different sectors in different periods (a sharp appreciation of Sterling and implementation of the European Single Market Program), Guadalupe identifies a causal relationship between implied changes in the degree of competition and returns to skill within each industry.

Our paper makes two contributions. We begin by providing further evidence on the impact of within industry changes in competition on returns to skill. To do so we exploit a large longitudinal matched employer-employee dataset for Portugal that covers almost all workers and firms in the Portuguese private sector over the 1986-2000 period, merged with very detailed trade data disaggregated at the industry level by both country of origin of imports and destination of exports. Our identification strategy involves two exogenous measures of changes in international competition. First, following Cuñat and Guadalupe (2005) and Guadalupe (2007), we exploit a

---

[1] An important exception to this consensus is Wood (1998). For recent surveys of literature on globalization and inequality see Greenaway and Nelson (2002), Feenstra and Hanson (2003), Bardhan (2005) and Goldberg and Pavcnik (2007).

strong appreciation of the Portuguese currency in 1989-1992 (over 25%) and pre-existing differences in cross-industry trade exposure in a differences-in-differences estimation. Second, following Revenga (1992), Campa and Goldberg (2001) and Bertrand (2004), we make use of industry-specific real exchange rates, for which we have data for a later period (1991-2000). Based on both strategies, and on two different skill definitions, we find strong confirmation for the hypothesis that within industry increases in international competition are an important determinant of rising wage inequality.

The second, and perhaps most important, contribution is that we investigate whether changes in competition also impact on skill upgrading. Specifically, we analyse whether a within industry increase in foreign competition causes skill upgrading and industry switching. This reallocation may result from workers' reactions or firms' decisions. The analysis of worker reactions relates to the theoretical framework in Falvey et al (2007), where we argue that skill acquisition is an important part of the adjustment process to a change or shock that impacts on relative wages. Here we also focus on adjustment by the existing workforce by explicitly considering reallocation between industries and skills. However, we focus on a different underlying mechanism for the change in relative wages: whereas in Falvey et al (2007) the driver was the change in relative output prices that followed liberalisation here its main cause is a within industry increase in competition.[2]

Using the same dataset and identification strategies, we estimate transition probabilities between skills and/or industries (controlling for worker, firm and sector characteristics) in a bivariate probit specification. We distinguish between four alternatives: no change; moving industry; skill upgrading; moving industry and skill upgrading. Our empirical results strongly support the view that labour market adjustment to globalisation involves significant worker movements across sectors and skills. We find that increased international competition induces skill acquisition and decreases skill downgrading.

Understanding the implications of increased competition for skill acquisition is important given the theoretical possibility of poverty traps generated by lack of education (Barham et al. 1995) and occupational choice (Banerjee and Newman 1993), and the role of human capital accumulation in growth. Additionally, uncovering the channels influencing skill upgrading in an open economy context may shed light on how human capital accumulates as countries grow and what policies are more effective in expediting this process.

---

[2] Modelling worker transitions induced by a trade shock is also the focus of Davidson and Matusz (2000, 2002 and 2004) and Long et al. (2007). However, whereas the first focuses on consequences of industry specific human capital for the adjustment process, the second focuses on firm specific human capital.

The remainder of the paper is organised as follows. In Section 2 we outline the empirical methodology. In Section 3 we describe the data. Section 4 presents some descriptive statistics about workers' transitions. Section 5 discusses the empirical estimates, and Section 6 concludes.

2. Empirical Strategy

2.1. The effect of increased international competition on the returns to skill

To identify an exogenous change in the degree of product market competition, Guadalupe exploits two quasi-natural experiments: the implementation of the European Single Market Program in 1992 and a sharp appreciation of Sterling in 1996. Making use of panel data on UK workers, she estimates Mincerian wage equations where competition is measured at the industry level and a set of individual and industry covariates are included. Specifically, her baseline equation is:

$$\ln w_{iKt} = X_{it}\alpha + IC_{Kt} * skill_{it}\lambda + \theta IC_{Kt} + skill_{it}\beta + \tau_K + \phi_i + \mu_t + \Psi_{iKt} \qquad (1)$$

where w_{iKt} is the wage of worker i employed in industry K at year t; X_{it} is a vector of individual characteristics (age, age squared, gender, tenure); IC_{Kt} is the degree of international competition in industry K at year t, $skill_{it}$ is a vector comprising measures of the skill level of worker i at year t; and τ_K, ϕ_i and μ_t are, respectively, pure industry, person and time unobservable effects; and Ψ_{iKt} is an exogenous disturbance.

Building on Guadalupe's analysis, we also exploit a sharp appreciation of the Portuguese Escudo during 1989-1992 and pre-existing differences in trade exposure across industries, for a panel of Portuguese workers. Our analysis, however, goes beyond Guadalupe's work in several important respects. First, due to the richness of our data, we adopt an econometric model that accounts for both individual and firm-level heterogeneity. In line with Abowd and Kramarz (1999) and Abowd et al (2006), we argue that, given the existence of heterogeneity in compensation and retention policies adopted by firms, the estimated wage equation should ideally control for worker and firm effects. With regard to firm characteristics, our data includes information on size, labour productivity, age, proportion of foreign owned capital, location and industrial concentration. To account for both worker and firm unobserved effects, we exploit the longitudinal nature of our matched worker-firm data and estimate models with worker and spell (worker-firm) fixed effects. While in individual fixed-effects models the effect is identified out of individuals who stay in the same firm as well as individuals who move after a shock, in spell fixed-effects models the effect is identified out of variation over the time period in which the worker is employed in a given firm, thereby ensuring that unobserved changes to the industry composition of employment are not driving the results.

A second important innovation is that we are able to use a more informative definition of skill level. In Guadalupe's study skills evaluation was exclusively based on workers' occupations; our data permits evaluation based on occupations and schooling levels. Given the focus on returns to skill, it is particularly important to investigate whether results are robust to these different measures.

Another innovative feature is that, besides the 1989-1992 exchange rate appreciation, we use an additional empirical strategy to identify an exogenous change in competition: changes in industry source-weighted real exchange rates. This is computed using real exchange rates and bilateral trade data on imports for each industry. This strategy was established in the literature by Revenga (1992) to investigate the effect of international competition on industry wages and employment in US manufacturing, and has been recently adopted by Campa and Goldberg (2001), Bertrand (2004) and Cuñat and Guadalupe (2006) to examine the effect of competition on, respectively, industry wages and employment, the sensitivity of wages to the unemployment rate, and provision of incentives to top managers inside the firm.

We start with the following baseline Mincerian wage equation:

$$\ln w_{iJKt} = X_{it}\alpha + IC_{Kt} * skill_{it}\lambda + \theta IC_{Kt} + skill_{it}\beta + \\ Z_{Jt}\nu + \gamma hhi_{Kt} + \tau_K + \phi_i + \mu_t + \varphi_J + \Psi_{iJKt}$$ (2)

where w_{iJKt} is the wage of worker i employed at firm J of industry K at year t; Z_{Jt} is a vector of characteristics of firm J at year t (size, labour productivity, age, proportion of foreign owned capital, regional dummy); hhi_{Kt} is the Herfindahl-Hirschman index for industry K in which firm J operates; φ_J is a firm unobserved effect and the other variables are as above[3]. The main parameter of interest is λ, which reflects how returns to skill vary with international competition and we expect it to be positive.

We consider two different specifications of equation (2). In the first, the worker's level of skill is based on schooling, defined as the number of completed years of education (equation (2.1)). In the second, skill is computed using the International Labour Office's (ILO) correspondence Table between major groups of occupations in the 1988 International Standard Classification of Occupations (ISCO-88) and skill level (equation (2.2)). The ISCO-88 "is based on the nature of the skills required to carry out the tasks and duties of the job not the way these skills are acquired" (Hoffmann 2000, pp. 2), considering formal education, training and experience. Table 1 presents the correspondence Table and description of requirements associated with each skill level provided

---

[3] See Appendix A for a detailed description of how the variables are constructed.

by Elias et al (1999)[4]. In the econometric analysis we aggregate skill groups 1 and 2 as low skilled workers, which is then used as the base category in the estimation of returns to skill.

Table 1: Definition of skill groups – ISCO-1988

Skill Level	ISCO-88 Major Groups Included	Decription
4th	1. Legislators, senior officials and managers; 2. Professionals.	Normally requires a degree or an equivalent period of relevant work experience.
3rd	3. Technicians and associate professionals.	Requires a body of knowledge associated with a period of post-compulsory education but not to degree level.
2nd	4. Clerks; 5. Service workers and shop and market sales workers; 6. Skilled agriculture and fishery workers; 7. Craft and related workers; 8. Plant and machine operators and assemblers;	Requires knowledge as for first skill level, but in addition typically have a longer period of worker-related training or work experience.
1st	9. Elementary Occupations.	Competence associated with general education usually acquired by completion of compulsory education.

Source: International Labour Office (1990, pp. 2-3) and Elias et al. (1999) as in Upward and Wright (2003).

Using each skill definition, we estimate the following equations:

$$\ln w_{iJKt} = X_{it}\alpha + \theta IC_{Kt} + \beta \, schooling_{it} + \lambda IC_{Kt} * schooling_{it} +$$
$$Z_{Jt}\upsilon + \gamma hhi_{Kt} + \tau_K + \varphi_i + \mu_t + \phi_J + \Psi_{iJKt} \qquad (2.1)$$

$$\ln w_{iJKt} = X_{it}\alpha + \theta IC_{Kt} + \beta_1 mskill_{it} + \beta_2 hskill_{it} +$$
$$\lambda_1 IC_{Kt} * mskill_{it} + \lambda_2 IC_{Kt} * hskill_{it} +$$
$$Z_{Jt}\upsilon + \gamma hhi_{Kt} + \tau_K + \varphi_i + \mu_t + \phi_J + \Psi_{iJKt} \qquad (2.2)$$

where $schooling_{it}$ is the number of completed years of education; $mskill_{it}$ and $hskill_{it}$ are dummy variables equal to one if skill level is equal to 3 or 4 respectively.

Two points are worth highlighting. First, the need for longitudinal matched employer-employee data, containing work histories as well as individual and firm characteristics. Second, the need to identify changes in international competition that are exogenous to the behaviour of firms and

---

[4] Using information for each worker schooling and tenure we have also checked the consistency of the described educational requirements with those in our data for each skill group and our results are in line with the Elias et al. description.

workers in each sector. We exploit real exchange rate movements to identify an exogenous change. Appreciation of the home currency leads to increased international competition for national firms for two reasons: it reduces the prices that foreign competitors can offer in the home country market; and it encourages more entry by increasing the number of potential foreign firms that can sell in the home country. As argued by Revenga (1992), Bertrand (2004) and Guadalupe (2007), exchange rate movements are largely unpredicted and exogenous to the behaviour of firms and workers within each industry. We adopt two complementary empirical strategies. First, we identify an episode of sharp appreciation in the Portuguese currency that can be regarded as a quasi-natural experiment that affected sectors differently. Figure 1 depicts the evolution of the real effective exchange rate against all currencies weighted by the respective country's relative importance in Portuguese imports. As this Figure makes clear, the Escudo appreciated sharply in 1989-1992, preceded and followed by a period of relative stability.

Figure 1: Real effective exchange rate, Portuguese Escudo (1985=100)

Source: Bank of Portugal.

In Figure 2 we plot the difference in mean log wages between skilled and unskilled workers of the manufacturing sector over our sample period. Whether we identify skill by schooling only or using the ILO's skill definition, between 1989 and 1992 this difference increased sharply.

Figure 2: High to low skill wage differentials of the manufacturing sector
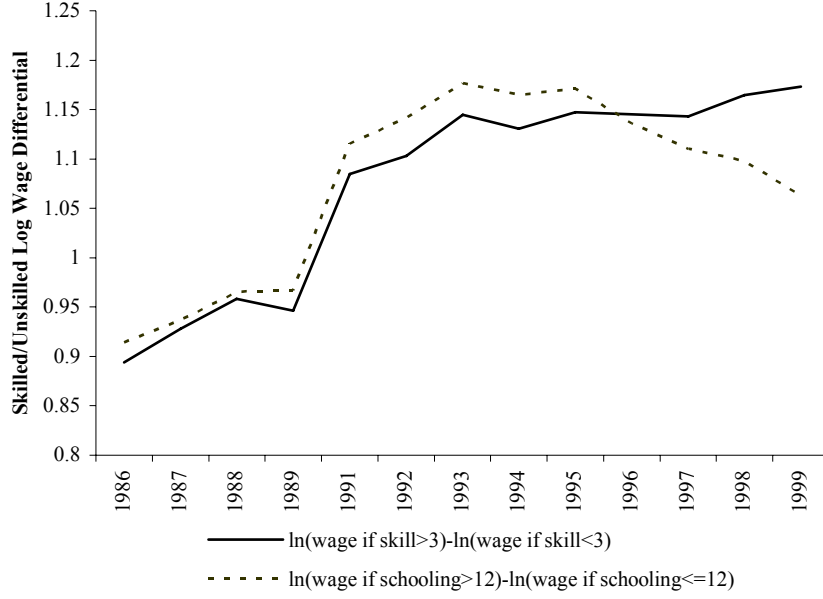
Source: Author calculations from *Quadros de Pessoal*.

We use the pre- and post-appreciation period (1986-1988 and 1989-1992 respectively) and pre-appreciation differences between sectors in trade openness to identify exogenous changes in international competition in a difference in differences specification. The advantage of this is that it controls for pre-existing differences across industries and changes common to all industries. The hypothesis is that the appreciation represents a higher increase in the degree of product market competition in the sectors that are (ex-ante) more open (treatment group) relative to those fairly closed (control group). More specifically, we estimate:

$$ln\, w_{iJkt} = X_{it}\alpha + \theta(indop88_K * post89_t) + skill_{it}\beta +$$
$$(indop88_K * post89_t * skill_{it})\lambda + (post89_t * skill_{it})\varsigma + (indop88_K * skill_{it})\varphi +$$
$$Z_{Jt}\nu + \gamma hhi_{Kt} + \tau_K + \phi_i + \mu_t + \varphi_J + \Psi_{iJKt}$$

(3)

where $indop88_K$ is the degree of openness to trade of industry K and $post89_t$ is a dummy variable that takes the value zero in the pre-appreciation period (1986-1988) and one during the appreciation (1989-1992). The rest of the variables are defined as before. Note that since trade openness may vary endogenously with real appreciation, the variable $indop88_K$ is computed as the level of openness for 1988[5]. In this specification λ is the differences-in-differences estimate of returns to skill and captures how these vary with international competition. To get this estimate it is necessary to control for differences in returns to skill before and after the experiment (captured by

---

[5] Note that the model does not have a variable measuring openness on its own, nor a before and after dummy on its own because they are swept out by the industry and time dummies.

ς) and differences in returns to skill between sectors with different degrees of openness (captured by φ).

The second empirical strategy uses changes in source-weighted industry real exchange-rates to measure exogenous changes in international competition. This is defined as the weighted average of the log real exchange rates of importing countries, where the weights are the shares of each trade partner in the industry's total imports in a base period. This index varies across industries based on the composition of imports by country of origin and has also been used by Revenga (1992), Bertrand (2004), Cuñat and Guadalupe (2006) to instrument for changes in import penetration. To avoid potential endogeneity issues, the weights should be prior to the period under analysis. Given that the first years for which bilateral data on imports by industry is available are 1990 and 1991, the period under analysis is restricted to 1991-2000. We therefore estimate equation (2), where IC_K is now the source-weighted real exchange rate index for industry K .

2.2. Increased international competition on skill acquisition and industry relocation

To examine the impact of increased international competition on skill acquisition and industry relocation we estimate a bivariate probit model. The underlying assumption is that moving skill and moving industry are two alternative routes for adjusting to increased competition, but they are related. The first route can be decomposed into skill upgrading and downgrading. The underlying assumption is that increased competition increases returns to skill (tested in this paper) and generates wage differentials between sectors for workers with the same skill, respectively. The latter effect has been established in the literature by Krueger and Summer (1988), who show that an increase in product market competition, by decreasing monopoly rents, decreases the ability of firms to pay higher wages and generates wage differentials between sectors.

We adopt the following baseline two equation system:

$$\begin{cases} moveind^*_{iJKt} = X_{it}\alpha_0 + \theta_0\Delta IC_{Kt} + Z_{Jt}v_0 + \gamma hhi_{Kt} + \phi_J + \mu_t + \Psi_{iJKt} \\ moveskill^*_{iJKt} = X_{it}\alpha_1 + \theta_1\Delta IC_{Kt} + Z_{Jt}v_1 + \gamma hhi_{Kt} + \phi_J + \mu_t + \Lambda_{iJKt} \end{cases} \quad (4)$$

where $moveind_{iJKt}$ and $moveskill_{iJKt}$ are two observed binary indicator variables driven by the two equation system of latent propensities to move industry ($moveind^*_{iJKt}$) and skill ($moveskill^*_{iJKt}$). ΔIC_K is the percentage change in competition in industry K . Ψ_{iJKt} and Λ_{iJKt} are exogenous disturbances (assumed to be correlated). The other variables are as before. The observability criteria for the two sets of observed binary outcomes are

$$\begin{cases} moveind_{iJKt} = 1(moveind^*_{iJKt} > 0) \\ moveskill_{iJKt} = 1(moveskill^*_{iJKt} > 0) \end{cases}$$

$moveind_{iJKt}$ is equal to one if individual i in the subsequent observation is employed in a different industry and $moveskill_{iJKt}$ is equal to one if individual i in the subsequent observation has a different level of skill.

We also estimate this system with $skillup$ instead of $moveskill$, where the observability criteria for the two sets of binary outcomes is

$$\begin{cases} moveind_{iJKt} = 1(moveind^*_{iJKt} > 0) \\ skillup_{iJKt} = 1(skillup^*_{iJKt} > 0) \end{cases}$$

$skillup_{iJKt}$ is equal to one if individual i in the subsequent observation has a higher skill level than at year t. The main parameters of interest are θ_0 and θ_1 which reflect how the propensities to move industry and skill vary with competition and we expect them to be positive.

For the bivariate model there exist four possible combinations of outcomes: stay ($moveind = 0$ and $moveskill = 0$), move industry only ($moveind = 1$ and $moveskill = 0$), move skill only ($moveind = 0$ and $moveskill = 1$), and move both industry and skill ($moveind = 1$ and $moveskill = 1$). We can derive the probabilities associated with each and the unconditional probability of moving industry, $Pr(moveind = 1)$, and moving skill, $Pr(moveskill = 1)$.

As in the estimation strategy for the effect of increased competition on returns to skill, here identifying changes in international competition that are exogenous is crucial and we adopt the same identification strategy as above.

The estimated two equation systems are given by:

$$\begin{cases} moveind^*_{iJKt} = X_{it}\alpha_0 + \theta_0(indop88_K * post89_t) + \varsigma_0 post89_t + \varphi_0 indop88_K + \\ \qquad Z_{Jt}v_0 + \gamma_0 hhi_{Kt} + \tau_K + \mu_t + \Psi_{iJKt} \\ moveskill^*_{iJKt} = X_{it}\alpha_1 + \theta_1(indop88_K * post89_t) + \varsigma_1 post89_t + \varphi_1 indop88_K + \\ \qquad Z_{Jt}v_1 + \gamma_1 hhi_{Kt} + \tau_K + \mu_t + \Lambda_{iJKt} \end{cases}$$

(4.1)

$$\begin{cases} moveind^*_{iJKt} = X_{it}\alpha_0 + \theta_0\Delta exchrate_{Kt} + Z_{Jt}v_0 + \gamma_0 hhi_{Kt} + \tau_K + \mu_t + \Psi_{iJKt} \\ moveskill^*_{iJKt} = X_{it}\alpha_1 + \theta_1\Delta exchrate_{Kt} + Z_{Jt}v_1 + \gamma_1 hhi_{Kt} + \tau_K + \mu_t + \Lambda_{iJKt} \end{cases}$$

(4.2)

where $\Delta exchrate_K$ is the percentage change in the source-weighted real exchange rate index for industry K. The other variables are defined as before.

3. Data Description and Descriptive Statistics

3.1. The data set

Our data is from a longitudinal matched employer-employee dataset, "Quadros de Pessoal" [QP], collected by the Portuguese Ministry of Employment, which covers virtually all workers and firms in the Portuguese private sector over the 1986-2000 period, around 200,000 firms and more than 2 million workers each year. It provides comprehensive information on worker's demographic characteristics (age, gender, schooling), occupation characteristics (occupational group, professional category, wage, hours worked) and plant tenure, along with employing firm ID codes. Firm-level characteristics includes sales, number of employees, equity, percentage of foreign capital, geographical location and date of constitution, along with industry code. This code allows us to merge this data set with very detailed trade data, disaggregated at the industry level with imports by country of origin, collected by the Portuguese National Statistics Office (INE). Trade data is only available for manufacturing for the period 1988-2000. As the Portuguese classification of industries has been revised in 1994 to match the NACE-Rev 2, a concordance was needed and the analysis considers 74 manufacturing industries[6].

There are two important characteristics that guarantee this data set's coverage and reliability. First, data is collected from a compulsory administrative census that the Ministry of Employment runs annually to check the firm's compliance with labour law. Second, and unique to this data base, firms are required by law to make the information provided to the Ministry available to every worker in a public place of the establishment. Another important advantage is its longitudinal nature that results from the fact that a unique identification number is attributed to each worker the first time he enters the data set. This is based on his social security number that does not change through time.

To control for any coding errors, we have performed extensive checks to guarantee the accuracy of the worker data using information on gender, date of birth and maximum schooling level achieved, as described in Appendix B. After these checks, we kept for analysis full-time wage earners, aged between 16 and 65, earning at least the national minimum wage, working in firms operating in mainland Portugal. The final panel used in the analysis contains information on 2,998,727 workers, 467,269 firms, imports and exports from 74 manufacturing industries over the period 1986-2000, yielding a total of 15,613,149 worker-year observations.

---

[6] The concordance used can be found at www.ine.pt/Prodserv/nomenclaturas/CAE.hml. Note that 56 industries have direct equivalents in the old and new classifications and are, therefore, defined at the 2-digit level of the NACE-Rev. 2. The remaining 46 categories of NACE-Rev. 2 do not have direct equivalents in the old classification and are aggregated into 18 sectors.

3.2. Workers Transitions: Variable Creation

An industry (skill) switcher is an individual that in the subsequent observation is employed in a different industry (has a different skill). The set of worker transitions contains five alternatives: the worker changes industry retaining the same skill; moves up the skill ladder while remaining in the same industry; moves down the skill ladder while remaining in the same industry; moves up the skill ladder and moves industry; moves down the skill ladder and moves industry. Skill classification follows the ILO's skill definition described in Section 2.1 and industry classification follows the NACE-Rev. 2 at the 2-digit level.

3.3 Descriptive Statistics

Moving industry and/or skill appear to be important forms of labour reallocation. Around 17 per cent of all worker-year observations are of some kind of switching. Figure 3 provides some detail on (average) rates of switching (expressed as a percentage of total number of observations). Switching by changing both industry and skill is least common, on average around 3 per cent of all worker-year observations are of this type. Switching in one dimension alone (either skill or industry) is more common. The rate of industry switching conditional on retaining the same skill is similar to that of changing skill conditional on staying in the same industry, on average around 7 per cent of all worker-year observations are of each of these types. Considering each of these forms of reallocation independently the (unconditional) switching rate raises to around 10 per cent (either for industry or skill).

As Figure 3 makes clear, moving up the skill ladder is more common than moving down, but both movements are important – the share of all workers who are upgraders and downgraders is 9 and 3.8 per cent, respectively. The difference is driven by differences in the fraction that moves skill whilst staying in the same industry. Whereas the unconditional rate of industry switching and its components are similar in both cases, the average rate of skill upgrading, conditional on staying in the same industry, is almost twice as much as that of skill downgrading conditional on staying in the same industry.[7]

---

[7] Detailed tables of transition patterns across industries are available from the authors on request.

Figure 3: Rates of switching, 1991-2000

Legend:
- Diff. skill & same ind.
- Diff. skill & diff. Ind.
- Diff. ind.& same skill
- Diff. ind.& no skill upgrade
- Diff. ind.& no skill downgrade
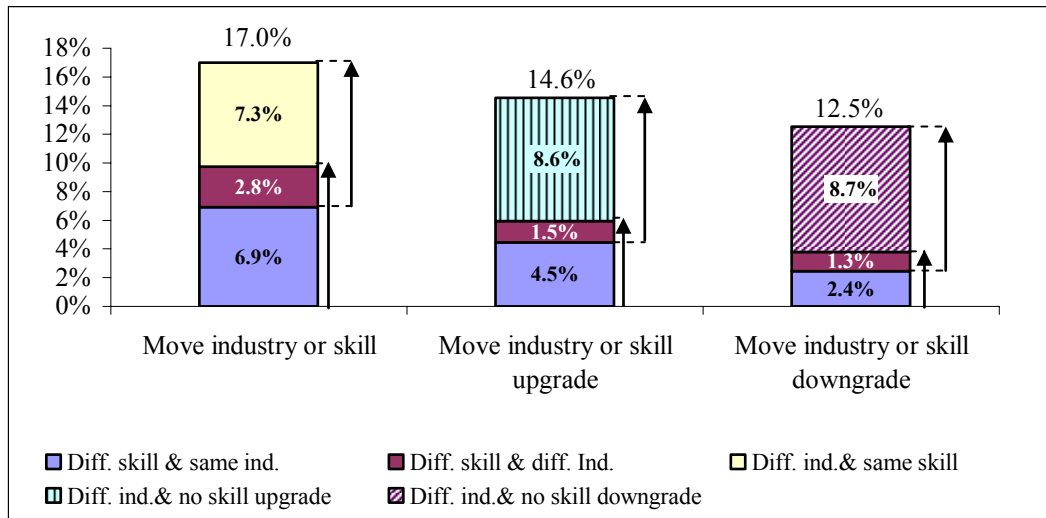
4. Estimation Results

As described in Section 2, we begin by investigating whether international competition has a direct effect on relative wages, then estimate the impact of increased competition on the probability of switching between skills and/or industries.

4.1. Summary Statistics

Table 2 reports summary statistics for the main variables of interest over the 1986-2000[8] period. As can be seen, there is considerable variability of actual wage between industries. Moreover, worker transitions between skills and occupations are an important feature of the Portuguese labour market. In manufacturing the annual average share of workers moving industry is 10 percent and skill-upgrading 6 percent. Also significant is the change in the real exchange rate (the annual average change is 3 percent) and level of openness (the annual average level is 37 percent). Three other characteristics of Portuguese labour markers are worth noting: high female participation, low level of education and high share of population in very skilled occupations.

---

[8] Note that 1986 is the first year for which the QP dataset is available and the appreciation finishes in 1992. Baldwin (1988) and Dixit (1989) argue that the appreciation may permanently reshape the competitive structure of the product market and therefore the analysis should be restricted to the end of the episode. Moreover, there has been a recession in the Portuguese economy in 1993 that might contaminate the differences in differences estimate. The second strategy requires industry bilateral trade data prior to the period under analysis. This is only available from 1990.

Table 2: Summary Statistics, 1986-2000

Variable	Mean	Standard Deviation
Actual Wage (ln)	11.57	0.44
Move ind	0.10	0.30
Move skill	0.10	0.30
Move skill-up	0.06	0.24
Move skill-down	0.01	0.11
Stayer	0.83	0.38
Real exchange rate	1.37	0.66
% change real exchange rate	0.03	0.67
Openness to trade in 88	0.37	0.27
Age	35.69	10.83
Age-square	1391.04	829.70
Tenure	9.97	8.80
Male	0.59	0.49
Schooling	5.52	3.01
Skilled (Schooling>12)	0.02	0.14
1st Skill Level	0.17	0.37
2nd Skill level	0.75	0.43
3rd Skill Level	0.06	0.24
4th Skill Level	0.02	0.15
Herfindal Index	840.27	1425.81
Firm size (ln)	4.88	1.64
Firm Average Labour productivity	8.83	1.18
Firm Age	24.24	21.15
Fraction of Foreign Capital	0.11	0.30
Number observations	5,561,687	

4.2. International competition and the returns to skill

Table 3 presents the estimated results of equations (2.1) and (2.2) using the 1989-1992 appreciation as the exogenous change in international competition. Columns 1-4 present estimates for skill defined as the number of completed years of education, columns 5-8 report estimates for skill using the ILO's skill definition. For each, we start by estimating the difference results (columns 1-2 and 5-6) and proceed by estimating difference in differences results (columns 3-4 and 7-8). The dependent variable in each column is the log real hourly wage. Each regression includes regional and year dummies to control for disparities in the returns to skill across regions and macro-shocks, respectively. To control for unobservable industry characteristics we include a full set of industry-dummies: 74 industry fixed-effects. Additionally, we run each specification with individual fixed effects (where the effect is identified out of the within sector variation in competition) and proceed by estimating the models with spell (work-firm) fixed effects. Whereas in the first case identification comes from the within sector variation in competition, in the second it comes from within spell variation, that is, from variation over the period in which the worker is employed in a

given firm. This procedure is important as we are interested in estimating the effect of within industry changes in international competition on relative wages.

The coefficient on the interaction of skill variables with $indop88*post89$ is always positive and highly significant in all specifications. In addition, one can see that the difference in difference estimates of returns to schooling (columns 3-4) and high skill (columns 7-8) are lower than the difference estimates (columns 1-2 and 5-6, respectively) and that the coefficients associated with the two-way interaction of the skill variables with, inter alia, $indop88$ and $post89$ are statistically significant. This confirms the importance of accounting for the fact that more open sectors may systematically pay a lower skill premium to start with and that during 1989-1992 returns to skill increased throughout the economy. Controlling for these, results on column 3-4 and 7-8 show that, relative to the control group, the appreciation had a positive and significant effect on the skill premium of the treatment group, than in industries that are relatively shielded. In particular, the estimated coefficients in column 8 indicate that for an industry with average trade openness (0.37), the pre- appreciation return to skill was 4 percent and the post-appreciation return, 15.4 percent. The full effect of the appreciation is only captured by the estimated coefficient on the interaction between the skill and the experiment variable (0.024 on column 8), which indicates that for an industry with average exposure to trade in 1988, the effect of the appreciation was to increase the differential (in returns to skill) by 0.88 percent (relative to an industry with no trade prior to 1988).

Table 4 also presents estimated results of equations (2.1) and (2.2) but here we identify exogenous changes as source-weighted industry real exchange rate movements. Columns 1-2 present the estimates for skill defined as the number of completed years of education, columns 3-4 report estimates using the ILO's skill definition. Column 1 and 3 present the individual fixed effects estimates and column 2 and 4 the spell (worker-firm) fixed effects estimates. A full set of industry, year and regional dummies is included in all specifications. The coefficient on the interaction of skill variables with the exchange rate index is positive and highly significant in all specifications, confirming that when the exchange rate index increases the impact of skill acquisition on actual wage is higher. Note that, as pointed out by Bertrand (2004), this methodology, by simultaneously including individual fixed effects and industry dummies, estimates the relationship between changes (not absolute values) in international competition and returns to skill within industries.

Our results are therefore very much in line with Guadalupe (2007). Based on two different identification strategies and skill definitions, we find strong confirmation of the hypothesis that increased international competition is an important determinant of rising wage inequality between skilled and unskilled workers.

Table 3: Effect of international competition on return to skill: 1989-1992 appreciation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variable								
age	0.617	0.619	0.497	0.502	0.656	0.665	0.652	0.654
	(172)***	(83.2)***	(122)***	(65.9)***	(184)***	(90)***	(184)***	(90)***
age-square	-0.217	-0.188	-0.185	-0.159	-0.274	-0.241	-0.282	-0.248
	(50.8)***	(41.8)***	(43.1)***	(35.2)***	(64.4)***	(53.9)***	(66.4)***	(55.6)***
tenure	-0.014	-0.001	-0.014	-0.002	-0.014	-0.001	-0.014	-0.001
	(13.4)***	(0.6)	(13.7)***	(0.9)	(13.5)***	(0.4)	(13.6)***	(0.5)
indop88*post89	-0.184	-0.174	-0.083	-0.085	-0.082	-0.080	-0.073	-0.072
	(92.6)***	(85.1)***	(31.5)***	(31.8)***	(61.7)***	(57.8)***	(55.6)***	(52.4)***
schooling	0.005	0.002	0.004	0.002				
	(9)***	(3.4)***	(5.4)***	(3.2)***				
indop88*post89*schooling	**0.022**	**0.020**	**0.002**	**0.003**				
	(77.1)*	**(71.6)***	**(4.5)***	**(5.6)***				
indop88*schooling			-0.004	-0.007				
			(2.9)***	(4.9)***				
post89*schooling			0.012	0.010				
			(52.8)***	(45.9)***				
mskill					0.030	0.022	0.022	0.017
					(16.2)***	(11.6)***	(6.7)***	(5.2)***
hskill					0.089	0.073	0.050	0.049
					(20.5)***	(17.3)***	(6.6)***	(6.5)***
indop88*post89*mskill					**0.142**	**0.128**	**0.041**	**0.036**
					(42.6)*	**(38.3)***	**(6.6)***	**(5.6)***
indop88*post89*hskill					**0.223**	**0.202**	**0.022**	**0.024**
					(31.3)*	**(29.2)***	**(1.7)***	**(1.9)***
indop88*mskill							-0.029	-0.033
							(4.1)***	(4.7)***
indop88*hskill							0.010	-0.023
							(0.6)	(1.4)
post89*mskill							0.067	0.060
							(23.3)***	(20.6)***
post89*hkill							0.118	0.105
							(19.4)***	(17.5)***
hhi	-0.025	-0.025	-0.023	-0.023	-0.028	-0.028	-0.027	-0.027
	(26.9)***	(27)***	(24.2)***	(24.6)***	(29.7)***	(29.6)***	(28.7)***	(28.6)***
firmsize	0.038	0.066	0.038	0.066	0.038	0.065	0.038	0.065
	(66.8)***	(60.7)***	(67.2)***	(60.9)***	(66.2)***	(59.4)***	(66.4)***	(59.7)***
firmlabprod	0.006	0.006	0.006	0.005	0.006	0.006	0.006	0.005
	(37.1)***	(33.7)***	(36.4)***	(33.1)***	(37.5)***	(33.8)***	(36.9)***	(33.3)***
firmage	-0.005	-0.047	-0.005	-0.033	-0.004	-0.056	-0.004	-0.050
	(10.7)***	(7.7)***	(10.6)***	(5.5)***	(10.4)***	(9.4)***	(10.4)***	(8.4)***
%foreignK	-0.003	-0.022	-0.003	-0.021	-0.004	-0.023	-0.004	-0.023
	(2.2)**	(14.9)***	(1.8)*	(14.3)***	(3.1)***	(16)***	(3)***	(15.7)***
Year+industry dummies	yes	yes	yes	yes	yes	yes	yes	yes
Regional dummies	yes	yes	yes	yes	yes	yes	yes	yes
Ind. fixed effects	yes	-	yes	-	yes	-	yes	-
Ind-firm fixed effects	-	yes	-	yes	-	yes	-	yes
Obs.				2300567				
R-square	0.189	0.147	0.215	0.164	0.185	0.144	0.187	0.147

* significant at 10%; ** significant at 5%; *** significant at 1%. The period of analysis is 1986-1992. Absolute value of t-statistic in parentheses, based on robust standard errors clustered by individual. The variables age, tenure are divided by 10, and age-square and hhi by 1000. Dependent variable: log real hourly wage.

Table 4: Effect of international competition on returns to skill: exchange rate changes

	(1)	(2)	(3)	(4)
Variable				
age	0.411			
	(156.32)***			
age-square	-0.256	-0.241	-0.266	-0.252
	(83.7)***	(74.78)***	(87.67)***	(78.38)***
tenure	0.014	0.004	0.013	0.004
	(17.91)***	(2.26)**	(16.06)***	(2.16)**
exchrate	-0.119	-0.110	-0.089	-0.077
	(59.31)***	(54.38)***	(55.60)***	(46.59)***
schooling	0.001	-0.002		
	(2.22)**	(2.98)***		
exchrate*schooling	**0.006**	**0.007**		
	(24.65)***	**(28.29)*****		
mskill			0.021	0.009
			(8.36)***	(3.71)***
hskill			0.034	0.012
			(7.23)***	(2.59)***
exchrate*mskill			**0.018**	**0.017**
			(10.86)***	**(10.42)*****
exchrate*hskill			**0.039**	**0.038**
			(12.03)***	**(12.02)*****
hhi	0.005	0.008	0.005	0.008
	(1.82)*	(3.24)***	(1.79)*	(3.26)***
firmsize	0.037	0.048	0.037	0.048
	(88.81)***	(66.38)***	(89.15)***	(66.39)***
firmlabprod	0.005	0.004	0.005	0.004
	(31.58)***	(24.60)***	(31.57)***	(24.7)***
firmage	-0.007	0.133	-0.007	0.131
	(23.12)***	(9.44)***	(23.22)***	(9.32)***
%foreignK	0.031	0.009	0.032	0.009
	(30.45)***	(8.58)***	(30.55)***	(8.48)***
Year+industry dummies	yes	yes	yes	yes
Regional dummies	yes	yes	yes	yes
Ind. fixed effects	yes	-	yes	-
Ind-firm fixed effects	-	yes	-	yes
Obs.		3858747		
R-square	0.226	0.005	0.001	0.003

* significant at 10%; ** significant at 5%; *** significant at 1%. The period of analysis is
1991-2000. Absolute value of t-statistic in parentheses, based on robust standard errors
clustered by individual. The variables age, tenure are divided by 10, and age-square and
hhi by 1000. Dependent variable: log real hourly wage.

4.3. International competition, skill acquisition and industry relocation

Using bivariate probit models, Table 5 reports the results for the two equation systems ((4.1) and
(4.2)) presenting each of the different forms of relocation that may be induced by increased
competition. The marginal effects on the probability of each potential outcome (when all variables
are held at their mean) are presented[9]. All regressions include industry fixed effects, year and

---

[9] Regression results can be found in Appendix C.

regional dummies and standard errors are clustered by individuals (to account for the fact that the individual error term may be autocorrelated). Columns 1-5 present estimates for the latent propensities of moving industry ($moveind^*$) and moving skill ($moveskill^*$), columns 6-10 report the estimates for the latent propensities of moving industry ($moveind^*$) and skill-upgrading ($skillup^*$). Columns 1-3 present each of the different forms of reaction to increased competition against the probability of no change in skill or industry, $\Pr(moveind_{iJKt} = 0, moveskill_{iJKt} = 0 | X_{it}, \Delta IC_{Kt}, Z_{Jt}, hhi_{Kt})$, that is:

$$\Pr(moveind_{iJKt} = 1, moveskill_{iJKt} = 1 | X_{it}, \Delta IC_{Kt}, Z_{Jt}, hhi_{Kt}),$$

$$\Pr(moveind_{iJKt} = 1, moveskill_{iJKt} = 0 | X_{it}, \Delta IC_{Kt}, Z_{Jt}, hhi_{Kt}),$$

$$\Pr(moveind_{iJKt} = 0, moveskill_{iJKt} = 1 | X_{it}, \Delta IC_{Kt}, Z_{Jt}, hhi_{Kt}),$$ respectively.

In addition, Columns 4-5 present bivariate probit estimates of the marginal effects of each of the covariates on the following unconditional probabilities:

$$\Pr(moveind_{iJKt} = 1 | X_{it}, \Delta IC_{Kt}, Z_{Jt}, hhi_{Kt}),$$

$$\Pr(moveskill_{iJKt} = 1 | X_{it}, \Delta IC_{Kt}, Z_{Jt}, hhi_{Kt}),$$ respectively.

Similarly, Columns 6-8 present each of the different forms of reaction to increased competition against the probability of no skill-upgrading or switching industry, $\Pr(moveind_{iJKt} = 0, skillup_{iJKt} = 0 | X_{it}, \Delta IC_{Kt}, Z_{Jt}, hhi_{Kt})$, that is:

$$\Pr(moveind_{iJKt} = 1, skillup_{iJKt} = 1 | X_{it}, \Delta IC_{Kt}, Z_{Jt}, hhi_{Kt}),$$

$$\Pr(moveind_{iJKt} = 1, skillup_{iJKt} = 0 | X_{it}, \Delta IC_{Kt}, Z_{Jt}, hhi_{Kt}),$$

$$\Pr(moveind_{iJKt} = 0, skillup_{iJKt} = 1 | X_{it}, \Delta IC_{Kt}, Z_{Jt}, hhi_{Kt}),$$ respectively.

In addition, Columns 6-10 present bivariate probit estimates of the marginal effects of each of the covariates on the following unconditional probabilities:

$$\Pr(moveind_{iJKt} = 1 | X_{it}, \Delta IC_{Kt}, Z_{Jt}, hhi_{Kt}),$$

$$\Pr(skillup_{iJKt} = 1 | X_{it}, \Delta IC_{Kt}, Z_{Jt}, hhi_{Kt}),$$ respectively.

The marginal effect of interest on the variable $indop88 * apprec$ is always positive and highly significant. Results therefore indicate that the propensity to switch (industry and/or skill) in response to the appreciation is higher in sectors more open to trade. In addition, results in column 1-6 show that the effect of increased competition on skill acquisition and industry relocation is similar (columns 5 and 6). However, the effect on the probability of changing in one dimension only is stronger than the effect on the probability of changing both skill and industry (coefficient in

columns 2-3 is higher than in 1). Furthermore, results on the second specification (column 6-10), show that increased international competition in the 1989-1992 appreciation also increases significantly the propensity to skill-upgrade, whether remaining in the same industry or changing industry, though the effect on the latter is weaker. In particular, the estimated coefficients on trade exposure, the post-appreciation dummy and their interaction (columns 9) indicate that for an industry with average trade exposure in 1988 (0.37), appreciation increased the propensity to move industry by 0.23 percent and, this effect was 0.05 percent higher than in an industry with 10 percentage point lower trade exposure in 1988. Similarly, column 10 indicates that for an industry with average trade exposure in 1988 (0.37), appreciation increased the propensity to skill-upgrade by 0.1 percent and, this effect was 0.03 percent stronger than in an industry with 10 percentage point lower trade exposure in 1988.

In addition, all signs of the coefficients of the control variables are as expected. Worker covariates indicate that moving between skills and industries is significantly less frequent in older workers but the effect of an additional year of age is higher in younger than older workers. High tenured workers also switch industry and/or skill less frequently. Skilled workers tend to be more mobile than unskilled workers. Male workers move more frequently than female workers. Moreover, industry covariates show that a high degree of industry concentration is associated with higher switching rates. Finally, firm covariates indicate that elevated firm size, labour productivity and participation of foreign capital predict lower switching rates, whereas firm's age increases this rate.

Table 6 presents bivariate probit estimates using source-weighted industry real exchange rate fluctuations to identify changes in competition[10]. Results are in line with those previously obtained and confirm the association between increased international competition and additional skill acquisition and industry relocation. For a worker who is average on all characteristics, employed in a firm that is average in all characteristics that belongs to an industry that has the average level of the Herfindahl-Hirschman index, a 1 percentage point increase in the exchange rate index is associated with a probability to move industry 0.03 percentage points higher and probability to skill-upgrading by 0.02 percentage points higher. The effect on skill upgrading while remaining in the same industry is more than twice as large as the effect on skill upgrading and moving industry simultaneously.

---

[10] Regression results can be found in Appendix C.

Table 5: Marginal effects of international competition on the probability of skill-upgrading and/or moving industry: 1989-1992 appreciation

	Move industry (ind.) and/or move skill					Move industry (ind.) and/or move skill-up				
	Propensity to move			Propensity to move ind.	Propensity to move skill	Propensity to Move			Propensity to move ind.	Propensity to skill-up
	ind.&skill	ind.only	skill only			ind.&skill-up	ind. only	skill-up only		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Predicted Propensity	2.63%	5.95%	6.71%	8.58%	9.35%	1.15%	7.43%	4.23%	8.58%	5.38%
Variables										
age	-0.036	0.007	-0.111	-0.029	-0.146	-0.024	-0.003	-0.096	-0.027	-0.120
	(83.5)***	(7.36)***	(106.66)***	(23.51)***	(111.49)***	(101.24)***	(2.82)***	(131.61)***	(21.98)***	(136.2)***
age-square	0.032	-0.027	0.124	0.005	0.156	0.023	-0.021	0.107	0.002	0.130
	(57.95)***	(21.97)***	(90.19)***	(2.98)***	(90.07)***	(78.55)***	(14.34)***	(113.19)***	(1.5)	(113.97)***
tenure	-0.014	-0.023	-0.014	-0.036	-0.027	-0.008	-0.028	-0.016	-0.037	-0.024
	(106.36)***	(88.18)***	(42.74)***	(107.3)***	(66.65)***	(112.25)***	(93.45)***	(69.67)***	(107.06)***	(86.25)***
skilled	0.032	0.011	0.065	0.043	0.097	0.019	0.023	0.049	0.042	0.068
	(32.15)***	(8.54)***	(30.26)***	(21.51)***	(35.2)***	(31.56)***	(14.39)***	(31.68)***	(20.99)***	(34.66)***
indop88*post89	**0.002**	**0.003**	**0.003**	**0.005**	**0.005**	**0.001**	**0.004**	**0.002**	**0.005**	**0.003**
	(4.6)*	**(3.16)***	**(2.25)**	**(3.96)***	**(3.23)***	**(4.57)***	**(3.59)***	**(2.33)**	**(4.01)***	**(2.99)***
indop88	0.002	0.004	0.002	0.006	0.004	0.001	0.004	0.002	0.005	0.003
	(1.35)	(1.25)	(0.53)	(1.36)	(0.89)	(1.37)	(1.16)	(0.69)	(1.25)	(0.91)
post89	-0.003	-0.001	-0.007	-0.004	-0.010	-0.003	-0.001	-0.010	-0.004	-0.012
	(10.64)***	(1.36)	(11.31)***	(4.66)***	(12.24)***	(17.21)***	(1.48)	(18.79)***	(4.52)***	(19.38)***
male	0.007	0.009	0.009	0.016	0.015	0.003	0.012	0.007	0.016	0.011
	(39.63)***	(26.08)***	(21.04)***	(33.91)***	(28.49)***	(41)***	(29.93)***	(24.25)***	(34)***	(29.59)***
hhi	0.006	0.006	0.010	0.012	0.016	0.003	0.010	0.005	0.013	0.007
	(11.8)***	(5.52)***	(8.42)***	(8.17)***	(10.4)***	(9.39)***	(7.72)***	(4.63)***	(8.62)***	(5.96)***
firmsize	-0.002	-0.005	-0.002	-0.007	-0.004	-0.001	-0.006	0.000	-0.007	-0.001
	(43.46)***	(39.99)***	(12.61)***	(45.81)***	(23.4)***	(31.14)***	(45.06)***	(0.28)	(45.72)***	(7.24)***
firmlabprod	-0.002	-0.005	0.000	-0.007	-0.001	-0.001	-0.006	0.001	-0.007	0.000
	(31.5)***	(41.26)***	(2.07)**	(42.46)***	(8.22)***	(22.53)***	(43.87)***	(6.93)***	(43.43)***	(0.52)
firmage	0.001	0.002	0.000	0.002	0.000	0.000	0.002	0.000	0.002	0.000
	(13.92)***	(21.12)***	(3.07)***	(21.14)***	(1.8)*	(10.11)***	(22.2)***	(5.73)***	(21.59)***	(2.31)**
%foreignK	-0.006	-0.023	0.009	-0.029	0.003	-0.002	-0.027	0.008	-0.029	0.006
	(20.17)***	(36.4)***	(12.91)***	(34.55)***	(3.63)***	(13.67)***	(36.65)***	(15.95)***	(34.92)***	(9.69)***
Observations			2300567					2300567		
rho			0.475					0.299		
%Correctely predicted			0.999					0.999		
McFadden's pseudo R2			0.052					0.066		

* significant at 10%; ** significant at 5%; *** significant at 1%. The period of analysis is 1986-1992. Absolute value of t-statistic in parentheses, based on robust standard errors clustered by individual. All specifications include a full set of industry dummies (74 industry fixed-effects), year and regional dummies. Marginal effects are computed at the mean of each variable. The variables age, tenure are divided by 10, and age-square and hhi by 1000.

Table 6: Marginal effect of international competition on the probability of skill-upgrading and/or moving industry: exchange rate fluctuations

	Move industry (ind.) and/or move skill						Move industry (ind.) and/or move skill-up					
	Propensity to move			Propensity to stay	Propensity to move ind.	Propensity to move skill	Propensity to Move			Propensity to stay	Propensity to move ind.	Propensity to skill-up
	ind.&skill	ind. only	skill only				ind.&skill-up	ind. only	skill-up only			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Predicted Propensity	2.10%	6.18%	6.47%	85.24%	8.29%	8.58%	0.95%	7.35%	3.9%	87.80%	8.30%	4.85%
Variables												
age	-0.032	-0.010	-0.100	0.142	-0.042	-0.132	-0.020	-0.021	-0.081	0.122	-0.041	-0.101
	(115.61)***	(13.6)***	(127.1)***	(121.14)***	(46.35)***	(135.92)***	(130.33)***	(24.94)***	(157.86)***	(119.04)***	(44.97)***	(165.53)***
age2	0.032	-0.001	0.112	-0.144	0.032	0.144	0.021	0.009	0.091	-0.121	0.030	0.112
	(89.19)***	(0.56)	(106.18)***	(92.39)***	(26.4)***	(110.99)***	(107.02)***	(8.31)***	(133.44)***	(89.32)***	(25.03)***	(137.66)***
tenure	-0.009	-0.016	-0.013	0.039	-0.025	-0.022	-0.005	-0.020	-0.013	0.039	-0.025	-0.019
	(110.1)***	(82.4)***	(55.19)***	(113.34)***	(102.07)***	(74.29)***	(118.02)***	(88.69)***	(80.47)***	(131.76)***	(102.08)***	(94.39)***
skilled	0.018	0.007	0.048	-0.072	0.024	0.065	0.008	0.016	0.023	-0.047	0.024	0.031
	(40.42)***	(8.38)***	(39.71)***	(46.99)***	(22.41)***	(44.2)***	(34.78)***	(16.64)***	(31.52)***	(37.15)***	(21.84)***	(34.56)***
Δexchrate	**0.008**	**0.019**	0.006	**-0.033**	**0.027**	**0.014**	**0.007**	**0.021**	**0.018**	**-0.046**	**0.028**	**0.024**
	(4.8)***	(4.53)***	(1.38)	(4.76)***	(5.01)***	(2.47)**	(7.21)***	(4.41)***	(5.01)***	(7.15)***	(5.21)***	(5.66)***
male	0.003	0.010	0.001	-0.014	0.013	0.005	0.002	0.011	0.002	-0.015	0.013	0.004
	(29.78)***	(33.9)***	(3.98)***	(29.23)***	(36.2)***	(11.15)***	(32.87)***	(34.85)***	(10.68)***	(37.1)***	(36.57)***	(16.13)***
hhi	0.000	0.001	0.000	-0.001	0.001	0.000	0.000	0.001	0.000	-0.001	0.001	0.000
	(19.82)***	(24.46)***	(0.03)	(19.54)***	(25.34)***	(5.58)***	(17.6)***	(24.32)***	(1.71)*	(22.13)***	(24.94)***	(5.12)***
firmsize	0.000	0.000	-0.001	0.001	0.000	-0.002	0.000	0.000	0.000	0.000	0.000	0.000
	(8.28)***	(1.6)	(11.04)***	(8.44)***	(1.23)	(11.12)***	(1.6)	(1.84)*	(0.36)	(1.86)*	(1.92)*	(0.65)
firmlabprod	-0.001	-0.004	0.001	0.004	-0.005	0.000	0.000	-0.005	0.001	0.004	-0.005	0.001
	(19.21)***	(33.86)***	(9.35)***	(18.64)***	(32.74)***	(2.22)**	(14.91)***	(34.88)***	(9.91)***	(23.65)***	(33.98)***	(5.06)***
firmage	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.9)	(2.49)**	(1.14)	(0.85)	(2.28)**	(0.68)	(1.7)*	(2.97)***	(0.36)	(2.34)**	(2.96)***	(0.07)
%foreignK	-0.002	-0.006	0.000	0.008	-0.008	-0.002	-0.001	-0.008	0.002	0.007	-0.008	0.001
	(11.07)***	(13.9)***	(0.09)	(10.88)***	(14.4)***	(2.98)***	(6.27)***	(14.97)***	(5.13)***	(10.02)***	(14.47)***	(2.87)***
Observations	3858747						3858747					
rho	0.409						0.267					
% correctely predicted	0.963						0.999					
McFadden's pseudo R2	0.053						0.065					

* significant at 10%; ** significant at 5%; *** significant at 1%. The period of analysis is 1991-2000. Absolute value of t-statistic in parentheses, based on robust standard errors clustered by individual. All specifications include a full set of industry dummies (74 industry fixed-effects), year and regional dummies. Marginal effects are computed at the mean of each variable. The variables age, tenure are divided by 10, and age-square and hhi by 1000.

5. Conclusions

This paper identifies international competition as a source of increased returns to skill. Using a large panel (1989-2000) of the Portuguese manufacturing sector with matched employer-employee data, two different skill definitions, and two different identification strategies of exogenous changes in international competition, we show that returns to skill within an industry increase with competition. Our analysis exploits one quasi-natural experiment: a strong appreciation of the Portuguese currency in 1989-1992 and heterogeneity between industries in trade exposure in a differences-in-differences estimation. It also makes use of industry-specific (source-weighted) real exchange rates whose fluctuations represent changes in international competition.

By affecting returns to skill, increasing international competition influences workers' incentives to acquire skills. This paper identifies increasing international competition as a significant determinant of skill upgrading. This result is valid both when workers stay in the same industry and when they move. This finding indicates that skill acquisition is an important part of the adjustment process to a policy change or shock (exogenous to the wage setting conditions within the country) that changes relative wages. Policy attention to the consequences of increased competition for human capital accumulation seems merited.

Appendices

APPENDIX A: Variable description

Wage data is the log deflated monthly earnings actually received including the base wage, tenure-related and other regularly paid components. Wages are deflated using the consumer price index.

Worker covariates: Tenure is defined as the number of years with the same firm, schooling as the number of completed years of education and skilled as having a number of completed years of education higher than 12 (that marks the end of high-school in Portugal).

Sector covariates: The Herfindahl-Hirschman index of industrial concentration in industry K is defined as $hhi_K = \sum_{J \in K} (mshare_J)^2$ where $mshare_J$ is the market share of firm J of industry K defined as firm sales over total industry sales. The level of openness for industry K in 1988 (*indop88*) is defined as the ratio of total industry trade (imports plus exports) to domestic demand (industry sales plus net imports).

Source weighted industry real exchange rate index: is defined as the weighted average of the log real exchange rate of each of the importing countries. The weights are the shares of each foreign country's imports in industry total imports in a base period (1990-1991). Real exchange rates are nominal exchange rates (expressed in foreign currency per escudo) multiplied by the Portuguese consumer price index and divided by the foreign country consumer price index. Nominal exchange rates have been provided by the Bank of Portugal and foreign consumer prices index's from the International Financial Statistics of the International Monetary Fund.

Firm covariates: The firm size is defined as the number of employees, firm (nominal average) labour productivity as the ratio of firm sales to number of employees, firm age as current year minus year of creation of the firm, and percentage of foreign capital as share of foreign capital in equity.

APPENDIX B: Consistency checks to the information on the employer-employee dataset

We have performed a number of consistency checks on the information provided by "Quadros de Pessoal" to guarantee the accuracy of the data used.

a) Elimination of invalid or duplicated worker identification codes in a given year: According to the Ministry of Employment valid worker's ID codes have 6 to 10 digits. In each year, observations with codes with less than 6 or more than 10 digits were not considered. Observations with duplicated identification codes were also eliminated. These restrictions led to dropping an average 8.93 percent and 4.51 percent of the observations in the original yearly datasets, respectively.

b) Consistency check of data for each worker across years: We have merged the yearly information and identified inconsistencies when gender, date of birth or year of hiring (for the same firm) were reported changing, or the highest schooling level was reported decreasing (or was missing) over time for the same worker.

(b1) Correcting missing values when reported data for the rest of the period was absolutely consistent by assigning the reported value for the remaining period. This changed 0 percent[11], 2.25 percent, 0.71 percent and 0.23 percent of the observations in the initial panel for gender, age, schooling and tenure firm, respectively.

(b2) Correcting inconsistent data across years by taking information reported over half of the times as correct[12]. Inconsistent values on gender were replaced by the value reported over half of the cases the worker has been observed, provided that the year of birth in that observation is the same as that reported in more than 50 percent of the cases for that worker. Similar procedures have been implemented for year of birth and schooling. This affected 0.87 percent, 1.77 percent, 6.65 percent and 1.68 percent of the initial panel for gender, year of birth and schooling, respectively. The whole information on a worker has been dropped when inconsistencies persisted after this correction. This restriction led to dropping 8.4 percent, 1.08 percent and 6.28 percent of the observations for gender, year of birth or schooling, respectively.

---

[11] Two observations.

[12] Note that this is a more demanding criterion than simply using the modal value as replacement.

Table B.1: Shares of regions and years

Variable	% of Total
Region	
North Coast	31.88
Central Coast	14.24
Lisbon	44.28
Inland	7.18
Algarve	2.42
Year	
1986	5.06
1987	5.5
1988	5.47
1989	5.19
1991	6.42
1992	6.72
1993	6.74
1994	6.86
1995	7.76
1996	8.21
1997	8.8
1998	8.74
1999	9.3
2000	9.23
Observations	15,613,149

APPENDIX C: Regression results on the effect of international competition on skill acquisition and industry relocation

The estimated results of the two equation systems ((4.1) and (4.2)) presented in Section 4.3 are marginal effects. Appendix Table C.1 displays the regression results instead.

Table C.1: Effect of international competition on skill acquisition and industry relocation: regression results

	Stay in the same industry and skill as base				Stay same ind and no skill up as base			
	Propensity to move ind.	Propensity to move skill	Propensity to move ind.	Propensity to move skill	Propensity to move ind.	Propensity to skill-up	Propensity to move ind.	Propensity to skill-up
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables								
age	-0.184	-0.876	-0.275	-0.844	-0.172	-1.094	-0.268	-1.008
	(23.58)***	(111.2)***	(46.36)***	(134.36)***	(22.04)***	(138.04)***	(44.98)***	(164.66)***
age2	0.031	0.934	0.208	0.921	0.016	1.193	0.198	1.114
	(2.98)***	(90.03)***	(26.41)***	(110.12)***	(1.5)	(115.15)***	(25.03)***	(137.06)***
tenure	-0.232	-0.163	-0.165	-0.141	-0.233	-0.222	-0.166	-0.187
	(105.24)***	(65.14)***	(100.59)***	(73.01)***	(104.98)***	(82.35)***	(100.56)***	(91.08)***
skilled	0.238	0.445	0.145	0.338	0.233	0.446	0.142	0.256
	(24.67)***	(43.59)***	(24.47)***	(52.85)***	(24.02)***	(45.47)***	(23.81)***	(41.27)***
indop88*post89	**0.034**	**0.028**			**0.035**	**0.028**		
	(3.96)*	**(3.23)***			**(4.01)***	**(2.99)***		
indop88	0.038	0.022			0.035	0.024		
	(1.36)	(0.89)			(1.25)	(0.91)		
post89	-0.023	-0.061			-0.023	-0.111		
	(4.66)***	(12.25)***			(4.52)***	(19.41)***		
Δexchrate			**0.174**	**0.087**			**0.181**	**0.243**
			(5.01)*	**(2.47)**			**(5.21)***	**(5.66)***
male	0.102	0.094	0.085	0.030	0.103	0.098	0.087	0.041
	(33.37)***	(28.09)***	(35.95)***	(11.12)***	(33.44)***	(29.05)***	(36.31)***	(16.05)***
hhi	0.079	0.098	0.004	0.001	0.084	0.067	0.004	0.001
	(8.17)***	(10.39)***	(25.37)***	(5.58)***	(8.62)***	(5.96)***	(24.97)***	(5.12)***
firmsize	-0.045	-0.025	-0.001	-0.010	-0.045	-0.008	-0.002	-0.001
	(45.97)***	(23.42)***	(1.23)	(11.12)***	(45.87)***	(7.24)***	(1.92)*	(0.65)
firmlabprod	-0.041	-0.009	-0.031	0.002	-0.042	0.001	-0.032	0.006
	(42.39)***	(8.22)***	(32.75)***	(2.22)**	(43.32)***	(0.52)	(33.98)***	(5.06)***
firmage	0.014	0.001	0.001	0.000	0.015	-0.002	0.002	0.000
	(21.14)***	(1.8)*	(2.28)**	(0.68)	(21.59)***	(2.31)**	(2.96)***	(0.07)
%foreignK	-0.183	0.019	-0.055	-0.012	-0.186	0.053	-0.055	0.012
	(34.47)***	(3.63)***	(14.38)***	(2.98)***	(34.84)***	(9.69)***	(14.46)***	(2.87)***
Year+Regional dummies	yes	yes	yes	yes	yes	yes	yes	yes
Industry fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Observations	2300567		3858747		2300567		3858747	
rho	0.475		0.409		0.299		0.267	
McFadden's pseudo R2	0.052		0.053		0.066		0.066	

* significant at 10%; ** significant at 5%; *** significant at 1%. The period of analysis is 1986-1992 in Column 1-2 and 5-6 and 1992-2000 in Column 3-4 and 7-8. Absolute value of t-statistic in parentheses, based on robust standard errors clustered by individuals. The variables age, tenure are divided by 10, and age-square and hhi by 1000.

References

Abowd, J., Kramarz, F. and Roux, S. (2006), "Wages, mobility and firm performance: advantages and insights from using matched worker-firm data", *Economic Journal*, vol. 116, pp. 245-285.

Abowd, J., Kramarz, F. (1999), "The analysis of labor market using matched employer-employee data", in O. Ashenfelter and D. Card, eds., *Handbook of Labor Economics*, Ch. 26, vol. 3B, pp. 2629-710, Amsterdam: North-Holland.

Acemoglu, D. (2002). 'Technical Change, Inequality, and the Labor Market.', *Journal of Economic Literature*, vol. 50, pp. 7–72.

Banerjee, A. and A. Newman (1993). "Occupational Choice and the Process of Development." *Journal of Political Economy*, vol. 101, 274-298

Bardhan, P. (2005). 'Globalization, Inequality, and Poverty: An Overview', University of California at Berkeley, mimeo.

Barham, V., Boadway, R., Marchand, M. and Pestieau, P. (1995). "Education and the Poverty Trap", *European Economic Review* 39, 1257–75.

Bertrand, M. (2004), "From the Invisible Handshake to the Invisible Hand? How employment competition changes the employment relationship", *Journal of Labour Economics*, vol. 22, pp. 723-765.

Black, S. and Lynch, L. (2004), "How workers fare when employers innovate", Industrial Relations, vol. 43, pp. 44-66.

Campa and Goldberg (2001), "Employment versus wage adjustment and the U.S. dollar", *Review of Economics and Statistics*, vol. 83, pp. 477-89.

Card, D. (2001), "The Effect of Unions on Wage Inequality in the U.S. Labor Market", *Industrial and Labour Relations Review,* vol. 54, pp. 296.

Caroli, E. and John V. R. (2001), "Skill Biased Organizational Change? Evidence from a Panel of British and French Establishments," *Quarterly Journal, of Economics,* vol. 116, 1449–1492.

Cuñat, V. and Guadalupe, M. (2005), "How does product market competition shape incentive contracts?", *Journal of the European Economic Association*, vol. 3, pp. 1058-1082.

Davidson, C., Matusz, S. (2000), "Globalization and Labour-Market Adjustment: How Fast and at What Cost?", *Oxford Review of Economic Policy*, vol. 16, 42-56.

Davidson, C., Matusz, S. (2002), "Globalization, Employment, and Income: Analysing the Adjustment Process", In Greenaway, D., Upward, R. and Wakelin, K., (eds.), *Trade. Investment, Migration and Labour Market Adjustment*, IEA Conference, vol. 35, New York: Palgrave MacMillan.

Davidson, C. and Matusz, S. (2004), 'An Overlapping-generation Model of Escape Clause Protection', *Review of International Economics*, vol. 12, pp. 749-768.

Elias, P. McKnight, A. and Kingshott, G. (1999), "Redefining skill: revision of the Standard Occupational Classification", Department for Employment and Education Skills Task Force Research Paper, 19.

Falvey, R., D. Greenaway and J. Silva (2007) "Trade Liberalisation and Human Capital Adjustment", *GEP Working Paper* 2007/34

Feenstra, R. and Hanson G. (2003). 'Global Production and Inequality: A Survey of Trade and Wages.' in J. Harrigan (eds.) *Handbook of International Trade*, Basil: Blackwell.

Garicano, L. and Rossi-Hansberg, E. (2006), "Organization and Inequality in a Knowledge Economy", *The Quarterly Journal of Economics,* Vol. 121, pp.1383-1435.

Goldberg, K. and Pavcnik, N. (2007), "Distributional Effects of Globalization in Developing Countries", *Journal of Economic Literature*, vol. 45 (1), pp. 39-82.

Greenaway, D. and Nelson, D. (2002). 'The Assessment: Globalization and Labour-Market Adjustment.', *Oxford Review of Economic Policy*, vol. 16, pp. 1-11.

Guadalupe, M. (2007), "Product market competition, returns to skill and wage inequality", *Journal of Labour Economics*, vol. 95 (3), pp. 439-476.

Hoffmann, E. (2000), "International Statistical Comparisons of Occupational and Social Structures: Problems, Possibilities and the Role of ISCO-88, Geneva: ILO.

International Labour Office (1990), ISCO-1988: International Standard Classification of Occupations, Geneva: ILO

Krueger, A. and Summers, L. (1988), "Efficiency wages and inter-industry wage structure", *Econometrica*, vol. 56, pp. 259-293.

Long, N., Riezman, R., Soubeyran, A. (2007), "Trade, Wage Gaps, and Specific Human Capital Accumulation", *Review of International Economics,* vol. 15, pp. 75-92.

Machin, S. (1997), "The decline of labour market institutions and the rise in wage inequality", *European Economic Review*, vol. 41, pp. 647-657.

Machin, S. (2003). 'Wage inequality since 1975' in R. Dickens, P. Gregg and J. Wadsworth (eds.), *The Labour Market under New Labour*, Basingstoke and New York: Palgrave Macmillan.

Revenga, A. (1992), "Exporting Jobs? The Impact of Import Competition on employment and Wages in U.S. Manufacturing", *Quarterly Journal of Economics*, vol. 107, pp. 255-84.

Slaughter, M. (2000). What are the results of product-prices studies and what can we learn from their differences? in R. Feenstra (eds.), *The Impact of International Trade on Wages*, NBER Conference Report. University of Chicago Press, Chicago, pp. 129– 170.

Upward, R. and Wright, P. (2007), "Snakes and Ladders? Skill upgrading and Occupational Mobility in the US and UK during the 1990s", GEP Working Paper 2007/38

Wood, A. (1998), Globalization and the Rise in Labour Market Inequalities, *Economic Journal,* vol. 108, pp. 1463-1482.