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Does inertia pay off?
Empirical assessment of an evolutionary-ecological model of human capital decisions at firm level

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ABSTRACT

This paper empirically assesses the validity of a model which combines organisational ecology and evolutionary theory to analyse human capital accumulation decisions at firm level. The main argument of the model is that factors underlying the process of plants' reproduction, especially the process of fission, must be isolated and related to the economic motivations of employers to hire top educated and highly skilled people. Inert behaviour in human capital accumulation decisions stands here as a rational outcome. Logistic estimates, based on the whole population of plants of the Portuguese textiles, provide statistical evidence corroborating the fission hypothesis. This evidence constitutes a critical examination of the mainstream economics concerning the demand side of human capital.

Keywords: Human capital; population ecology theory; evolutionary theory; Inertia; Fission; textiles; Portugal

RESUMO

Este artigo testa empiricamente a validade de um modelo que combina as abordagens evolucionista e ecológica para análise das decisões de investimento em capital humano ao nível da empresa. O argumento principal do modelo é que factores subjacentes ao processo de reprodução das empresas, em particular os processos de fissão, têm que ser isolados e relacionados com a motivação económica dos empregadores na contratação de indivíduos que detêm elevados níveis de capital humano ('altamente habilitados' e 'altamente qualificados'). Comportamentos inertes nas decisões de investimento em capital humano são considerados aqui um resultado economicamente racional. As estimativas logísticas, baseadas na população dos estabelecimentos têxteis, fornecem evidência estatística que corrobora a hipótese de fissão. Tal constitui uma análise crítica à posição da teoria económica ortodoxa relativa às questões de capital humano quanto ao tratamento do lado da procura de capital humano.

Keywords: Capital humano; teoria ecologista da população; teoria evolucionista; Inércia; Fissão; têxteis; Portugal

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INTRODUCTION

The starting point of this research has been a critical examination of the mainstream economics concerning the demand side of human capital.

The existing theoretical and empirical literature relating to the human capital theory approach involves resorting to the belief that employers must be ill-informed or irrational to explain why there remain distinctly low limits on the demands they place on the education and training system. None of the authors following this theoretical approach have focused attention upon the determinants of demands for human skills and how those demands change. As the 'demand' side in rate of returns studies is already incorporated recursively in the formulation of the incentives for accumulation given the existence of labour market equilibrium, by studying supply one is studying demand as well. If there were an insufficiency of demand for higher levels of human capital, the incentives for its accumulation would be lower and the supply would automatically adjust to the demand. In this vein, most theory and research within human capital issues treat firms as rational, flexible, and rapid adapters to changing environmental circumstances. According to this view, Portuguese textile firms, facing increasing availability of top educated and skilled individuals, considered as the most productive, should 'adapt' by becoming relatively more education/skill intensive. The flexibility of price mechanisms and the substitutability between different labour inputs would guarantee that human capital supply and demand match. The apparent paradox observed in the Portuguese textile industry and the concomitant failure of human capital demand to match the corresponding supply seemed to challenge the orthodox theory of human capital. The structural inertia observed in Portuguese textile firms demand for high levels of human capital called, therefore, for alternative theoretical approaches.

An alternative explanation is presented in this study, which combines heterodox economics contributions, namely the organisational ecology and the evolutionary approaches. Within this heterodox framework, and highlighting the economic rationality of the low skills path that Portuguese textiles firms have found themselves in, the present paper introduces a new concept, 'fission'. Here, the hiring process of high levels of human capital is viewed from a probabilistic or fitness perspective. Fitness is related not only to the actual productivity contribution of a highly skilled or highly educated person to the plant, but also to the probability that this same person will leave the plant to create or join a new (rival) unit. The fission argument intends therefore to answer the

following questions: why are employers so reluctant to hire additional numbers of top educated people if these are accepted as being the most productive and are abundant in the labour market? Does inertia pay off?

The paper is structured into five main sections. Section 1 presents theoretical considerations on the relationship between human capital and firm performance. The section begins by defining the human capital concept and then to highlight the limitations of mainstream economics in the context of human capital issues, in particular concerning the neglect of features of inertia associated with the demand side of human capital demand. In order to fill this gap, it further analyses the contribution of heterodox approaches, which constitute the building block of the 'fission' model. The following section (section 2) describes the 'paradox' pervading the Portuguese textile industry and the pertinence of the fission model in this context is put forward in section 3. In section 4 the empirical particulars of the fission model are presented and interpreted. Finally, the main findings of the study are discussed in section 5.

1. THEORETICAL CONSIDERATIONS ON THE RELATIONSHIP BETWEEN HUMAN CAPITAL AND FIRM PERFORMANCE

1.1. CONCEPT OF HUMAN CAPITAL

The development of modern ideas about human capital is largely due to the works of Theodore Schultz (1961 a, b) and Gary Becker (1962) because of their separation (and Becker's wording) of the terms 'general' and 'specific' human capital.[1] This, for the first time, provided a comparative insight into the incentives for the accumulation of capabilities. Other (previous) authors have written about capital and some of these recognised that the productive powers of individuals could be augmented by the accumulation of skills or capabilities (much like improving a physical capital good). These earlier contributions do not, however, offer the richness of analytical capabilities that the modern definition of 'human capital' offers.

Currently, human capital is a widely used concept with complex and varying definitions that are often left rather vague. In certain contexts it might include only schooling (i.e., acquired formal education), whereas in other circumstances it can encompass a wider

[1] Employers could not be expected to invest in an employee's general human capital because of an absence of appropriability. Its accumulation could be seen as the responsibility of the individual or the society as a whole. Specific human capital would serve to stabilise employment and provided its own incentive problems since employees would be reluctant to co-invest in its accumulation unless the employer was willing to compensate them.

set of investments that potentially influence the well-being and productivity of people, firms, and nations (Mincer, 1996). These might include investments in health and nutrition, as well as vocational training acquired outside the formal education system. Moreover, given operationalisation difficulties, human capital and skills often appear in the literature as interchangeable concepts, which might, at best, be misleading. Skill tends to be a more all-embracing concept than human capital and, besides tangible investment in education and off-the-job training (i.e., human capital as commonly defined), includes intangible (tacit) knowledge acquired by people in the course of their activities.

Adopting the human capital framework regarding the measurement of the human capital concept, the present study considered a somewhat broad notion of it, which included (formal) education and skills. In particular, two groups of workers, the 'top educated' and the 'top skilled' (i.e., those with the highest measured levels of human capital), were singled out for analysis as they turned out to be the main 'actors' of the fission hypothesis. 'Top educated' included workers with tertiary (university or polytechnic) education, whereas 'Top skilled' were workers classified (on the basis of the nature or complexity of their job tasks within the firm) as top or medium professionals.

1.2. HUMAN CAPITAL AND FIRM PERFORMANCE

Classical economists drew attention to the importance of education as a form of national investment. For several classical authors (*e.g.*, Smith, Say and Senior), acquired skills and abilities were seen as increasing worker productivity. Smith and his followers, however, accepted that popular education, though socially important, was largely unrelated to success in the workplace (Bowman, 1990). Research in the late 1950s and early '60s, which constituted the foundations of the human capital theory (Schultz, 1961a, b; Becker, 1962), stimulated a new level of interest in the relationship between education and the economy. These approaches were typically driven by supply side economics, and by the neoclassical notion of equilibrium in which supply (of education) will create its own demand. Since the late '80s, education (mainly at higher levels) became increasingly associated with economic performance issues. In particular, with the revival of research into economic growth and the emergence of the so-called 'endogenous growth theories', an important role – "the engine of growth" (Ehrlich, 1990: S4) – has been assigned to human capital. The development of both the Lucas

(1988) approach (inspired by the work of Becker) and the Nelson-Phelps (1966) approach (which assumes complementarity between education and R&D activities) converge in a positive effect being attributed to educational attainment. This positive effect was visible in terms of the productivity of workers, with an important growth enhancing effect.

The shift towards human capital issues and performance was also a consequence of the growing concern that the education system should be more responsive to expectations from the economic system. At present, governments mainly treat education not as a consumer good but as a productive asset. Increasingly, all over the world it is taken for granted that educational achievement and economic success are closely linked (*The Economist*, 1997). The conventional wisdom is that 'more' education and training is assumed to lead automatically to improved economic performance. Moreover, there is a widely held belief that new ways of organising production are also putting a premium on education (Rodrigues and Lopes, 1997).

The perceived status of more schooling in conjunction with political pressures on the education system to expand in order to accommodate all aspirants have tended to expand the number of educated persons beyond the availability of appropriate jobs in the economic system. This outcome may be influenced by the fact that, even though the earnings and employment opportunities for highly educated persons, such as university graduates, may decline over time, the earnings and employment opportunities for less educated persons may deteriorate even more (Levin, 1987). Irrespective of the underlying causality, however, the production of numerous graduates and post-secondary trained individuals who are not able to obtain appropriate employment presents an immense problem for the formal education sector of many countries (Whiston *et al.*, 1980).[2]

It is reasonable to expect that in recessions the first reaction of employers is to stop recruiting new entrants (Bosanquet, 1987). However, what is puzzling is the widening of educational wage differentials, which accompanies the increasing number of educated workers in the labour force.

[2] Two decades ago, Dore (1980) was already focusing on the problem of "educated unemployment" and the associated "diploma disease". The problem of a surplus of job seekers over jobs available was also tackled by Thurow (1975) who developed the concept of the 'labour queue'.

The current solutions offered to this puzzle are based on the argument of the existence of a corresponding (an even stronger) demand for educated labour derived from capital-skill complementarities (Griliches, 1969, 1970) and the technology-skill interaction (Katz and Murphy, 1992; Card and Limieux, 1996), which is based on the argument that education becomes more valuable in periods of rapid technological change (Nelson, 1964; Nelson and Phelps, 1966; Welch, 1970). However, empirical evidence corroborating these explanations is not convincing.

An alternative explanation put forward in this paper and empirically tested in the context of the Portuguese textile industry argues that the risk of fission (the event that a given plant loses part or all its top educated and/or top skilled workers), which is likely to undermine an establishment's survival capacity, leads employers to pay increasing amounts to top educated or skilled workers (in spite of the increasing availability of these type of workers in the labour market) and justifies the relative inertia on the demand side for human capital. This argument takes the view that the composition of human capital accumulation is shaped by demand, which is more socially constructed than admitted in the economics literature.[3]

Next section provides a review of heterodox approaches – the ecological and evolutionary. By admitting inertia in firm behaviour as a pro-survival characteristic, ecological and evolutionary approaches provide an important contribution to the attempt to explain the human capital supply-demand 'paradox' (section 2) which constitutes the starting point of the fission hypothesis.

[3] In fact, the majority of studies within human capital theory did not focused attention upon the determinants of demands for human skills and how those demands change (see Teixeira, 1999; 2002b, for detailed surveys). The main concern in the studies about human capital was, and continues to be, to explain 'the residual' (see, for instance, the works of Solow, Lundberg, Griliches, Denison and Schultz). At a more micro level, some authors (*e.g.*, Walsh, Friedman, Kuznets, and Becker) attempted to assess to what extent individuals behave in an economically rational optimising manner with respect to human capital investment and also to assess the impact of human capital on individual productivity, essentially based on Mincerian earning regressions. Rate-of-return studies and more aggregative approaches assume that demands for the better educated will rise with an increase in their relative numbers in such a way as to maintain the same real incomes (Bowman, 1966). More accurately, one of the reasons that there is no specific focus on the 'demand' side in rate of returns studies is that it is already incorporated in recursively in the formulation of the incentives for accumulation given the existence of labour market equilibrium. If there were an insufficiency of demand for higher levels of human capital, the incentives for its accumulation would be lower and the supply would automatically adjust to the demand. By studying supply, therefore, one is studying demand as well.

1.3. CONTRIBUTIONS OF THE POPULATION ECOLOGY AND EVOLUTIONARY APPROACHES TO THE STUDY OF INERTIA IN HUMAN CAPITAL DECISIONS

1.3.1. POPULATION ECOLOGY APPROACH

Most theory and research within human capital issues treat firms as rational, flexible, and rapid adapters to changing environmental circumstances. According to this view, firms facing increasing availability of top educated and skilled individuals (considered as the most productive) should 'adapt' becoming relatively more education/skill intensive. The flexibility of price mechanisms and the substitutability between different labour inputs would guarantee that human capital supply and demand match. In this vein, government or other institutions have no role as active agents of change.

The ecology of organisations or population ecology theory (Hannan and Freeman, 1989), in contrast with mainstream economic theory, treats firms (or more accurately, organisations) as complex systems that have enormous limitations in terms of flexibility and speed of response, that is, systems characterised by substantial inertia. Hannan and Freeman's (1984) reformulation of the structural inertia thesis contends that selection processes favour firms with fairly static structures since these are seen as being both more reliable and more accountable than their less inert counterparts. It is important to stress that structural inertia does not mean that structures subject to strong inertial forces never change. It means, instead, that organisations respond relatively slowly to the occurrence of threats and opportunities in their environments. In particular, structures of organisations have high inertia when the speed of reorganisation is much lower than the rate at which environmental conditions change (Hannan and Freeman, 1984).

This approach began and ultimately relies upon Stinchcombe's (1965) "imprinted" argument, which suggests that each 'vintage' of organisations is "imprinted" with the social, cultural, and technical features that are common in the environment at the time of the respective foundation. These imprinted characteristics, being highly resistant to change, are more likely to be reflected to a large extent in the current characteristics of populations of organisations than recent adaptations. Moreover, the organisational ecology approach, relying on a dynamic version of Hawley's (1968) principle of isomorphism, underlines the interdependence between organisations, implying that the

success of any tactic for dealing with an environmental constraint is likely to depend on the strategies adopted by the other organisations in the system.[4]

Core features tend to be more inert than peripheral ones due to the dense webs of connection which retard change (Hannan and Freeman, 1977, 1984). Employment structures lie at the core of an organisation (Baron *et al.*, 1996). Indeed, to Oi (1962) labour is a quasi-fixed factor, and the degree of fixity of labour tends to increase with the corresponding level of human capital. It seems unrealistic to suppose that firms exist in a stable equilibrium or that they continually adjust employment practices in response to changes in their external environment and internal constraints, as transaction cost economics (Williamson, 1975, 1992) implicitly assumes. Therefore, decisions relative to the accumulation of human capital, namely hiring of top educated and top skilled individuals, are likely to be characterised by substantial inertia.

Ecological-population arguments, however, turn to be quite static and disconnected with economic rationality. Selection works rather mechanically through a replicator mechanism, which is silent concerning the economic motivations underlying firm behaviours. Adaptation occurs mainly at the population level, with forms of firms replacing one another (selection) as conditions change. This selection process is characterised by some inertia at the beginning as "… new organizational forms … must overcome legitimation obstacles and gain social acceptance …" (Hannan and Carroll, 1992: 14) but gradually the competitive edge of established organisations erodes as social conditions change. To these authors, the shape of the typical time path of organisational density – initial slow growth, subsequent explosive growth, and stabilisation – tends to be quite regular among both "profit oriented" (*e.g.*, American brewing firms) and "non-profit oriented" (*e.g.*, American national labour unions) organisations. This perspective, thus, lefts unexplained what prevents the genesis of variety in firms routines when environment conditions change.

The case of Portuguese textile firms in the context of human capital decisions is paradigmatic. The increasing availability of top educated individuals in the labour market (environment change) should, in the line of ecological reasoning, lead to the exit of less 'environment fitted' organisational forms and the emergence of new forms of

[4] The principle of isomorphism holds that, in equilibrium, "units subjected to the same environmental conditions … acquire a similar form of organization" (Hawley, 1968: 334, *cited in* Hannan and Freeman, 1989: xiii).

organisations, specifically, firms characterised by relative high intensity in human capital. Notwithstanding, the resilience and even flourishing within the Portuguese textile industry of firms characterised by low intensity in human capital has been striking (section 2). This fact stands against the claimed regularity of industry life cycle supported by ecological approaches. In fact, the inertia elements within Portuguese textile industry seem to be much more enduring than ecological approaches suggest.

By admitting inertia in firm behaviour as a pro-survival characteristic, ecological approaches provide an important contribution to the attempt to explain the human capital supply-demand 'paradox' observed in the Portuguese textile industry. They, however, are mute regarding the reasons why firms make choices that lead to inert response behaviour, and therefore provide no clues why the genesis of variety in Portuguese textile firms routines is highly constrained. As Jovanovic (2001: 105) says, population ecologists [Hannan and Carroll (1992)] "never got as far as to show that the aggregate laws that they *did* posit were actually consistent with individual rationality."

This study tries to fill this gap of the population ecology theory in the sense that it seeks to explain, in an economically rational manner, *plant* behaviour in terms of human capital accumulation decisions. Specifically, it argues that the inertia observed on the human capital demand side is likely to derive from an economically rational attitude of entrepreneurs given a particular institutional context. Section 3 presents the fission risk argument, which is identified as being one potential microeconomic foundation for the inertia observed at industry level.

1.3.2. EVOLUTIONARY ECONOMICS

Contrasting with population ecology theory, the theoretical quest of evolutionary theories is for an understanding of the dynamic process behind the observed change – understanding the current state of a variable or a system in terms of *how it got there* (Nelson, 1995).[5]

The emphasis of evolutionary approaches on the co-evolution of organisational competencies, behaviours and environmental dynamics permits one to complement the somewhat economically disconnected industrial evolution perspective of ecological approaches and, most importantly, enables one to highlight the potential risk of

[5] Hodgson (1994) identifies evolutionary theory as a subset of a wide class of theories, variously described as 'capabilities', 'resource-based', or 'competence-based' theories of the firm.

neglecting a pro-active behaviour towards environment and thus the importance of public authorities and concomitant policy measures in such context.

Despite their emphasis on adaptation, evolutionary economists (Nelson and Winter, 1982; Langlois and Robertson, 1995; Teece and Pisano, 1998) certainly recognise the inertial properties of organisations. They account for inert behaviour in the notion of path dependence and routines, both limiting firm learning capabilities: "… highly flexible adaptation to change is not likely to characterise the behavior of individual firms" (Nelson and Winter, 1982: 135).

Evolutionary theories have a developmental flavour. In virtually all evolutionary models, the particular firms that survive in the long run are influenced by events, to a considerable extent random events, occurring early in a model's run. Within the evolutionary model, more productive and profitable techniques tend to replace less productive ones, through two mechanisms. First, firms using more profitable technologies grow; secondly, more profitable technologies tend to be imitated and adopted by firms who are using less profitable ones. The more a particular technology is employed, the greater is its attractiveness relative to its competitors (dynamic increasing returns). These dynamic increasing returns derive from cumulative technologies (Nelson and Winter, 1982). With a cumulative technology, today's technical advances build on and improve upon the technology that was available at the start of the period (Arthur, 1988, 1989; David, 1985, 1992).

This aspect of cumulativeness is taken account of in this thesis when the argument of fission is put forward. Plants in the Portuguese textile industry emerge and reproduce existing plant employment structures in terms of human capital ('limited core of top educated and top skilled individuals and a large "reserve army" of unskilled poorly educated workers'), which in turn is the widely accepted structure at the industry level (see section 3). Nevertheless, according to the cumulative technology theory, the reason that a particular technology becomes the dominant one might just simply be a matter of luck; the argument developed in this thesis, in contrast, argues that the underlying reason may be a very concrete, economic one – the achievement of better performances in terms of fitness.

For selection to operate consistently in favour of some characteristics rather than others, behaviour cannot be purely accidental. There must be some structural characteristics or

routines of the firm, which fix, determine, mould or constraint the phenotype in some way (Hodgson, 1994). Thus, the 'active' selection factor put forward in this paper, drawing upon but going beyond the evolutionary contributions, involves selection based upon the relative effectiveness of firms in operating within the common or collective employment practice. Moreover, this gives economic soundness to the 'latent' selection factor, which reflects the common adoption of a relatively 'inert' employment practice in the line with Hannan and Freeman's argument.

Before detailing the fission argument and model, next section describes the human capital paradox that pervades the Portuguese economy and in particular the textile industry.

2. THE HUMAN CAPITAL PARADOX IN THE PORTUGUESE ECONOMY. EMPIRICAL EVIDENCE

2.1. DEMAND *VERSUS* SUPPLY SIDE OF HUMAN CAPITAL

2.1.1. NATIONAL LEVEL

Despite the manifest educational backwardness of Portugal relative to its main European counterparts, it is undeniable that, after the 1974 Revolution, and more particularly in the last twenty years, human capital (more precisely, its education and training components) has been elevated to the status of a political and social priority (Teixeira, 1999).

Data obtained from the Portuguese general census of population indicate that, between 1981 and 1991, the total number of resident individuals with tertiary education (licentiate and baccalaureate) grew at an annual average rate of 12%, whereas in the total labour force, the corresponding rate was only 5.7%. By contrast, for individuals with the secondary and third cycle of basic education, the annual average growth rate of the labour force was higher than that for the resident population (4.5% against 3.9%). Relative to individuals possessing the first and second cycle of basic education, there was a gradual decline (-0.2% per year) in the labour force, and stagnation in terms of the resident population.[6]

The comparison between the human capital supply and demand dynamics at the beginning of the 1990s (Table 1) seems to confirm an excess of supply over demand in

[6] The meaning of each education cycle is presented in Table 1.

terms of the tertiary human capital component, especially licentiates. It should be noted that for those with licentiates in the reference period, unemployment growth was more pronounced. Moreover, data referring to tertiary human capital 'investment' (reflected in the evolution of enrolment and completions) indicate, in terms of demand dynamics, an over-investment in this type of capital.

At the other extreme, there seems to be evidence (based on the evolution of the unemployed population) of some shortages of the labour force at the 1st and 2nd cycle of basic education. However, the possibility of a lower rate of unemployment growth in this group being related to 'voluntary' exit from the labour market cannot be excluded.

Table 1: Supply *versus* demand of human capital for the whole Portuguese economy

	Annual average growth rates, in percentages					
	Human capital supply dynamics (1990/91-1992/93)			Human capital demand dynamics (1992-1993)		
	Enrolments	Graduations	Total Population [1]	Active Population	Employed Population	Unemployed Population
Tertiary [2] *(Licenciates)*	15.1	39.9	0.7 *(3.0)*	0.9 *(3.8)*	0.1 *(2.9)*	56.8 *(68.8)*
3rd cycle basic + secondary[3]	0.4	12.6	5.2	4.1	1.1	63.0
1st + 2nd cycle basic[4]	-2.8	-4.0	-6.2	-1.6	-3.0	28.3
Total	0.3	4.6	-3.6	-0.5	-2.0	32.9

Note: [1] Rate of growth between 1992 and 1993 of the resident population aged six or more; [2] Includes medium, baccalaureate and licentiate; [3] Nine to twelve years of schooling; [4] Four to six years of schooling.
Sources: Author's data, based on Barreto (1996) who computed enrolment and completion rates; remaining figures were computed based on INE data.

In spite of the more dynamic growth of the best educated groups (namely, those with secondary and tertiary education), in 1993 the less well educated individuals (those with four to six years of schooling only) constituted the highest share of the active and employed labour force, making up approximately 70% of total employment. Taking into consideration all individuals with a schooling level of six years or less, the percentage of the active and employed population reaches almost 80% (85% in the case of population aged six years and over). In this scenario there is no doubt that in terms of the active and employed population structure, Portugal is on a trajectory favouring very low levels of education.

Restricting the employed population to wage earners, that is, individuals working for a third party, registered in "Quadros de Pessoal" (DE_MQE), it is possible to make a more

detailed analysis of the human capital demand side.[7] Between 1988 and 1993, the average growth of wage earners with nine years of schooling (third cycle) was superior to that of the remaining categories, leading to an increase in the former's relative weight in total wage earners (representing, in 1993, 11% of the total). The demand side dynamics for this type of human capital were conclusively higher than the corresponding supply, which is evidence of a relatively high pressure of demand in the market for this type of labour.

Table 2: Human capital supply *versus* demand, Portuguese wage earners only

	Human capital supply 1985/86-1992/93				Human capital demand 1988-1993/94			
	Enrolments		Graduations		TPCO, 1988-1993		TPCO, 1993-1994	
	a.a.g.r. %	%total 1993	a.a.g.r. %	%total 1993	a.a.g.r. %	%total 1993	a.a.g.r. %	%total 1994
Tertiary	**13.8**	12.8	**17.4**	4.8	**7.7**	4.7	**-0.6**	4.8
Secondary	**7.9**	15.0	**15.6**	29.8	**6.0**	12.6	**-8.1**	11.8
Basic, 3rd cycle	**3.6**	22.3	**7.4**	18.8	**8.2**	10.6	**27.5**	13.7
Basic, 2nd cycle	**-1.9**	18.3	**-0.7**	23.8	**6.6**	20.8	**1.0**	21.3
Basic, 1st cycle	**-4.5**	31.6	**-2.7**	22.7	**-1.3**	45.7	**-7.8**	42.8
< 1st cycle					**-7.0**	4.4	**-20.4**	3.6
Total		100.0		100.0	**2.0**	100.0	**-1.6**	100.0

Note: a.a.g.r. – annual average growth rate.
Source: Barreto (1996) and "Quadros de Pessoal" (DE_MQE)

Using the same criterion (i.e., difference between supply and demand of human capital), demand pressure for individuals with the lowest education levels (first and second cycle of basic education) was, in the reference period, substantial. In the following period (1993-1994) the demand pressure was even more pronounced, especially relative to individuals with nine years of schooling and, at the lower extreme, those with six years; consequently, these groups increased their share in the total wage earners (from 31% in 1993 to 35% in 1994). The combined effect of the growing share of the 2nd and 3rd cycle educated workers in the labour force dominated the growth in the secondary and tertiary educated labour. This evidence clear indicates difficulties in absorbing better-educated workers by the Portuguese economy as a whole.

[7] According to INE statistics, wage earners ('TPCO' – '*trabalhadores por conta de outrem*') represented, in 1993, 73.3% of total employed population, which in turn represented approximately 94% of total active population. However, "Quadros de Pessoal" inquiry encompasses only firms with wage earners, excluding therefore 18% of TPCO that in INE statistics are classified as self-employees without workers at service. It excludes also Public administration, entities that employ rural non-permanent workers and housekeepers. In this vein, the number of individuals working for a third party registered in "Quadros de Pessoal" represents around 64% of the corresponding INE's total.

A study by Batista (1993), which focused on the importance of education in the Portuguese labour market, corroborates the evidence gathered above. Batista states that the highest demand on the side of employers is for individuals with basic education, despite the fact that in the period in question (fourth quarter of 1991) the 1st cycle registered a significant fall in corresponding net employment. Moreover, the highest recruitment difficulties were experienced, in decreasing order of importance, in the second, first and third cycles of basic and in technical-professional education.[8] The lowest recruitment difficulties were for tertiary education (especially the baccalaureate). However, within tertiary education, a significant percentage of places were filled at the level of engineering licentiates. This reveals, once more, important mismatches between human capital supply and demand.

In terms of skills, between 1985 and 1994 there was a significant increase in the relative importance of medium level professionals in total employment (from 1.7% to 2.5%). Growth of top level professionals was also important, but less so than medium level professionals. The corresponding annual growth rates, for the reference period (1988-1994), reached respectively 5.9% and 8.8%. The combination of these two dynamics resulted in a reinforcement at the top, reflected by the evolution of the restricted version of the framework rate. This seems to be evidence of an increasing importance attributed by firms to organisational-related functions. It is important to stress, however, that the skills structure evolution is highly differentiated depending on the size of the firms. Indeed, large firms (with 500 or more workers) demonstrate employment shares associated with top and medium level professionals four times higher than that of very small firms (less than 10 workers). Also, the evolution of the restricted version of the framework rate is positively related to the sizes of firms, being very strong in firms belonging to the highest size group.[9] In contrast, the skills index shows substantial stability in the period in question and little variability among the different size groups, being conclusively higher for the smaller firms.[10]

[8] Recruitment difficulties are measured in terms of the existence of job vacancies.

[9] In 1994 the restricted version of the framework rate for firms with 500 or more workers was 9.8% against 6% in 1985. In very small firms, the corresponding figures were, respectively, 2.6% and 1.6%.

[10] The skills index measures the relative importance of more skilled and complex tasks compared with simpler, more repetitive and lower autonomy tasks at the level of operative function. Between 1985 and 1994 this index remained almost unchangeable for the different size groups, representing, in 1994, 1.5% for large firms and 2.0% for very small firms.

Table 3: Structure and dynamics of skills (wage earners or 'TPCO')

	% Total wage earners ('TPCO')		**a.a.g.r. %**
	1985	1994	**1988-1994**
Top skilled professionals	2.1	2.4	**5.9**
Medium professionals	1.7	2.5	**8.8**
Foremen, team chiefs and similar	4.1	3.9	**2.1**
Highly skilled workers	3.7	4.5	**4.1**
Skilled workers	39.5	41.0	**2.5**
Semi-skilled workers	19.7	16.7	**-0.6**
Non-skilled workers	10.9	11.9	**1.9**
Apprentices	9.9	8.9	**-2.2**
Unknown	8.5	8.3	**0.2**
Total	*100.0*	*100.0*	***1.4***
Framework rate (*stricto sensu*)[1]	3.8	4.9	**5.3**
Framework rate (*lato sensu*)[2]	7.8	8.8	**3.2**
Skill level [3]	1.4	1.6	**2.3**

Note: [1] (Top+Medium)/Total employment; [2] (Top+Medium+Foremen)/Total employment;
[3] Highly+Skilled workers)/(Semi+non-skilled).
Source: MQE-DE, "Quadros de Pessoal"

The apprentices group emerges as the most penalised in terms of evolution, having suffered a decrease of 2.2% *per* year, on average, between 1988 and 1994. However, this does not seem to have contributed to any improvement in the skills structure tail as, in the same period, the number of individuals classified as non-skilled increased by a similar amount (1.9%).

2.1.2. INDUSTRY LEVEL. THE PARTICULAR CASE OF TEXTILES

Similarly to the macro level analysis undertook in the last section, the evolution of employees' education levels by industry leads to the conclusion that the growth of human capital demand did not match that of supply.

At national level, human capital demand growth, as reflected in the evolution of the education levels of people employed in establishments, was positive, with a more pronounced increase at higher schooling levels. However, in the manufacturing sector, the capacity to absorb the increasing availability of better-educated human resources in the period in question has been limited.

Using the aggregation criterion of manufacturing industries put forward in Teixeira (2002a),[11] one can conclude additionally that in the 'low skill activities', in particular

[11] Portuguese manufacturing activities were aggregated by skills categories into three groups: 1) 'Low skills and low capital-labour ratio' (LS/LK); 2) 'Low skills and high capital-labour ratio' (LS/HK); and 3) 'High skills' (HS). The first group encompasses textiles, clothing, leather, footwear, wood, furniture, metals and other manufacturing industries, whereas food, beverages, ceramics, glass, cement, and ornamental rocks were included in the second.

those related to industries with weak capital intensity ('low skills, low capital-labour ratio industries'), which are mainly located in the Northern region of Portugal and where textiles is together with clothing the major industry,[12] the quantitative increase in terms of employment does not seem to have been accompanied by a corresponding increase in quality (*cf.* Table 4). [13]

Table 4: Structure and growth of skills and education in 'low skill, low capital intensity' industries

	Number of employees working in establishments								
	Annual average growth rate (%) 1984-1992			Relative importance in total employment (%), 1992					
	LS/LK	**TEXTILES**	MANUF. IND.	LS/LK		**TEXTILES**		MANUF. IND.	
				1984	1992	**1984**	**1992**	1984	1992
Skills									
Top skilled	3.2	**1.3**	1.8	1.2	1.2	**1.5**	**1.7**	2.2	2.4
Foremen	2.7	**0.8**	1.3	3.0	3.0	**3.3**	**3.7**	3.9	4.0
Highly skilled and skilled workers	2.7	**-0.6**	1.0	40.8	41.4	**34.2**	**35.3**	40.8	40.7
Semi-skilled and non-skilled	0.9	**-2.1**	0.2	34.1	30.2	**48.8**	**44.4**	32.3	30.3
Apprentices	3.7	**-0.4**	3.4	15.1	16.7	**9.1**	**9.6**	11.3	13.5
Education									
Top educated	4.8	**5.0**	3.6	0.9	1.0	**0.8**	**1.3**	1.9	2.4
Secondary+3rd cycle	6.6	**4.2**	4.7	6.8	9.3	**5.6**	**8.4**	10.6	14.1
2nd cycle and lower	1.8	**-1.5**	0.3	90.0	85.3	**91.4**	**87.1**	84.7	79.5

Note: LS/LK – 'low skills, low capital-labour ratio industries': textiles, clothing, leather, footwear, wood, furniture, metals and other manufacturing industries.
Source: Computation made by the author, based on unpublished data from "Quadros de Pessoal" inquiry.

Between 1984 and 1992, the weight of top skilled professionals (including medium level) in low skill (and low capital intensity) industries did not change, remaining at a very low share compared to the manufacturing average. In addition, the importance of top educated individuals barely changed, contrasting again with manufacturing industry as a whole.

Note that in textiles there seems to have been an effort to improve labour skills and education structures. In fact, the decline in total employment was accompanied in this industry by an increase (in both absolute and relative terms) in the highest categories of

[12] Approximately three-quarters of employees working in establishments located in the North region are concentrated in low skill industries, representing almost 70% of total national employment in this type of industry (Source: DE_MQE, "Quadros de Pessoal").

[13] Data in Gepie (1995) shows that between 1984 and 1993 activities characterised by low skills increased their relative importance in Portuguese manufacturing industry, especially in terms of gross value added and employment. In 1993, low skill activities represented almost two-thirds of manufacturing value-added as against 45% in 1984. In terms of employment, 68% of the total manufacturing workforce was employed in low skilled activities in 1984, increasing to three quarters in 1993. In terms of exports, imports and gross capital formation, the weight of low skill industries also increased in the reference period: from 60% to 64% in terms of exports; 24% to 33% in imports; and 54% to 65% in investment [computation by the author based on data in Gepie (1995)].

skills (namely, top skilled) and education (top educated and secondary educated). In general, however, the evolution of human capital demand in low skill industries seems to have put pressure on the availability of low or non-skilled and poorly educated human resources. As the already mentioned study by Batista (1996) elucidates, the highest percentage of job vacancies in the textiles and clothing industries (which constitute the bulk of low skill, low capital intensity industries) are in the lowest education levels (second and first cycles of basic education). The highest percentage of entries and exits also occurred in these education groups, which seems to indicate that in these industries firms continue to replace poorly educated labour by labour with identical education levels, despite the increasing availability in the labour market of better educated individuals. Moreover, recruitment difficulties concerning human resources with tertiary education are, in these industries, almost non-existent (those that do exist relate to engineering licentiates only).

Thus, the increasing availability of better educated and higher skilled individuals in the labour market is not a sufficient condition for improvement in employment distribution. In fact, the demand side of human capital presents in the Portuguese manufacturing industry and in particular in textiles, a high degree of inertia relative to the supply side.

2.2. THE EVOLUTION OF EARNINGS AND THE HUMAN CAPITAL PARADOX

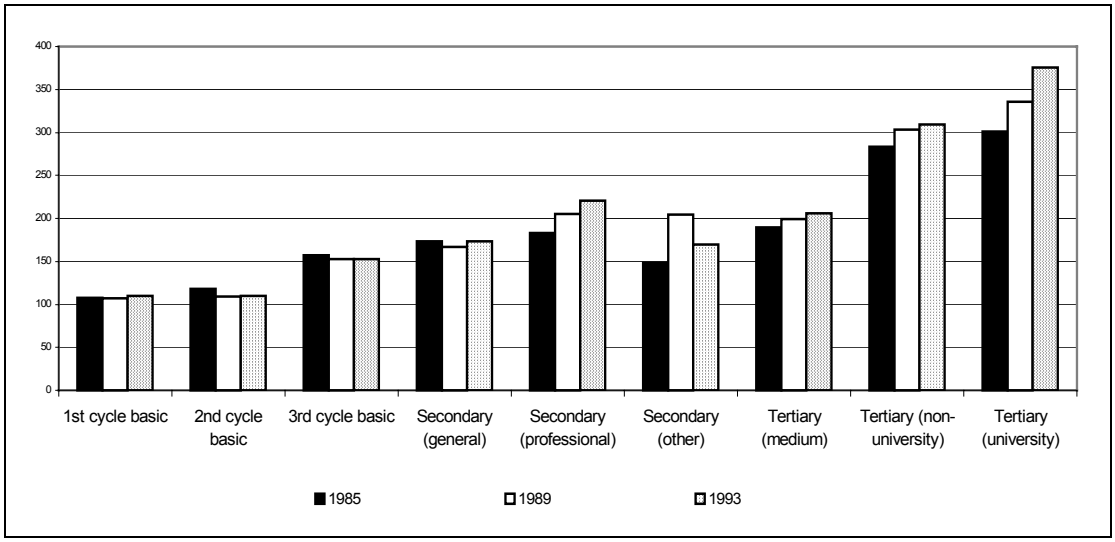
The analysis of human capital demand and supply undertaken in last section seems to reveal a quite paradoxical situation. On the one side, top skilled and top educated people are not in short supply in the labour market and seem to be accepted to be the most productive. On the other side, employers, and in particular, new firms, reveal a poor hiring record at this level.

In fact, as documented before, in the last twenty years or so, there was an 'explosion' in the Portuguese education and training system, with the number of post-secondary (university and polytechnic) graduates showing an enormous increase. Between 1980/1981 and 1992/1993 the number of enrolments in tertiary education almost trebled (from approximately 87,000 to 248,000 students) and completion rates rose from a mere 11,000 in 1981/1982 to 27,000 in 1992/1993 (a global growth of 150%). Also, in more recent years, unemployment rates for post-secondary graduates rose quite sharply. The number of unemployed post-secondary graduates grew 57% (69% for licentiates) between 1992 and 1993 against a global unemployment growth rate of 33%. Moreover,

corresponding employment stagnated. This seems to ignore the issue of shortage (at least quantitative) of top educated people.

Notwithstanding this fact, which presumably would lead to a decrease in respective earnings, the earnings distribution registered significant improvements in the premium accruing to workers with higher education and skill levels, namely those classified as top skilled and top educated relative to those with correspondingly lower levels. Indeed, as Figure 1 shows, those workers with a university degree and those with secondary education in the technical or professional route recorded the strongest increase in relative earnings.

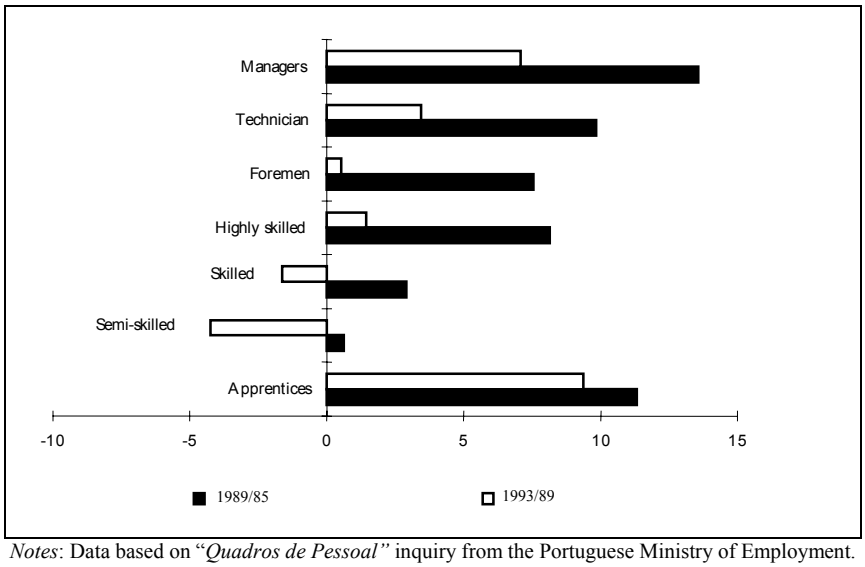
Figure 1: Average monthly earnings relative to earnings of workers with less than the first cycle of basic education (less than first cycle = 100)



Notes: Data based on *"Quadros de Pessoal"* inquiry from the Portuguese Ministry of Employment.
Source: OECD (1995), *OECD Economic Surveys: Portugal*, p. 70.

In terms of skills (Figure 2), managers, technicians, highly skilled workers and foremen experienced similar improvements, contrasting with the deterioration of unskilled and semi-skilled relative earnings.

Figure 2: Average monthly earnings, relative to earnings of non-skilled workers, 1985-1989 and 1989-1993 (global growth rates)



Notes: Data based on "*Quadros de Pessoal"* inquiry from the Portuguese Ministry of Employment.
Source: OECD (1995), *OECD Economic Surveys. Portugal*, p. 70.

Considering that earnings indicate to an extent the 'value' or productivity of workers (Mincer, 1969), the evidence collected seems to indicate that the best educated and most highly skilled employees are 'more valuable', i.e., more productive, than the rest of the workers.

The poor hiring record displayed by Portuguese employers relative to the best educated and highly skilled individuals referred to in Batista (1993) and Coopers and Lybrand (1994), and documented in the last section, does not square with the above mentioned supply availability and relative productivity of those same individuals. In particular, in the light of orthodox economic theory, namely human capital theory, the behaviour of Portuguese employers does not seem 'rational'.

According to the argument introduced in the present study, this apparently ill-conceived irrationality on the part of Portuguese employers derives, at least to some extent, from the neglect of an important factor in the hiring decisions of employers, that is, the risk of fission. The next section presents the particular of the fission model. It starts providing evidence on the reproduction pattern of firms and the associated human capital patterns in the Portuguese textile industry. This evidence constitutes the starting point of the fission hypothesis that aims to explain the 'rationality' of the low skill path that Portuguese firms seem stuck in.

3. 'APPRECIATIVE' THEORISING . THE FISSION MODEL

3.1. REPRODUCTION OF FIRMS AND SKILLS IN PORTUGUESE TEXTILE INDUSTRY

Information gathered from several studies indicates that, in general, new firms were not a vehicle for structural change in the Portuguese economy. In fact, Demess/Cisep's (1994) study emphasises that the kind of employment created by new firms (which are responsible for the increased employment creation) does not change the structural features of the Portuguese economy in terms of education and skills. New jobs tend to be even less skilled than existing ones, bringing lower than average wages. It also underlines that in spite of the apparent need for top skilled and top educated workers the hiring in this direction is worryingly weak.

This conclusion is reached with regard to the textile industry either through database analysis or case-study evidence. Indeed, information collected during Teixeira's (2002a) fieldwork, which encompassed personal visits to and formal interviews with seventeen Portuguese textile firms, corroborates the above facts in relation to textile plant reproduction processes and, in addition, provided important clues about this process. Within the selected sample of fieldwork firms there was some similarity in the process by which they emerged. Often, the entrepreneurs who were interviewed had formerly been top skilled employees in neighbouring firms. Evolution processes, at least in terms of skill patterns, were very similar; firm skill patterns tended to 'imitate' existing firm human capital traits, characterised by a limited core of top skilled and top educated workers and a large 'reserve army' of low paid, undifferentiated workers.

Additionally, the process of new firm creation implied, in general, the exit of some (or, in certain cases all) top skilled or top educated workers from the existing firm. Usually, for the incumbent firm, vital knowledge and experience is lost when people leave (especially those with high levels of human capital).[14] Departures are often accompanied by a spin-off of a new venture by former employees who set up a firm which is complementary to, or in competition with, their former employer.

A mail survey carried out by Teixeira (2002a) in October-December 2000 targeting all Portuguese textile firms created between 1991 and 1997 which were still in business,

[14] The emergence of new establishments, which are often founded by former top skilled employees of existing establishments, is accompanied by a decline in the average sales per worker of the original plants (see Teixeira, 2002a, Appendix 7). This evidence seems to corroborate the negative impact of exits on existing establishment economic performance.

provides additional information about textile firm reproduction processes.[15] In terms of the reproduction system for recently created firms, the responses show a heavy path dependency in the sense that the current entrepreneur's origins (in terms of characteristics of their last employer) seem to matter substantially and significantly influence the choice of activity, location, and most importantly, the 'new' firm's labour organisation. In fact, almost three quarters of 'new' entrepreneurs are operating in the same (textile) activity as their previous firm, and are located in the same area.[16] As in existing firms generally, in the 'new' firm the top educated and top skilled core is very limited and often non-existent. At the outset, around 91% of 'new' firms operated with no top educated workers and 71% operated with no top skilled employees. In 2000 those percentages decreased but are still very high (82% and 62%, respectively), though closer to those of existing firms.

In short, taking firm employment distributions as a whole, it is clear that both 'new' and existing firms present a bifurcated employment structure, with a limited core of top educated and top skilled workers and a large number of undifferentiated, low educated and low skilled employees. Recently created firms, as mentioned above, seem to imitate the employment structures of existing firms, especially regarding top educated and top skilled human capital types.[17]

3.2. THE FISSION HYPOTHESIS

The starting point of the fission hypothesis is derived from the empirical observation that in the Portuguese textile sector the pattern of human capital accumulation at establishment level increases the risk of fission and contributes to the perseverance of education and skill employment structures at industry level (*cf*. section 3.1). In other words, the hiring of one top skilled or top educated individual increases the establishment's probability of fission, regardless of the return from such a hiring.

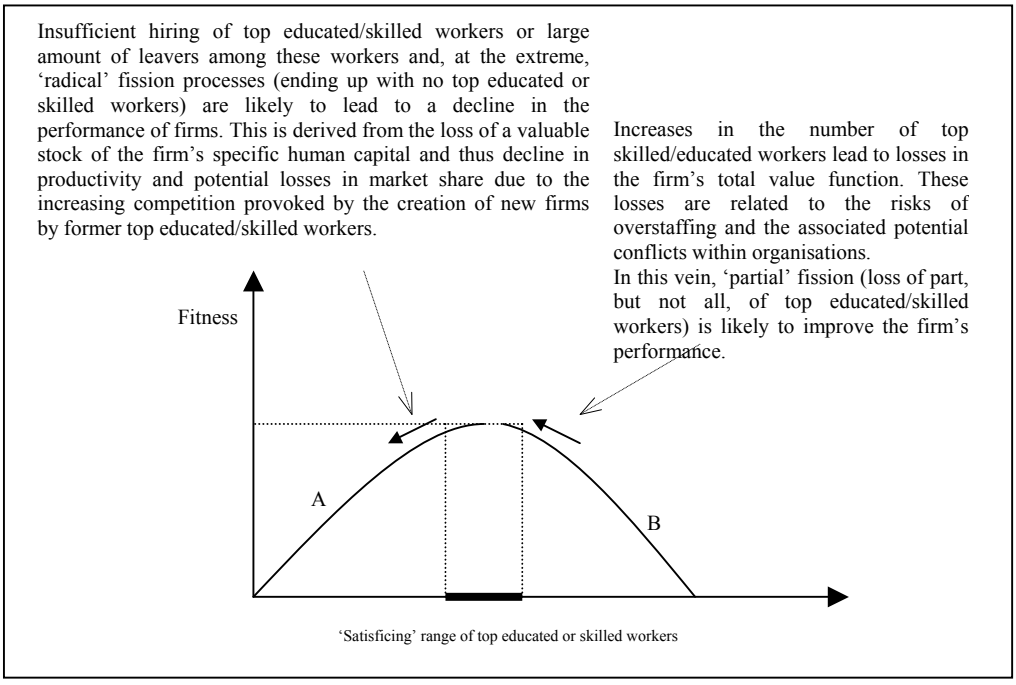
[15] The response rate to this inquiry was very low, only 34 out of 897 firms responded. However, the sample was considered as 'dynamically' representative of the whole population (see Teixeira, 2002a, section 7.2.2 for further details).

[16] Around half of the respondents stated that their current firm was located in the 'localidade' of their previous firm or employer and another 40% in the same 'concelho' (that is, municipality).

[17] A study coordinated by Lança (2000), based on information gathered from an inquiry to the Portuguese manufacturing industry, involving 880 firms with more than 10 workers, which (according to "Quadros de Pessoal") were in business in 1986, sketches the profile of the Portuguese industry entrepreneur. Results relative to these 'existing' firms corroborate the thesis of a path-dependent reproduction process within Portuguese industry, namely in terms of human capital. In fact, according to that study, the vast majority of existing manufacturing firms were run without top educated workers.

In fact, evidence provided in last section does seem to suggest that the process of plant creation in the Portuguese textile industry occurs in a similar way to atomic nuclear fission.[18] At a given moment, the nucleus of a plant (its core of top educated and skilled workers) may split, producing a new plant of a different size to the previous plant but with a similar skill and education structure. It is assumed here (similar to the nuclear atom case) that when an additional top worker enters the firm, the risk of fission increases.[19] Moreover, and unlike the case of the atom, there is a real possibility that the nucleus of the incumbent firm ends up with no elements, that is, all the top workers will leave the firm (radical fission) instead of the firm diminishing but continuing with a positive number (partial fission). It is argued here that the ultimate reason why the industry's skill and education patterns remain relatively inert is the risk of fission, in particular the risk of radical fission. The "fission argument" implicitly assumes that there is a 'threshold' number of top skilled or top educated workers needed to run a plant. Below and above this level, the establishment's fitness decreases. Figure 3 illustrates this relationship.

Figure 3: The fission risk and its impact on establishment fitness



[18] In physics, when a nucleus splits (fission), two (or more) daughter nuclei are formed with uneven masses, which do not add together to form the mass of the original nucleus. The process of fission is not ordered or regular, and it is uncertain (*http://www.users.bigpond.com/Sinclair/fission*).

[19] By adding an extra neutron to the nucleus, mass is increased, and binding energy is consequently reduced to conserve energy. When the binding energy is reduced, the electrostatic repulsion within the nucleus is greater than the binding energy, and the nucleus splits (*http://wwwusers.bigpond.com /Sinclair/fission*).

Note that attempts on the behalf of employers to secure valuable existing top educated workers (and thus diminish the risk of radical fission) through increasing their already high wages, or offering them non-monetary compensations (which renders their jobs even more attractive) may act to amplify employment structural inertia. In fact, it reduces the hiring propensity as higher wages lead to less monetary resources being available for new hiring. Moreover, given the higher wage or job incentive of more education, it contributes to an ever-expanding supply of top educated labour and, therefore, an aggravation of top educated unemployment.

In practice, one should distinguish between the two 'fission' processes, 'partial fission' and 'radical fission'. Partial fission occurs when the plant has a relative excess of top skilled or top educated workers, whereas radical fission happens when the plant has its 'desired' level of these types of workers. In the first case the fission may be beneficial for plant performance or fitness, whereas in the second case fission is expected, in general, to be detrimental to plant survival.

In the event of fission occurring, in particular radical fission, the plant will incur costs, namely in the form of loss of a qualified worker with associated training costs, potential loss of market share (in favour of the new competitor's) and, ultimately, threat to the plant's fitness or survival prospects. In this way, the likelihood of fission influences the skill and education structures being maintained at a certain level in existing units. In addition, and given the existence of a sufficiently large pool of appropriate personnel, new organisations will tend to reproduce existing plants' employment structures as they have been revealed to be those that are likely to lead to a 'satisficing' fitness level. In the end, industry employment structures in terms of human capital will remain fairly constant; that is, they will be characterised by substantial inertia.

What follows attempts to formulate an empirical economic behavioural model of the hiring pattern for top skilled and top educated workers. It is a realistic model, which recognises that, the existence of a "fission risk" must certainly affect the prospective employer's probability of hiring in new top skilled or top educated workers. Accordingly, when analysing the determinants of hiring at top level, one should look not at the prevailing effective productivity differentials as such, but instead at the expected productivity differential (that is, the productivity differential adjusted for the probability of fission). This probabilistic approach is then incorporated into an empirical model of the determinants of establishment performance (that is, fitness or likelihood of

survival), which is then used to explain or justify employment structure dynamics (or often inertia) in terms of education and skills at the industry level. This empirical model, in particular, is likely to provide a convenient framework for analysing and explaining the apparent paradox within the Portuguese economy and more specifically the textile industry of a structural inertia in industry employment distribution in terms of both education and skills, in a context of increasing availability of educated and skilled individuals in the labour market.

The next section presents the empirical model within which the impact of establishments' fission processes in terms of human capital in the context of firm fitness will be studied, and describes the operationalisation of the fission concept and other relevant variables.

4. THE EMPIRICAL ASSESSMENT OF THE FISSION MODEL

4.1. CONSIDERATIONS ABOUT THE DATA

Statistical information used in this section is based on unpublished data from a Portuguese survey, "Quadros de Pessoal". The statistical department of the Portuguese Ministry for Qualification and Employment (DE_MQE) has collected these data on a yearly basis since 1982.[20] "Quadros de Pessoal" is a survey that is compulsory for every Portuguese firm with at least one wage-earner. It thus covers almost the whole population of Portuguese firms with paid employees.

The database employed to compute measures presented in this work includes a file for each year of the study (1984, 1988 and 1992).[21] This file includes all establishments classified in the textile industry. For each establishment, for the reference period of March of each year, information was gathered relative to a set of variables that characterise the establishment, the corresponding firm, and each of its workers. Specifically, this information encompasses the following variables: 1) relative to the establishment and firm - identification number; district and village; industry; firm total turnover (sales plus service rendered);[22] legal nature;[23] 2) relative to employees -

[20] The former designation of DE_MQE was DEMESS.

[21] The reason for not choosing an earlier period was because of the survey's initially poor coverage. Substantial changes in data collection methodology after 1992 influenced the choice of the last period. Despite the small number of periods considered, the eight-year period seems to be sufficiently wide to permit statistical inferences to be drawn on the topic pursued here.

[22] For multi-establishment firms, their turnover figure was assumed to be proportional to their employment share in firm's total employment.

[23] The firm's juridical nature was aggregated into five categories: 1) Limited liability company (LDA.); 2) Public company (S.A.); 3) Sole ownership; 4) Other; 5) Unknown.

gender; birth date; date of joining the firm; schooling level achieved;[24] skill level;[25] normal and extra remuneration earned in March; normal and extra hours worked in March. In the database, information relating to each worker was aggregated at the level of the establishment.

The database provides rich and comprehensive information about Portuguese textile establishments. However, it also presents some problems that must be minimised (through feasible correction) to permit a more consistent and meaningful analysis. These problems (e.g., intermitting establishments, missing values, and adjustments of firm sales, including services rendered, in order to find establishment sales) and how they are overcome are discussed in Teixeira (2002a).

4.2. SPECIFICATION OF THE PROBABILISTIC MODEL OF ESTABLISHMENT SURVIVAL

4.2.1. THE LOGISTIC MODEL

The aim here is to collect evidence on the relation between human capital accumulation patterns and the corresponding survival probability of establishments. In particular, the work undertaken is intended to evaluate the empirical relevance of fission processes (in terms of education and skills) for the fitness of textile establishments.

The nature of data observed relative to the dependent variable [Establishment survived? (1) Yes; (0) No] dictates the choice of the estimation model. Conventional estimation techniques (e.g., multiple regression analysis), in the context of a discrete dependent variable, are not a valid option. Firstly, the assumptions needed for hypothesis testing in conventional regression analysis are necessarily violated – it is unreasonable to assume, for instance, that the distribution of errors is normal. Secondly, in multiple regression analysis predicted values cannot be interpreted as probabilities – they are not constrained to fall in the interval between 0 and 1.[26] The approach used, therefore, will be to analyse each situation in the general framework of probabilistic models.

$$Prob\ (event\ j\ occurs) = Prob\ (Y=j) = F[relevant\ effects: parameters].$$

[24] Three schooling levels were considered: ED01 – post-secondary education (*'Top educated'*); ED02 – second cycle of basic (exclusive) up to secondary education; ED03 – six or less years of schooling.
[25] Skills are divided into five groups: SK01 – top professionals and intermediate technicians (*'Top skilled'*); SK02 – foremen and team chiefs; SK03 – highly and skilled workers; SK04 – low and non-skilled workers; SK05 – apprentices.
[26] The logistic regression model is also preferred to another conventional estimation technique, discriminant analysis. According to Hosmer and Lemeshow (1989), even when assumptions required for discriminant analysis are satisfied, logistic regression still performs well.

In the model of establishment survival, during a given period, the establishment either survived (*Y=1*) or did not (*Y=0*). Moreover, it is believed (*cf.* literature reviewed in Teixeira, 2002b) that a set of factors, such as human capital accumulation patterns, size, industry, and workforce composition, among other variables, gathered in a vector *X*, explain the outcome, so that

$$\Pr ob(Y = 1) = F(X, \beta)$$
$$\Pr ob(Y = 0) = 1 - F(X, \beta)$$

The set of parameters β reflects the impact of changes in *X* on the probability of survival. For example, among the factors that are of interest in this thesis is the marginal effect of human capital accumulation patterns, in particular the fission associated with top educated or skilled workers, on the probability of establishment survival (proxy for establishment fitness).

The problem at this point is to devise a suitable model for the right-hand side of the equation. The requirement is for a model that will produce predictions consistent with the underlying theory. For a given regressor vector, one would expect

$$\lim_{\beta'X \to +\infty} \Pr ob(Y = 1) = 1$$
$$\lim_{\beta'X \to -\infty} \Pr ob(Y = 1) = 0$$

Partly because of its mathematical convenience, the logistic distribution, $\Pr ob(Y = 1) = \frac{1}{1 + e^{-\beta'X}}$, has been used in many applications (Greene, 1993).

Rearranged in terms of the log odds (the ratio of the probability that it will occur to the probability that it will not), this expression is the so-called *logit* model.[27]

The probability model is a regression:

$$E(Y \setminus X) = 0\left[1 - F\left(\beta'X\right)\right] + 1\left[F\left(\beta'X\right)\right] = F(\beta'X)$$

Whatever distribution is used, it is important to note that parameters of the model, like those of any non-linear regression model, are not necessarily the marginal effects. In general,

$$\frac{\partial E(Y \setminus X)}{\partial X} = \frac{dF(\beta'X)}{d(\beta'X)}\beta = f(\beta'X)\beta$$

[27] If instead a normal distribution function is assumed, one would have the *probit* model. The logistic distribution is similar to the normal except in the tails, which are considerably heavier. There are practical reasons for favouring one or the other in some cases for mathematical convenience, but it is difficult to justify the choice of one distribution over another on theoretical grounds. Notwithstanding this, in most applications, it seems not to make much difference (Greene, 1993).

where *f(.)* is the density function that corresponds to the cumulative distribution, *F(.)*. For the logistic distribution,

$$\frac{d\Lambda(\beta'X)}{d(\beta'X)} = \frac{e^{\beta'X}}{(1+e^{\beta'X})^2} = \Lambda(\beta'X)\left[1-\Lambda(\beta'X)\right]$$

Thus, in the *logit* model,

$$\frac{\partial E\left[Y \setminus X\right]}{\partial X} = \Lambda(\beta'X)\left[1-\Lambda(\beta'X)\right]\beta .$$

It is obvious that these values will vary with the values of *X*. In interpreting the estimated model, it will be useful to calculate this value at, say, the means of the regressors and, where necessary, other pertinent values.

In the logistic regression, the parameters of the model are estimated using the maximum-likelihood method (ML). That is, the coefficients that make observed results most "likely", given the assumptions made about the error distribution, are selected.

4.2.2. EXPLANATORY VARIABLES

In this section explanatory variables are defined for inclusion in vector *X*. Based on theoretical contributions, the variables considered are:[28] human capital accumulation patterns, employment dynamics, wage levels and dynamics, establishment size, industry and age, gender and age composition of establishment employment. The following subsection describes the construction of each of these variables.

4.2.2.1. HUMAN CAPITAL ACCUMULATION PATTERNS

The operationalisation of fission concept

In order to capture the dynamics of the human capital accumulation patterns of establishments, in relation to top educated and top skilled workers, a categorical variable was constructed indicating the particular pattern of human capital accumulation for each given establishment presented in the database.

In effect, the variable constructed encompasses five distinct categories or groups of establishments:

- 'Radical fission' [RF] – establishments that between 1984 and 1988 lost all their top educated (skilled) workers;

[28] See Teixeira (2002b) for a survey.

- 'Partial fission' [PF] – establishments that between 1984 and 1988 lost some of their of top educated (skilled) workers, i.e., the number of top educated (skilled) workers in 1988 is less than that for 1984 but still positive;
- 'Inert zero' [INZ] – establishments that in neither period (1984 and 1988) had any top educated (skilled) workers;
- 'Inert positive' [INP] – establishments that maintained the same number of top educated (skilled) workers in 1984 and 1988;
- 'Expanding' [EXP] – establishments that increased the number of their top educated (skilled) workers between 1984 and 1988 [default category].

This categorical variable was constructed for both top educated and top skilled employees.[29]

Relative importance of the alternative human capital accumulation patterns

As described above, human capital accumulation patterns were measured using a categorical variable encompassing five main groups, which can be aggregated into three – fission ('radical' and 'partial'), inertia ('inert zero' and 'inert positive'), and expansion.

In the case of both top educated and top skilled, the vast majority of textile establishments that were in business from 1984 up to 1988 exhibited inertia in terms of human capital accumulation.[30] In other words, around three quarters of the establishments considered did not change the number of top educated workers during the four-year period under study. In the case of top skilled workers inert behaviour was present in about sixty per cent of textile establishments.

Additionally, sixteen (eighteen) per cent of establishments increased their top educated (skilled) employment, representing approximately 40% of total employment. Fission

[29] Due to the importance of missing cases for top educated and top skilled employment categories, three alternative hypotheses regarding to the missing cases were considered [see Teixeira (2002a, chapter 6) for further details]. Given the highly likelihood that missing cases are in fact zeros, the estimates presented in this study are restricted to this scenario - DE_MQE technicians, who were responsible for treating the data from the "Quadros de Pessoal" inquiry, emphasised that missing values in the education and skills categories are in the majority of cases zeros; additionally, several studies (*e.g.*, Godinho and Sousa, 2000) that are based on the same data source take for granted that the missing values are zeros, thus corroborating this assumption.

[30] Note that establishments in the analysis are those that were in business in both 1984 and 1988 whether or not they survived until 1992. Including those establishments that present missing cases for top educated and top skilled workers, they totalled 1,478, of which approximately three quarters survived until 1992.

processes are relatively less important, encompassing around 8% of total textile establishments for top educated and double that in the case of top skilled. The percentage of establishments that between 1984 and 1988 lost their entire top educated (top skilled) workforce was approximately 5% (6%).

Table 5: Human capital accumulation patterns (fission, inertia, expansion) – establishment and employment distributions, %

	% Total establishments		% Total employment	
	Top Educated	Top Skilled	Top Educated	Top Skilled
Radical fission	4.8	6.2	5.9	4.5
Partial fission	3.4	8.4	14.9	30.9
Inert zero	66.9	53.4	22.7	12.8
Inert positive	8.9	13.9	15.2	14.8
Expanding	16.0	18.1	41.3	37.1
Total (number)	*1478*	*1478*	*144215*	*144215*

Note: Computations made by the author based on unpublished data from "Quadros de Pessoal"

Total employment distribution shows that increases and partial fission in top educated and top skilled employment occurs essentially in relatively large units, whereas inert behaviour, in particular inert zero, is basically concentrated in very small establishments. This behaviour on the part of small establishments can be easily rationalised in the context of fission risk. According to the fission argument depicted in Figure 3, in their decision to hire a top educated or top skilled worker, employers must balance the probability or risk of fission. If the risk of fission is high, employers tend to be more prone to hire a given number of top educated (skilled) people in order to avoid sliding down left along the curve of fitness (see Figure 3), that is, the danger of incurring losses derived from radical fission processes. However, they must not hire too many of these types of workers as there is a risk of falling onto the right-hand side of the fitness curve, and thus also suffering losses due to overstaffing. In very small firms both radical fission and overstaffing risks are higher. Consequently, small firms tend to be much more reluctant to hire top educated or top skilled workers than large establishments. Moreover, in order in avoiding future processes of radical fission, which are likely to undermine their survival probability, small establishments tend to prefer to maintain an employment structure without top skilled or top educated workers rather than hiring and then losing the workers in question.

In contrast to small establishments, large ones, which on average include a comparatively higher number of top skilled and educated workers, tend to hire periodically a limited number of such workers (just enough to compensate for exits) in

order to avoid eventual drastic future decreases in their human capital stock and, ultimately, radical fission processes.

Based on logistic estimates it is empirically demonstrated in section 4.3 that inert behaviour on the employers' behalf towards human capital accumulation might be, in certain institutional contexts such as those characterising Portuguese textile establishments, economically rational.

4.2.2.2. OTHER EXPLANATORY VARIABLES

Size

The size of establishments is measured in terms of total employment in the initial period (1984). This is included in the model as a categorical variable encompassing nine employment categories: S1, establishments with one to five employees [1, 5] (default); S2, establishments with six to ten employees [6, 10]; S3, establishments with eleven to nineteen employees [11, 19]; S4, establishments with twenty to forty-nine employees [20, 49]; S5, establishments with fifty to ninety-nine employees [50, 99]; S6, establishments with one-hundred to one-hundred and ninety-nine employees [100, 199]; S7 establishments with two-hundred to four-hundred and ninety-nine employees [200, 499]; S8, establishments with five-hundred to nine-hundred and ninety-nine employees [500, 999]; S9, establishments with over one thousand employees [1000, …]. In practice, it means that in terms of the model's estimation there are eight 'dummies' for establishment size (concretely, S2, …, S9). Thus, each dummy may take two alternative values, 1 if the establishment belongs to the dummy's corresponding size class and 0 otherwise.

Industry

Original data on establishments encompassed twenty-eight textile sub-industries (classified using the Portuguese economic activity code, CAE, at the six-digit level). These twenty-eight sub-industries were re-classified into ten main sub-industries: preparation of textiles (PREP); spinning, weaving and finishing of wool and wool mixed fibres (WOOL); spinning, weaving and finishing of cotton, artificial and synthetic fibres (COTTON); other made-up textiles (MADE-UP); home textiles (HT); embroideries (EMB) manufacture of knitted articles (KNIT); carpets, mats and rugs (RUG); ropes, cables and nets (ROPES); and other textiles (OTHER). In the estimated model the industry encompassed nine dummies, using cotton as the default category.

Total employment dynamics

In order to account for the individual dynamics of each establishment in terms of its whole workforce, a categorical variable was constructed (E8488) which equals 1 if the establishment maintained or expanded its total employment between 1984 and 1988 and 0 otherwise.

Wages

To measure the influence of wages on the likelihood of survival of establishments, two wage components were considered: the wage level in the initial period and the wage growth rate between 1984 and 1988.

The wage level is defined as the natural logarithm of the wage in 1984 (LNWAGE84), where the wage is the average monthly base remuneration in real terms, which in turn is given by the ratio: $Wage_{it} = \frac{\sum BREM_{it}}{\text{Paid Workers}_{it}}$,

where $\Sigma BREM_{it}$ is the sum of real[31] monthly base remunerations earned by establishment i's workers in March of year t,[32] and $Paid\ Workers_{it}$ is the number of wage earners in the service of establishment i in the same reference period.

The wage growth is given by rate of growth of wages between 1984 and 1988, that is,

$$Wage8488 = \left(\frac{Wage_{1988}}{Wage_{1984}} - 1 \right) \times 100$$

Establishment age

As no information is available about the beginning of activity of establishments, their length of time in business is measured by the highest length of tenure of workers within the establishment in the reference period.[33]

[31] Wages were computed at 1985 constant prices, using the consumer price index as deflator (*Source*: INE and Banco de Portugal).
[32] Base remuneration is taken to be the gross amount that each worker has the right to receive in the reference month relative to normal working hours.
[33] This same procedure has been used by several authors working with "Quadros de Pessoal" data (*e.g.*, Carneiro, 1995).

Multi-establishments

The case of more than one establishment in a firm is measured by a categorical variable (MULTES) assuming the value 1 in the case of an establishment belonging to a single-establishment firm and 2 if it belongs to a multi-establishment firm.

Employment composition

Establishment employment composition is analysed through two perspectives, gender and age of the corresponding workforce. Thus, two variables were computed in order to measure the relative importance of females (F_W) and youngsters (PAGE25) in establishments' total employment. The former is computed as the ratio of the number of women working in the establishment to total employees, whereas the latter having the same denominator uses as the numerator the number of employees aged 25 or under.[34]

4.2.3. THE EMPIRICAL LOGISTIC REGRESSION

The empirical assessment of the fission argument is based on the estimation of the following general logistic regression:

$$P(SURV) = \frac{1}{1+e^{-Z}}$$

$$Z = \beta_0 + \underbrace{\beta_1 RF + \beta_2 PF + \beta_3 IN0 + \beta_4 INP}_{\text{Human capital accumulation patterns}} + \underbrace{\beta_5 S2 + ... + \beta_{12} S9}_{\text{Size dummies}} + \underbrace{\beta_{13} PREP + ... + \beta_{21} OTHER}_{\text{Industry dummies}}$$
$$+ \beta_{22} E8488 + \beta_{23} LNWAGE + \beta_{24} WAGE8488 + \beta_{25} MULTES + \beta_{26} PAGE25 + \beta_{27} F\_W + \varepsilon_i$$

Definitions of the variables were given in the last section. In order to have a more straightforward interpretation of the logistic coefficients it is convenient to consider a rearrangement of the equation for the logistic model, in which the logistic model is rewritten in terms of the odds of an event occurring. Writing the logistic model in terms of the odds, one obtains the *logit* model

$$\log\left(\frac{\Pr ob(SURV)}{\Pr ob(NOSURV)}\right) = \beta_0 + \underbrace{\beta_1 RF + \beta_2 PF + \beta_3 IN0 + \beta_4 INP}_{\text{Human capital accumulation patterns}} + \underbrace{\beta_5 S2 + ... + \beta_{12} S9}_{\text{Size dummies}} + \underbrace{\beta_{13} PREP + ... + \beta_{21} OTHER}_{\text{Industry dummies}}$$
$$+ \beta_{22} E8488 + \beta_{23} LNWAGE + \beta_{24} WAGE8488 + \beta_{25} MULTES + \beta_{26} PAGE25 + \beta_{27} F\_W + \varepsilon_i$$

The logistic coefficient can be interpreted as the change in the log odds associated with a one-unit change in the independent variable.

[34] The reference period is the initial year (1984).

$$\left(\frac{\Pr ob(SURV)}{\Pr ob(NOSURV)}\right) = e^{\left[\underbrace{\beta_0 + \beta_1 RF + \beta_2 PF + \beta_3 IN0 + \beta_4 INP}_{\text{Human capital accumulation patterns}} + \underbrace{\beta_5 S2 + \ldots + \beta_{12} S9}_{\text{Size dummies}} + \underbrace{\beta_{13} PREP + \ldots + \beta_{21} OTHER}_{\text{Industry dummies}} + \beta_{22} E8488 + \beta_{23} LNWAGE + \beta_{24} WAGE8488 + \beta_{25} MULTES + \beta_{26} PAGE25 + \beta_{27} F\_ + \varepsilon_i W\right]}$$

Then e raised to the power β_i is the factor by which the odds change when the i^{th} independent variable increases by one unit. If β_i is positive, this factor will be greater than 1, which means that the odds are increased; if β_i is negative, the factor will be less than one, which means that the odds are decreased. When β_i is 0, the factor equals 1, which leaves the odds unchanged.

In the following section industry level data, taking the establishment as the reference unit, are used to empirically assess the validity of the fission argument. If empirical evidence corroborates the fission model, then it can be argued that the failure of human capital demand to match supply is, at least in part, related to the process of human capital accumulation at establishment level. This kind of inertia mechanism on the demand side of human capital, therefore, would help to explain why, despite the fact that a large supply of top educated individuals may be economically justifiable for plants (potentially producing a higher fitness level), in practice, given certain environmental conditions such as the risk of fission, additional top educated individuals are not hired.

4. 3. ESTIMATION OF THE FISSION MODEL

The next table (Table 6) presents a summary version of the estimated logistic regressions in 'preferred' estimated models for both top educated and top skilled employment categories. The choice of these 'preferred' models was based on goodness-of-fit measures, namely the log-likelihood statistic and Hosmer and Lemeshow measure.[35] In these models estimates associated with 'radical fission' and 'inert zero'

[35] The log-likelihood statistic is analogous to the error sum of squares in multiple regression and, as such, is an indicator of how much unexplained information there is after the model has been fitted. It follows, therefore, that high values of the log-likelihood statistic indicate poorly fitting statistical models, because the higher the value of the log-likelihood, the more unexplained observations there are. Hosmer and Lemeshow's (H&L) measure might be considered an analogue to the R^2 value in linear regression; it is the proportional reduction in the absolute value of the log-likelihood measure and as such it is a measure of how much the goodness-of-fit improves as a result of the inclusion of the predictor variables. It can vary between 0 (indicating that the predictors are useless for predicting the outcome variable) and 1 (indicating that the model predicts the outcome variable perfectly). H&L's goodness-of-fit statistic tests the hypothesis that the observed data are significantly different from the predicted values from the model. So, in effect, one wants a non-significant value for this test (because this would indicate that the model does not differ significantly from the observed data). A non-significant value for the H&L test is indicative of a model that is predicting real world data fairly well.

categories are in general statistically significant, whereas 'partial fission' and 'inert positive' categories fail to be statistically significant.

Table 6: Human capital and establishment fitness in the Portuguese textile industry - logistic estimates of the odds of establishment survival

Indep. Variable	Definition	Coef. estimates and significance	Top Educated	Top Skilled
RF	'Radical fission' – establishments that between 1984 and 1988 lost all their top educated (skilled) workers;	Exp(β)	0.534	0.552
		Significance	*0.047*	*0.037*
PF	'Partial fission' – establishments that between 1984 and 1988 lost some of their of top educated (skilled) workers, i.e., the number of top educated (skilled) workers in 1988 is less than that for 1984 but still positive;	Exp(β)	1.390	1.198
		Significance	*0.444*	*0.536*
INZ	'Inert zero' – establishments that in neither period (1984 and 1988) had any top educated (skilled) workers;	Exp(β)	0.695	0.607
		Significance	*0.067*	*0.008*
INP	'Inert positive' – establishments that maintained the same number of top educated (skilled) workers in 1984 and 1988;	Exp(β)	1.030	0.729
		Significance	*0.917*	*0.171*
E8488	Equals 1 if the establishment maintained or expanded its total employment between 1984 and 1988 and 0 otherwise	Exp(β)	1.923	1.694
		Significance	*0.000*	*0.000*
LNWAGE84	The natural logarithm of the average monthly base remuneration in real terms in 1984	Exp(β)	0.974	1.232
		Significance	*0.954*	*0.593*
WAGE8488	The growth rate of the average monthly base remuneration in real terms between 1984 and 1988	Exp(β)	1.008	1.004
		Significance	*0.089*	*0.391*
LNAGE	The natural log of the highest length of tenure of workers within the establishment in the reference period	Exp(β)	1.305	
		Significance	*0.001*	
MULTES84	Assuming the value 1 in the case of an establishment belonging to a single-establishment firm and 2 if it belongs to a multi-establishment firm in the reference period	Exp(β)	0.788	
		Significance	*0.380*	
PAGE2584	The ratio of the number of employees aged 25 or under in establishments' total employment in 1984	Exp(β)	0.999	
		Significance	*0.751*	
F_W84	The ratio of the number of women working in the establishment to total employees in 1984	Exp(β)	0.996	
		Significance	*0.128*	
CONST.		Exp(β)	1.763	1.415
		Significance	*0.701*	*0.790*
Dummy variables				
Size			No	No
Industry			Yes	Yes
N			1395	1417
Survived			1039	1055
Died			356	362
-2Log Likelihood			1517.7	1563.7
Hosmer and Lemeshow test				
Chi-Square			3.53	8.49
Sig.			0.90	0.39
No. Iterations			3	3

Note: Computations made by the author based on unpublished data from "Quadros de Pessoal".

Estimation results show that even when one controls for establishments, industry, employment and wage dynamics, length in business and employment gender and youth composition, for both top educated and top skilled cases, the odds of survival are significantly lower for establishments that suffered radical fission processes when compared with establishments that expanded the number of such workers or those that

maintained an inert zero behaviour, that is, did not have any top educated or top skilled workers in the period under study (1984-1988).

In fact, establishments that present inert behaviour in terms of human capital accumulation perform better than establishments that in the initial period had some positive number for top workers but four years later ended up with none. Therefore, in the top educated case, the odds of survival for radical fission establishments are estimated at 0.534 times those for establishments that expanded; whereas in case of inert zero establishments the corresponding odds of survival are estimated to be 0.695 (in the case of top skilled, the respective figures are similar at 0.552 and 0.607).

In this vein, although in the short run expanding seems to be the most profitable alternative (in terms of fitness, at least), in the medium run, given the highly detrimental impact of radical fission on fitness, establishments may improve their survival prospects by instead maintaining an inert (zero) behaviour. Moreover, in the particular case of top educated employment, the evidence seems to indicate that inert positive behaviour is, in fact, even more profitable than expanding. Notwithstanding this, as already referred to above, this conclusion lacks statistical significance. For top skilled cases, and taking into account the same limitation, inert positive behaviour presents odds of survival substantially higher than radical fission, though lower than the expanding alternative.

Note that although the 'reverse causality' argument could provide an alternative explanation for the empirical evidence gathered here, it is discarded based on further evidence gathered from the survey to recently created textile firms (*cf*. Teixeira, 2002a). According to this later, the "prospective closure" or "economic difficulties" of the former employer of the respondents (owners of newly created textile firms) is consider important or very important motive for creating their present firm in only 22% of cases; the vast majority (78%) of the new owners claimed that the most important reasons for starting the new business (in competition with their former employer) were the existence of a business opportunities, desire for independence or expectation of higher incomes. This isolated peace of evidence tends thus to support the argument of fission.

5. CONCLUSION

This paper aimed to seek an economic 'rational' explanation for the relative inertia of human capital demand side in the Portuguese economy and more specifically in the textile industry. In this vein, a new concept, fission, was introduced.

The fission argument stated that Portuguese textile establishments' reproduction process occurs in a similar way to atomic nuclear fission. At a given moment, the 'nucleus' of the establishment, constituted by its core of top educated and top skilled workers, may split, originating a new plant with a similar education and skill structure.

It is argued then that due to this fission risk, establishments would tend to maintain a bifurcated employment structure characterised by a limited core of top educated and top skilled workers and a large 'reserve army' of undifferentiated and low educated individuals. Implicitly it was assumed that the existence of a limited number of top educated and top skilled workers would yield 'satisficing' levels of fitness. Also that the risk of fission would produce new establishments, which, in turn, would profit (in terms of fitness) by imitating existing plants' employment structures. In this vein, the mechanism of establishment reproduction would explain the observed inertia at the industry level on the human capital demand side, and thus the human capital paradox.

The pertinence of the fission argument, concerning the 'profitability' of maintaining inert behaviour in terms of the hiring of individuals with high levels of human capital (i.e., top educated and top skilled workers) was assessed empirically through the estimation of a probabilistic model of establishment survival which took into account the accumulation pattern of human capital, in particular the fission risk.

The estimated logistic model, based on the whole population of the Portuguese textile establishments that were in business in the period 1984-1988 (whether or not they survived until 1992), provided statistical evidence that corroborates the fission argument. In fact, taking a dynamic perspective, there was enough evidence that it is more profitable for an establishment, in terms of fitness or survival capacity, to maintain inertia (characterised by employment of no top educated or top skilled workers) than to hire an individual with high levels of human capital which would run the risk of eventually suffering a fission process. This evidence, however, was stronger in the case of top educated than top skilled workers.

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