A Darwinian theory of transformation pressure – the stimuli of negative shocks for productivity and renewal in established firms

Lennart Erixon*

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Abstract

The theory of transformation pressure maintains that central actors in established firms will be more productive when experiencing an actual fall in profits. Actors fearing that the survival of the firm is at stake will then become more alert, calculating and creative favoring a transformation. The neo-Schumpeterians follow Schumpeter by largely ignoring the importance of negative driving forces for innovations and the productivity performance of firms. In the neoclassical Schumpeterian literature stronger competition and also lower product demand may induce innovations and productivity increases in established firm. But this literature neglects the underlying psychological mechanism. The ideas in the theory of transformation pressure can easily be incorporated into a Darwinian framework emphasizing basic human drives, the struggle for existence and the adaptation to new external circumstances.

The results from tests of the theory of transformation pressure are ambiguous. An experiment confirmed that firms are governed by bounded rationally but only partly that they will upgrade their growth strategy in a profit recession. There are arguments in both industrial economics, psychology and neuroscience for a qualified theory of transformation pressure. Productivity is enhanced by moderate pressure or by periodic shifts between hard pressures and good opportunities.

JEL classification: B52; D21; E32; L21; O31

Key words: transformation pressure, bounded rationality, creative destruction, negative driving forces, productivity growth, innovations, neuroscience, stress, economic psychology, universal Darwinism

* Department of Economics, Stockholm University. E-mail: lex@ne.su.se. Geoff Dow has made very constructive comments on earlier versions.

1. Introduction

A conventional belief is that people become more alert, efficient and dynamic if they experience setbacks and tougher external environments. According to a related argument firm productivity and renewal is enhanced by negative shocks. The stimulus of severe external circumstances may explain why total-factor and labor productivity growth move countercyclically in some countries and time periods at least after adjustment for labor-hoarding effects (Aghion and Howitt, 1998, pp. 239-243; Malley and Muscatelli, 1999; Estrella, 2004) and why countries exposed to foreign competition have more favorable productivity development and product composition (Baily and Gersbach, 1995; Bloom and Van Reenen, 2007). However, the idea that firm performance is improved by worse external conditions is not obvious. By visualizing the salience of scale advantages and learning effects evolutionary and macroeconomists alike generally shed light on positive driving forces behind sustainable growth. And when considering the positive effect of "pressure" on aggregate productivity (growth) they primarily envisage the business-stealing and industry-composition (possibly vintage) effects of innovations captured by Schumpeter's notion of creative destruction – firms and industries with low productivity (growth) will perish because of the expansion of innovative firms and industries. Neither Schumpeter nor the neo-Schumpeterians stress the pivotal role of negative driving forces for the renewal and productivity development in established firms.

The central hypothesis in the theory of transformation pressure (henceforth TTP) is that harder external circumstances and, more specifically, reductions in actual profits, will enhance the productivity, and possibly also innovative, performance of established firms (Erixon, 1991, 2007). Pertinent ideas about the stimulating role of bad times for innovations and productivity can be found in Robertson (1915) and also in an "orthodox" Schumpeterian tradition (Van Duijn,

1983, pp. 137-143; Kleinknecht, 1987, ch. 3). The so-called Rehn-Meidner model, a unique Swedish economic and wage policy program developed during the early postwar years, advocates that profit pressure on the business sector, particularly on the least-productive firms, can increase economic growth. The profit pressure was expected to speed up structural change and stimulate rationalization and technological progress (Erixon, 2010). Case studies have pinpointed the importance of factor disadvantages, qualified product demand and rivalry among domestic producers for the competitive advantage of nations (Porter, 1990, ch. 3). The notion of transformation pressure was invented by Erik Dahmén, a Swedish economist in the Veblen-Schumpeterian tradition, who in the 1990s came to make a clear distinction between opportunities and pressures when defining the external conditions for firm evolution (Dahmén, 1998). Neoclassical Schumpeterian economists recognize the possibility of countercyclical productivity growth and the positive effect of stronger competition on the productivity of incumbent firms (Aghion and Howitt, 2009). But they are reluctant to elaborate the underlying psychological mechanism.

Through its focus on the adaptation to changing external circumstances, struggles for existence, emergent properties, path dependent processes and, not least, by providing room for psychological and genetic factors, universal Darwinism seems to suggest that the transformation of established firms is stimulated by negative events (cf. Hodgson and Knudsen, 2010). But this idea has no special status in Darwinian economics. A distinction between positive and negative forces, and more specifically, an emphasis on negative drives, may facilitate the application of universal Darwinism and also its integration with the theory of bounded rationality.

The aim of this article is to describe the TTP using the Schumpeterian and Darwinian theories of evolution as points of departure. The article will also survey the results from tests of central hypotheses in the TTP and eventually make some inevitable modifications to the original theory. The presentation of the TTP ultimately aims to contribute to the development of Darwinian macroeconomics. The article will primarily unveil the psychological mechanism underlying the suggested negative relationship between actual profits and productivity growth in the TTP. Not being deterred by the risk of "biological reductionism", the theory highlights the emotional and cognitive adaption to various external circumstances by established firms. The numerous references to basic psychological and neural processes are not intended to deny that reactions by firm actors to variation in profits can also be explained by social conventions and customs. Nor does our focus on the productive behavior of existing firms exclude the basic Darwinian presumption that the existing industrial structure, technologies and actor characteristics are the result of a selection process.

The TTP has many similarities with Harvey Leibenstein's theory of X-inefficiency. When defining a state of low productivity growth, Leibenstein, though not his neoclassical followers, referred to habits and psychological distortions (Leibenstein, 1979, pp. 484-485, 1985, pp. 6-7). Moreover, both the TTP and the Leibenstein theory of selective rationality assert that actors will be (more) rational if the firms are put under external pressure. And both the TTP and the Leibenstein theory suggest that harder external circumstances (stronger competition in Leibenstein's case) will induce agents not only to become more efficient (as emphasized in the X-inefficiency literature) but also to use and even develop new technologies (Leibenstein, 1980, pp. 39, 46 and 234-236). But there is some dissimilarity between the two theories. By emphasizing that managers and owners share the same psychological biases and interests in the

survival of the firm the TTP downplays the micro-micro perspective and the related principal-agent dichotomy in Leibenstein's works. Also the effort of owners, including to supervise, evaluate and select managers, is assumed to be a function of the external pressure. What is more, in contrast to the Leibenstein theory of selective rationality, the TTP maintains that firms will only take action to increase productivity if they experience an *actual* decline in profits. And the TTP suggests that a profit fall may boost not only the effort by firm actors but also their cognitive skill.

In the TTP the productivity-enhancing role of negative driving forces can be played either by stronger market competition (possibly from newcomers), declining and demanding markets or by adverse supply shocks. The TTP incorporates the idea that political regulation such as stricter environmental standards, by leading to higher input prices, will stimulate innovations (cf. Porter and Van den Linde, 1995). And by focusing on current profits the theory sheds light on the effects of economic policy on economic growth. An unqualified TTP maintains that productivity growth and possibly also innovations are stimulated by restrictive fiscal and monetary policy and by currency revaluation.

This article will first survey the importance of external pressure and psychological factors for economic evolution in the Schumpeterian tradition including Schumpeter himself (Section 2), the neo-Schumpeterians (Section 3) and the neoclassical Schumpeterians (Section 4). The next section assesses the status of negative driving forces and psychology in universal Darwinism. The Darwinian "school" represents, together with the Schumpeterian branches above, evolutionary

economics in this article (Section 5).[1] The following sections present the TTP (Section 5) and the results from tests of its central hypotheses (Section 6). The subsequent section (section 7) introduces two qualified theories defining the optimal transformation pressure. The final section (Section 8) provides an overview of the main conclusions in the article.

2. Schumpeter's opportunity approach

There is actually weak support in Schumpeter's works for the idea that innovations and productivity are stimulated by difficult external conditions. In *Business Cycles* the prosperity phase is initiated by exogenous innovations (though Schumpeter also refers to the importance of accumulated knowledge). New innovative firms are started by entrepreneurs on the basis of expected profit opportunities (Schumpeter, 1939, p. 130, see also Schumpeter 1962, pp. 88 and 214). What is more, Schumpeter emphasized the opportunity aspect of innovation clusters – the first innovations induce new innovations in the same or nearby industries and will also be copied by other firms through knowledge spillover effects (Schumpeter 1962, pp. 228-229, 1939, pp. 100-101 and 131). Thus, Schumpeter did not refer here to the rejuvenating influence of competitive pressure from the first innovators.

Schumpeter did mention in *Business Cycles* that innovations would force established firms and industries to undergo modernization, rationalization and reconstruction (Schumpeter, 1939, pp. 134, 137 and 155). But enforced innovations and productivity increases have no central role in Schumpeter's theory of the business cycle. First, renewal, rationalization and reconstruction

[1] The growth-enhancing role of opportunities rather than pressure is emphasized not only in the Schumpeterian theories addressed in this article but also in the Keynesian tradition and in the neoclassical new (endogenous) growth theory (Erixon, 2007, p. 328).

activities in old firms under the pressure of innovations by new firms are not necessarily more frequent in recessions and depressions. Second, the hypothesis by Schumpeter that established firms favored by entrepreneurial investment demand will "expand on old lines" in prosperity (Schumpeter, 1939, p. 147) did not persuade him to put strong emphasis on product renewal by these firms in the recession (reflecting an end to the innovation cycle) or in the (possible) subsequent depression. Third, Schumpeter did not explain the extensive spread of innovations in recessions and depressions by reference to the general decline in profits.[2] Fourth, he downplayed the possibility that profit fall in recession and depression would result in enforced innovations and productivity changes by firms laying the ground for a revival and new prosperity phase. On the contrary, a recovery may occur through the reduction in production costs and interest rates in the depression.[3] Schumpeter focused on the structural side of the positive relation between external pressure and productivity - innovations by new firms which would lead to liquidation of older firms with low productivity. The elimination of firms would be abnormal during depressions.[4]

Notwithstanding the tendency to countercyclical productivity through extensive liquidation, diffusion of innovations and the abandonment of status-quo strategies by established firms in the downswing, Schumpeter did not take for granted in *Business Cycles* that productivity moves countercyclically. Innovations gather together in the prosperity phase. And Schumpeter was ambiguous about the cyclical pattern of productivity increases within established firms induced by the stronger competition from innovative new firms.

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[2] Schumpeter (1939, pp. 143 and 146-147), (1962, pp. 242-245), (1989, p. 113).

[3] Schumpeter (1962, pp. 242-244), (1939, pp. 139 n1, 143 and 150-155).

[4] Schumpeter (1962, p. 236, 1939, p. 149), (1989, pp. 113, 115 and 117).

In his analysis of a big-business economy in *Capitalism, Socialism and Democracy* Schumpeter focused even less on negative driving forces. In fact, he stressed that frequent bankruptcies under competitive conditions would, by intensifying irregularities and disequilibrium tendencies, have a *negative* effect on innovations and long-run output. The conditions for R&D investments are more favorable in a big-business economy though Schumpeter underlined here the long-run perspective and stability rather than the scale and financial advantages of large companies (Schumpeter, 1976, pp. 90-91, 95 and 101-105). Schumpeter introduced the notion of creative destruction in *Capitalism, Socialism and Democracy* to describe the elimination and phasing out, not the vitalization, of firms and industries hit by the innovations by other firms and industries.

In all his works Schumpeter gave a peripheral role not only to enforced innovations but also to psychological and biological factors. In *The Theory of Economic Development* he explicitly argued against an economic analysis based on the Darwinian ontology and biological concepts (Schumpeter, 1962, pp. 57-58 and 156). Schumpeter brought out, although inconspicuously, the socio-psychological motives for entrepreneurship (ibid., pp. 90-94). And he focused here on positive drives, that is, on people's ambition to accomplish social status, self-assertion and self-realization (where the last phenomenon seems close to being a basic human trait). Schumpeter did not explicitly mention the importance of social and economic failures for entrepreneurship, and more importantly, he provided no room in his stylized new-firm model for the possibility that innovations are promoted by the threat of firm failure.

In *Business Cycles* psychological factors do not explain the turning points but only the amplification of the cycle. For example, the prosperity phase is reinforced by weaker social

resistance to change (facilitating innovation clusters) and exaggerated by overconfidence and herd behavior (Schumpeter, 1939, pp. 145-146). By emphasizing the pivotal role of overconfidence (though Schumpeter never used the concept) *Business Cycles* opened the door for an analysis of basic human drives. But Schumpeter still refused to formulate a psychological theory about a positive relation between external pressure and economic development. For example, *Business Cycles* did not uncover the psychology behind enforced productivity changes or its role in the liquidation process. *Capitalism, Socialism and Democracy* is completely devoid of psychological references apart from the sections on the growing anti-capitalist and non-entrepreneurial attitudes among people ripening the fruits of economic progress. The exceptionally few references by Schumpeter to psychology in this work are explained by the emphasis on managerial planning, firm bureaucracies and R&D departments and by the long-run perspective excluding an analysis of reinforcing psychological factors in the business cycle.

To sum up, Schumpeter played down the possibility that stronger competition would force established firms to become more innovative and undertake measures to increase productivity in general. And he did not elaborate the possibility that the recessions and depressions, by imposing profit pressure on firms, would sow the seeds of a recovery. Further, in his analysis of entrepreneurship, Schumpeter did not refer to basic human traits. And psychological factors were completely absent in his analysis of economic evolution in a big-business economy.

3. The Neo-Schumpeterian opportunity approach

The neo-Schumpeterians have an opportunity approach to economic evolution similar to Schumpeter's. They share the latter's emphasis on the incentive of expected profits for innovations and the diffusion of new knowledge. The neo-Schumpeterian literature also refers to

initial technological opportunities (through external scientific breakthroughs or accumulated knowledge) and particularly in the case of R&D investments to learning by doing (and learning by using) and the financial and scale advantages of large companies.[5] In the Nelson-Winter model of virtuous growth circles, innovations by some R&D investing firms (there are strong random elements in the invention and innovation process) will foster new innovations by the same firms by extending their opportunities for self-financing and learning by doing.[6] The importance of good opportunities in the Nelson-Winter model is accentuated at the macroeconomic level by the assumption that the new knowledge is gradually spread throughout the economy.[7]

Neo-Schumpeterians refer to changing external circumstances as a source of economic evolution but without making any explicit distinction between positive and negative driving forces. Undoubtedly, learning by doing, self financing and the use of static scale advantages are facilitated by favorable product-demand conditions. In addition, some neo-Schumpeterians have adopted Jacob Schmookler's theory of invention that high demand will encourage R&D investments (and other inventive activities) through the positive effects on expected sales.[8] This demand perspective on innovations was a clear break with Schumpeter's supply-side approach,

[5] Nelson (1981, pp. 1035-1052); Nelson and Winter (1982, pp. 210-211); Dosi (1988, 1124-1125, 1131, 1136, 1147, 1150 and 1162); Hanusch and Pyka (2007, pp. 278-279 and 281).

[6] Many of the neo-Schumpeterian ideas have been incorporated by mainstream "new-growth" economists (see Romer, 2011, ch. 3). Neo-Schumpeterians declaring their affiliation to the heterodox camp stress the uncertainties of the innovation process, the paradigm-bound (path-dependent) aspects of technological progress, the emergent property and organizational complexity of large firms and the importance of (national) innovation systems and organizational routines for innovations and productivity (Nelson 1981; Dosi 1988; Dosi et al., 2000; Levinthal, 2006; Hanusch and Pyka, 2007; Hartmann et al., 2008).

[7] Nelson and Winter (1978, pp. 525-541); Nelson (1981, pp. 1060), (1995, pp. 68-729); Nelson and Winter (1982, pp. 2010-212).

[8] Schmookler (1972, pp. 76-77); Nelson (1981, p. 1046); Nelson and Winter (1982, pp. 198 and 250-251); Dosi (1988, pp. 1135, 1139 and 1141).

but it certainly reinforced the opportunity profile of the neo-Schumpeterian analysis. Neo-Schumpeterians have also pointed to the existence of dynamic scale advantages, implying that high aggregate demand will stimulate productivity by inducing investments embodying new technologies (Nelson, 1981, pp. 1046 and 1056).

Neo-Schumpeterian economists are aware of that technological opportunities, dynamic and static increasing returns, self-financing, learning by doing, habits and (other) heuristics may have a path-dependent "lock-in" effect on firm development (Dosi, 1988, pp.1137-1138 and 1146-1148; Hanusch and Pyka, 2007, pp. 277-278). However, they maintain that some learning mechanisms can, for example as a response to new external circumstances, improve the firms' operating routines leading to higher R&D investments and efficiency and even to radical innovation (Zollo and Winter, 2002; Levinthal, 2006, p. 393). This proposition exemplifies the neo-Schumpeterian propensity to despite all play down the possibility that learning may result in dead-end growth paths. It also exemplifies the neo-Schumpeterian reluctance to distinguish between positive and negative external events and to regard low product demand as a favorable condition for improvements in organizational routines (and other innovations) and for the prevention or termination of path-dependent low-growth processes. The neo-Schumpeterians also provide a secluded spot for the idea that stronger competition will encourage innovations by existing firms and reduce the number of dead-end growth trajectories.

The neo-Schumpeterians follow Schumpeter by primarily considering competitive pressure as a consequence rather than a stimulant of innovations.[9] Thus, they generally focus on creative destruction - innovations lead to the abandoning of inferior organizational routines and the

[9] Nelson (1981, pp. 1054 and 1059); Dosi (1988, pp. 1159-1161); Dosi et al. (2000, p. 15).

retardation or elimination of industries and enterprises unable to respond by imitation or own innovation.[10] In fact, the early neo-Schumpeterian literature maintained on both theoretical and empirical grounds that harder competition would *restrict* the amount and efficiency of R&D investments.[11] This conclusion was later qualified by the neo-Schumpeterians themselves emphasizing the high proportion of innovations and technological progress by small (often new) firms in new and technically specialized industries. However, in the neo-Schumpeterian literature, new technological opportunities and initial R&D investments by established (large) firms, possibly based on favorable product-market, financial and organizational conditions, are generally seen as the ultimate driving forces behind innovations and productivity growth. In line with the Nelson-Winter model the degree of competition is mostly endogenous and competition the modus operandi of the innovation process rather than a strategic causal factor.[12] Thus, there is no large scope in neo-Schumpeterian analysis for the hypothesis that low product demand or hard competition from innovative firms will enforce R&D investments and innovations in the economy. Severe external circumstances occupy a central role in neo-Schumpeterian innovation theory particularly in the case of input scarcity (see Section 6.5).

Most neo-Schumpeterians analyze secular economic processes, thus not the business cycle. However, by their emphasis on sale- and profit-induced R&D investments (where high actual profit is both an indication of good prospects and a financial source of investment), scale advantages (especially in R&D activities) and learning effects neo-Schumpeterian theory would expect innovations to move procyclically (cf. Geroski and Walters, 1995). And notwithstanding

[10] As in Schumpeter's work there are few passages in the neo-Schumpeterian literature on the possibility that competitive threats will enforce innovations (Dosi 1988, pp. 1158 and 1161; Zollo and Winter, 2002, p. 343).

[11] Scherer (1984, p. 291); Scherer and Ross (1990, pp. 637, 643 and 652); Scherer (1992, pp. 1420 and 1422).

[12] Nelson (1981, pp. 1051-1052); Dosi (1988, pp. 1141-1142, 1151-1153 and 1157-1163); Dosi et al. (2000, p. 13).

the possibility that the closure of non-innovative firms may be more frequent in recessions and the diffusion of new knowledge delayed, neo-Schumpeterian economists have suggested that productivity growth moves procyclically (cf. Dosi et al., 2005).

Except for the case of intra-firm learning and references to bounded rationality in the analysis of organizational routines the neo-Schumpeterians (as in fact the orthodox Schumpeterians) pay minor interest to the psychology of innovations and productivity changes, thus they follow in the footsteps of "the late" Schumpeter. In neo-Schumpeterian literature technical opportunities, industry and firm structures and networks, organizational designs and procedures and (other) institutional conditions are the hub of the growth process. The neo-Schumpeterian ignorance of psychology is partly be explained by a weak interest in enforced innovations and productivity changes.

4. The neoclassical Schumpeterian theory

When referring to Schumpeter the neoclassical economists primarily seize upon the idea of temporary profits through innovations and the notion of creative destruction (Aghion and Howitt, 2005, p. 272, 2009, p. 16). But they have also been keener than both Schumpeter and the neo-Schumpeterians to develop the idea that negative driving forces in general and harder competitive pressure in particular will lead to the renewal of established firms. In contrast to the neo-Schumpeterians, the neoclassical Schumpeterian economists make a clear distinction between pressures and opportunities, a distinction that largely reflects the difference between positive and negative shocks in mainstream macroeconomics.[13]

[13] By its emphasis on institutions, technological diffusion, innovation-led cumulative and also path-dependent growth processes, of which some are assumed to be dead-end streets, neoclassical Schumpeterian economics have many

Neoclassical Schumpeterians have suggested that stronger competition through trade creates incentives for product differentiation increasing the efficiency of R&D investments (the duplication of R&D activities can be avoided). By depressing profits, foreign competition will, ceteris paribus, lower the stimulus to R&D. But this tendency may the offset by the increasing motives for technological leaders to invest in R&D to keep the distant to technological followers (Helpman, 2004, pp. 65-67). In particular**,** more intense "neck-and-neck" competition will induce duopolists to increase R&D efforts to get ahead of their rivals.[14] In the case of national growth, competition between domestic producers, especially through entry, is more important when the countries have obtained an advanced industrial composition and approached the global technological frontier. At high development levels countries must be good innovators rather than good imitators.[15] Neoclassical Schumpeterians have recently formulated theories in which stronger competition from technological leaders through entry and liberalized trade will stimulate innovations by incumbent firms (Aghion and Howitt, 2005; Aghion et al., 2009; Aghion and Howitt, 2009).

Yet, when modeling the endogenous growth process at the aggregate level the neoclassical Schumpeterians do not focus on negative driving forces and enforced innovations. Like Schumpeter, the neoclassical Schumpeterians stress that initial innovations (possibly based on accumulated knowledge) are made by entrepreneurs rewarded by temporary monopoly profits. The neoclassical Schumpeterians add that innovations are based on R&D investments (with an

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features common to neo-Schumpeterian economics. However, economists in the neoclassical tradition are less likely than the neo-Schumpeterians to focus on firm organization and routines.

[14] Aghion et al. (1997); Aghion and Howitt (1998, pp. 216-229), (2005, pp. 280-281).

[15] Aghion and Howitt (2005, pp. 281-282); Acemoglu et al. (2006); Aghion and Howitt (2009, pp. 249-250).

uncertain outcome) by established firms (Grossman and Helpman, 1991, pp. 6-14 and 334-335) or by entrepreneurs and facilitated by favorable financial conditions (Aghion and Howitt, 2005, pp. 274-278; 2009, pp.15-18, ch. 4 and ch. 6). The neoclassical Schumpeterians also point to the diffusion of new knowledge, especially in their analysis of cross-country convergence (Aghion and Howitt, 2009, ch. 7). Despite the cumulative features of the growth process the neoclassical Schumpeterians are open to the possibility of negative path-dependent processes - countries following a growth strategy based on high (physical) capital intensity, knowledge assimilation and scale advantages are unable to sustain high growth rates when approaching the world (US) technological frontier (Aghion and Howitt, 2005, pp. 276-277).

In the analysis of productivity movements and innovations in the business cycle the neoclassical Schumpeterians are directly concerned with the relative impact of pressures and opportunities. The tendency to procyclical innovations and productivity growth (see the paragraph above) may be offset (ignoring labour hoarding) by countercyclical variations in the use of X-inefficiencies and the elimination of low-productivity firms and plants. A higher frequency of firm closure in a recession may reflect that the degree of competition moves countercyclically. Creative destruction will be intensified in a recession through reductions in entry barriers (Caballero and Hammour, 1994, pp. 1353-1357). Moreover, notwithstanding shrinking financial opportunities, firm-specific training and R&D investments may increase in a recession (Aghion and Howitt 1998, pp. 239-243). Accordingly, the neoclassical Schumpeterians conclude that the movement of innovations and productivity growth over the business cycle is theoretically ambiguous.[16]

[16] The neoclassical Schumpeterians have recently referred to indisputable evidence of a procyclical movement in R&D investments (Aghion and Howitt, 2009, ch. 14).

There are some limitations in the neoclassical Schumpeterian analysis of the causal nexus between pressure and innovations or productivity growth. It does not primarily refer to pressure when explaining why productivity growth moves countercyclically within firms. Training and R&D investments are primarily enhanced in a recession by low opportunity costs and abundant resources, not by low profits.[17] Furthermore, the innovative reaction by incumbent firms to advanced entry and foreign competition is restricted to firms (in industries) close to the technological frontier. Only these firms have any hope of surviving the challenge from newcomers by own innovations.[18] At the same time the neoclassical Schumpeterians endorse, and have actually confirmed in a study of UK industries, the Veblen-Gerschenkron hypothesis that laggards grow faster - a long distance to the technology frontier has a *positive* effect *per se* on productivity growth and also on innovations (the number of patents) (Aghion et al., 2009, pp. 21-31).

The argument by the neoclassical Schumpeterians that the distance to the technological frontier is decisive for the relationship between entry (or foreign competition) and innovations is not obvious. The argument conceals the importance of differences in organization, strategy choices and competences (which may also explain the firms' distance to the technological frontier). And entry can reduce (or even eliminate) the profits also of innovating incumbent firms close to the technological frontier if their innovations are inferior or even equally successful. In the "neck-and-neck" case the neoclassical Schumpeterians admit that stronger competition will reduce the

[17] See Aghion and Howitt (1998, pp. 239-243), Malley and Muscatelli (1999, pp. 339-340) and Barlevy (2004), see also Grossman and Helpman (1991, pp. 152-154 and ch. 9).

[18] Aghion and Howitt (2005, pp. 282-284); Aghion et al. (2009, pp. 20-22); Aghion and Howitt (2009, pp. 277-278).

profits also for innovating incumbents.[19] Besides, neoclassical Schumpeterian models provide weak support for the contention that firms far from the technological frontier make no endeavors to innovate under the threat of entry or harder competition by other reasons.[20] It is not clear why these firms would give up the fight by making no effort to combat the challenges (but somewhat paradoxically will continue to copy new ideas) if they have the same capacities and make the same priorities as firms near the frontier. Empirical studies by the neoclassical Schumpeterians have actually reaffirmed that firms and industries far from the technological frontier will continue to exist despite the profit-depressing effect of actual entries. Finally, to meet stronger competition or other external threats established firms have an array of strategies to increase productivity ranging from radical innovation to rationalization and merger. They can also utilize a competitive advantage to imitate rather than innovate.[21]

To summarize, notwithstanding their emphasis on positive driving forces in the analysis of endogenous growth processes (profit expectations, knowledge accumulation, financial opportunities for R&D and the spread of new technologies), neoclassical Schumpeterians have

[19] Aghion and Howitt (2005, pp. 280-282). The difference between exogenous changes in the competitive pressure and endogenous changes in the degree of competition through innovations is not completely clear in the oligopolistic model under review.

[20] The argument in the neoclassical Schumpeterian theory is that incumbent firms far from the technological frontier will innovate in vain since the frontier is always advancing (Aghion and Howitt, 2005, pp. 283-284). This argument is the same as that in Zeno's paradox of the Turtoise and Achilles – in the race between them the speedy Achilles will never catch up and pass the slow Turtoise that has started earlier. When Achilles approaches the position of the Turtoise, the latter has already moved to a new position. Mathematically the paradox ignores that an infinite number of distances (here between Achilles and the Turtoise) adds up to a finite sum. Thus, laggard companies capable of innovating at a relatively high speed have surely the opportunity to catch up with other companies.

[21] The recommendation by the neoclassical Schumpeterians that countries at high development levels should innovate rather than imitate to sustain high growth rates is controversial, especially in the case of small open countries. In fact, primarily on the basis of implemented innovations (imported knowledge), countries like Sweden and Finland experienced exceptionally high productivity growth in the 1995-2006 period.

creditably pinpointed the role of negative shocks and enforced innovation and productivity increases for firm evolution, thus they are not bounded by the notion of creative destruction. But the restriction to firms and industries near the technological frontier is dubious. A reasonable hypothesis is that established firms in general will react to harder external circumstances by action, for example R&D activities, to increase productivity. The negative effects of stronger external pressure on actual and expected profits may be fully offset by enforced innovations and productivity-enhancing measures if firm actors (ignoring luck) become more alert and creative or compelled to depart less from rational behavior. If the negative effects on profits are *not* neutralized by enforced productivity measures decision makers may still wish to fight back if they are governed by the goal of firm survival (see Section 6.4). The failure by neoclassical Schumpeterian economists to provide convincing explanations for why firm efficiency and renewal are stimulated by strong competitive pressure partly reflects their propensity for analytical reductionism – the firm is not seen as an independent entity in relation to the owners and chief executive officers (CEOs). There are only some ad hoc sentences suggesting that neoclassical economists consider firm survival is a superior goal (Nickell et al., 1997, pp. 784-785; Aghion et al., 2009, p. 209).

Following the mainstream tradition to ignore the effects of varying degrees of competition on firm behavior the neoclassical Schumpeterian economists make few references to psychology and even fewer to neuroscience. Thus, their works illustrate that a prominent role for negative driving forces in the analysis of economic evolution is not necessarily connected with a strong concern for psychological and neural processes. A vagueness characterizes the neoclassical Schumpeterian theory as to whether a potential threat (which always exists in a market economy) is sufficient to increase productivity growth and innovation or if the threat must be manifest. A

sensible psychological hypothesis is that firms will only react to an actual reduction in profits; it is then that actors first become eager to raise productivity and also capable of realizing their ambitions.

5. Universal Darwinism

The adaptation by a population to new external circumstances is central in universal (generalized) Darwinism. Economists applying the Darwinian principles focus on the notion of (natural) selection. According to evolutionary biologists the adaptation to changing environments results in a selection process eliminating the least fitted individuals**.** In a universal Darwinian perspective, firms and industries are also subject to selection. Biologists claim that the selection of individuals and the associated installation of genotypes is not only a function of external circumstances in the past but also conditional for the phenotypic adaptation to current environmental conditions. Accordingly, the selection of firms and industries will ultimately determine the relationship between external threats and innovations or productivity**.** From a universal Darwinian perspective the conclusion by neoclassical neo-Schumpeterians that firms and industries closer to the technological frontier are better fit to meet new entries by innovations and productivity increases is reasonable. But selection may also have generated other firm and industry characteristics facilitating the adaptation to new threats.

In evolutionary biology the concept of retention (replication) defines the composition of species, populations, individual characteristics and underlying genetic endowments that are inherited over time. David Hull's distinction between replicators (fundamentally the genes) and interactors (individuals but also emergent entities) has inspired the Darwinian economists to make a distinction between interacting institutions such as firms and social replicators such as individual

habits, customs, knowledge (for example technological know-how) and routines (cf. Hull, 1980, pp. 317-327 and Hodgson and Knudsen, 2010, p. 35). Furthermore, Darwinian economists emphasize like evolutionary biologists since Darwin the prominence of variation. Selection will reduce but not eliminate variations in a given population. Variation can be maintained by chance or by less severe environmental conditions in some periods and regions. Selection is then associated with the non-survival of the least fitted rather than with the survival of the fittest (den Boer, 1999, pp. 89-90; Mayr, 2004, 31, 113 and 134-138). There are also strong random elements in biological replication leading to gene mutations and new gene combinations and therefore to new variations (Mayr, 2004, pp. 91-92). Economists applying the Darwinian concepts have shed light on the variations that emerge when path-breaking innovations alter the industrial structure and the way of doing business as emphasized by the "young" Schumpeter (cf. Metcalfe, 2002, p. 112 and Hodgson and Knudsen, 2010, pp. 34-36).

There are clear parallels between the universal Darwinian and the neo-Schumpeterian analysis of economic evolution.[22] Also neo-Schumpeterian economists use the concepts of variation, selection and retention (Nelson and Winter, 1982, pp. 9-11). The perception of creative destruction in the Schumpeterian literature is easily interpreted as a natural selection process eliminating the least fitted firms, thus firms with the most inferior technologies, growth strategies, organizations and habits. And Darwinian economists demonstrate in their analysis of ideas, culture and social relations that they share the idea of emergent properties not only with evolutionary biologists (cf. Mayr, 2004, pp. 74-79) but also with the neo-Schumpeterians (Hodgson and Knudsen, 2010, pp. 24-25 and 183-189). The Darwinians emphasize, like the neo-Schumpeterians, the importance of learning by doing and organizational routines in their analysis

[22] Hodgson (2002, p. 270); Hodgson and Knudsen (2010, pp. 40, 86, 106-108 and 178-179).

of social retention and endogenous evolutionary processes. Moreover neo-Schumpeterians and universal Darwinians alike suggest that endogenous processes may lead to path-dependent outcomes that are globally inefficient.[23] And notwithstanding their common reference to path dependent processes (and to Veblen's notion of imbecile institutions), both Darwinian and neo-Schumpeterian economists have a tendency to eventually associate the accumulation of knowledge, cognitive skills and institutions (including attitudes and ideas) with social progress, thus to focus on good rather than bad habits, customs, routines, etc and on virtuous rather than vicious growth circles (Hodgson and Knudsen, 2010, ch. 8). In their analysis of the basic forces behind economic evolution the universal Darwinians are less specific than the neo-Schumpeterians emphasizing the importance of technological opportunities and R&D investments by established companies. If the Darwinian economists have to define the external forces triggering a productivity increase they would probably refer to the chance of innovations because of firm heterogeneity and to new external circumstances eliciting new responses from existing firms (cf. Hodgson and Knudsen, 2010, pp. 54, 115 and 121).

Like the neo-Schumpeterians the universal Darwinians make no explicit distinction between positive and negative external circumstances. In their formal and empirical analysis of evolutionary processes biologists do consider the possibility of weak selection pressure. External circumstances can be favorable to a specific generation or even across several generations. But evolutionary biologists maintain that selection pressures will reemerge through endogenous population growth. In Malthusian terms, the least adapted individuals will not survive the stronger competitive pressure when the population grows in relation to available resources. Besides, weak selection pressure is not necessarily destructive for evolution according to

[23] Metcalfe (2002, pp. 124-125); Hodgson and Knudsen (2010, pp. 20, 36-37, 87-88, 91-92, 150 and 218-221).

biologists. The lack of serious external threats is associated with high genetic diversity allowing gene combinations that open completely new routes of development (den Boer, 1999; Reid, 2008). In economic terms, beneficial external conditions may create a large pool of heterogeneous firms increasing the chance of radical inventions and innovations.

But we should not too hastily draw the conclusion, by reference to evolutionary biology, that the distinction between positive and negative driving forces is not constructive in economic analysis or that economic (or biological) evolution cannot be obstructed by favorable external circumstances. The open Darwinian perspective does not rule out that evolution is subdued by easy external circumstances if the positive effects of larger variations are offset by the negative effects of weaker competitive pressure. Moreover, stronger selection pressure when competition is tightened in the wake of an (endogenous) population increase is often a prolonged process beyond the time perspectives of social science and sometimes even of evolutionary biology. Easy external conditions may select individuals and institutions that are less adaptive and innovative provided the induced population increase is delayed or neutralized for some reason. The extinction of the Neanderthals illustrates that evolution can be hampered by the combination of a weak selection pressure, low genetic and individual variation and a slow endogenous increase in the population.

In the analysis of the disappearance of the Neanderthals 24 000-28 000 years ago the dominant explanation among biologists today is that they faced hard competition from modern humans with anatomic advantages and better diets (Roebroeks, 2008; Banks et al., 2008; Hublin, 2009). The large energy constraints made the Neanderthals less mobile and innovative than modern humans. New research indicates however that most European Neanderthals died off as early as

50 000 years ago, thus well before the appearance of modern humans, because of colder climate (Dalén et al., 2012). In any case, the crucial question is why the Neanderthals did not adapt to the new challenges. A plausible answer is that selective pressure on the Neanderthals was weak for a long time. Small and isolated populations lead to modest genetic drift but also to low competitive pressure. Further, natural selection pressure was weak because of stable climate and favorable geographic and vegetation conditions. The Neanderthalian combination of low genetic variation and weak selection pressure (slowing down the replacement of less fit traits) impaired the development of complex technologies to handle costly resources more efficiently and ward off potential external threats (cf. Finlayson et al., 2006, pp. 852; Roebroeks, 2008, p. 920; Hublin, 2009, p. 16022). The Neanderthals actually managed, partly under the threat or influence from modern humans, to develop stone tool technologies, social cultures and perhaps also a primitive language (Noonan, 2010, p. 548). However, the associated accumulation of knowledge and cognitive skills and the underlying biological selection process was too slow and incomplete to prevent their extinction or assimilation (Finlayson et al., 2006, pp. 850-851).

The Neanderthal story of punctuated equilibrium does not unconditionally support the hypothesis that human progress is stimulated by negative external circumstances. The superiority of modern humans was explained by a complex cumulative process shaped by interaction between genetic, cultural and environmental factors, a process where both opportunity and pressure factors are involved. But the Neanderthal case illustrates that the pressure-opportunity dichotomy is a constructive tool in the analysis of human developments and more specifically, that easy external conditions can obstruct the selection process.

Despite their reluctance to separate negative from positive external conditions the universal Darwinians focus mostly on negative external events when illustrating their theoretical approach. Their main ambition here is to illuminate the natural selection of species and institutions, not changes in human behavior in the phenotype dimension. However, when scrutinizing the importance of external threats for the productivity of existing firms it is more legitimate to refer to phenotypic adaptation and to Darwin's notion of the struggle for existence rather than to natural selection. The argument that economic evolution is stimulated by unfavorable external conditions is strengthened by an analysis of phenotypes. A given population is likely to react differently to positive and negative external circumstances. A plausible hypothesis is that negative shocks are more effective than positive shocks and also than endogenous knowledge accumulation processes in generating innovative responses and also in creating adaptive organizations, skills, customs and individual habits. Negative events may also be more effective than positive events in breaking with a path-dependent cumulative development leading to suboptimal social outcomes. A reasonable idea is that negative events will enlarge modern humans' potential for storing information, making calculations and being flexible and creative instead of falling back upon instincts, including an unreflective sense of living in the present, crude decision rules, inflexibility and uninventiveness characteristic for our ancestors and other primates.

The Darwinian adaptation approach is well suited to analysis of economic growth and the business cycle in terms of positive and negative driving forces. The concept of the struggle for existence is highly relevant to the impact of negative driving forces in the phenotype dimension. Besides, by the emphasis on emergent properties, the Darwinians provide, like the neo-Schumpeterian organizational approach, a pivotal role for companies as an interacting entity for

replication (Hodgson and Knudsen, 2010, 24-26 and 141). Actors may fight for the survival of an established company even with pessimistic expectations of future profits. Finally, the Darwinian naturalistic ontology, not shared by the neo-Schumpeterians, makes it plausible to explain the adjustment by firm actors to new external circumstances by fundamental cognitive and emotional characteristics. The ontological statement in universal Darwinism that human intentions should not be taken for granted but be explained, especially by analyzing their formation in the psyche, comes near the idea of bounded rationality (Hodgson, 2002, pp. 268-269 and 274).

Studies of the interaction between biological and social evolutionary processes within the universal Darwinian research program do not exclude separate inquiries into individual psychological mechanisms or the impact of basic genetic endowments. On the contrary, a naturalistic analysis of the importance human genetic and psychological factors is perhaps the most salient Darwinian contribution to the analysis of economic evolution, particularly in light of insights by the neo-Schumpeterians (cf. Witt, 2008, pp. 548, 550 and 564). However, the few references to psychology and neuroscience, together with the meta-theoretical perspective and the focus on natural selection (rather than on the struggle for existence), have hitherto obstructed an analysis of industrial growth and the business cycle in the universal Darwinian tradition.

Table 1 summarizes the main driving force, reinforcing mechanism and pressure mechanism (creative destruction or enforced changes) behind innovations and productivity increases, the cyclical movement in innovation and productivity growth and the place of psychological factors in the Schumpeterian and Darwinian literature. It also gives a brief presentation of the TTP in similar terms.

Table 1: The determinants of innovation and productivity growth in Schumpeterian Economics, universal Darwinism and the theory of transformation pressure

	Main driving force	Main reinforcing mechanism	Main pressure mechanism	Cyclicality	Psychological factors
Schumpeter	Entrepreunerial new firms	Enlarged opportunities (knowledge spillover effects)	Liquidation and external structural change through innovations (creative destruction)	Procyclical innovations, ambiguous movement in productivity growth	Sociological (TED), reinforing, not basic (BC) or missing (CSD)*
Neo-Schumpeterian theory	New technological opportunities and R&D investments by established firms	Enlarged opportunities (learning-by-doing, knowledge spillover effects, financial endowments and scale advantages)	Creative destruction	Procyclical innovations and productivity growth	Almost missing
Neoclassical Schumpeterian theory	R&D investments by entrepreneurs or established firms	Enlarged opportunities (knowledge spillover effects) and enforced productivity increases and innovations (in advanced industries)	Both creative destruction and enforced productivity increases and innovations	Ambiguous movement in productivity growth and innovations	Missing
Universal Darwinism	New external circumstances and firm variation (leading to innovations)	Knowledge accumulation (habits through learning-by-doing, etc)	Natural selection (creative destruction)	Not defined	Potential for psychological and neuro-scientific explanations
Theory of transformation pressure	Actual decline in profits	Overreaction	Enforced productivity increases and possibly also innovations	Countercyclical productivity and possibly countercyclical innovations	Basic human drives

* References to Schumpeter's main works, TED – *The Theory of Economic Development* (1962), BC – *Business Cycles* (1939), CSD - *Capitalism, Socialism and Democracy* (1976).

6. The theory of transformation pressure

6.1 The priority of firm survival

Productivity increases within established firms are more important components of national productivity growth than entries, exits and changes in the industrial composition (World Bank, 2008, ch. 3). This conclusion does not deny that surviving new firms display high productivity

growth, probably reflecting a selection and learning process, and that entry may stimulate the productivity of established firms. The basic idea in the unqualified TTP is that the productivity of established firms is enhanced by fierce competition, demand saturation (or qualified demand) and negative supply shocks. The theory includes the possibility that firms' investment to improve their own productivity performance will increase in periods of tougher external circumstances.

A conjecture that investment is promoted by negative shocks is controversial in economics. Tougher external circumstances will reduce actual and expected profits having a negative effect on the net present value of investment. The TTP takes for granted that aggregate physical investment will be restricted by negative shocks and that this investment accordingly moves procyclically. But it maintains that investments aimed at transforming the firm (for example R&D investment) may be stimulated by negative events. The actors' confidence in enforced investments to enhance the firm's productivity can neutralize the negative effects of negative external events on investment. What is more, the TTP does not exclude that an established firm may be willing to meet an external challenge by investments in order to transform the firm even if net present values are negative.

It is not obvious that firm actors will invest if net present values are negative. The owners always have the opportunity to invest in other firms and other assets than equity. And the CEOs probably have other employment options and should therefore have no particular loyalty towards a specific firm. The readiness to invest in an established firm can be questioned even in the cases where firm actors have great hopes of being able to maintain or even increase the firm's profit despite a serious external threat. It is not evident that they will mobilize all their efforts and skills to upgrade the firm where they are (strategic) owners and employees at the moment. For example, it

can be disputed that owners are always prepared to be engaged in activities intended to transform a firm specializing in maturing markets.

The TTP considers the survival of an established firm as a superior goal. In this perspective the firm is an independent entity in relation to the current CEOs and owners, thus it is more than the sum of the individual interests. Firm-specific competences and even emotions may explain why both managers and major owners give priority to the survival of the firm. In addition new managers and owners are supposed to be attracted by (and willing to adjust to) the culture and goals of an established firm. At the same time the interests of the firm must coincide, or at least not conflict, with the interests of the actors. The prestige, career and expected incomes of the managers in particular are closely related to the survival of the established firm where they are currently employed.

Notwithstanding the possibility that some investment extending the life of the firm may be unprofitable (both ex ante and ex post) the goals of firm survival and profit maximization will generally coincide. Furthermore, the TTP downplays the goal conflict between profit maximization and other priorities than firm survival. The theory puts doubt on the hypothesis in the X-inefficiency literature that "utility-maximizing" managers may depart from profit maximization if the firm is facing (or expecting) favorable profit conditions (see De Alessi, 1983 and Hermalin, 1992). Agent laziness in good times could be a threat to the firm's long-run profit and existence and therefore to the managers' comfort and incomes even in their current employment (Erixon, 2007, pp. 332-333). Arrangements must often be made in good times to sustain profitability and increase the chance of firm survival. But the TTP holds that firms will only react to an external challenge associated with a decline in *actual* profits.

6.2 The priority of current profits

The central role of current profits in the TTP is not explained by the difficulties in constructing a valid and reliable measure of external shocks or expected profits. The TTP simply assumes that a current increase in profits has a decisive impact on the investment and growth policies of established firms. And it suggests that a decline in actual profits, whatever its origin, will induce actors to reduce (or give up) their obsessive concern with current outcomes. Irrational actors make no conscious calculations to maximize profits or to satisfy their ultimate goal of firm survival. Instead, they are governed by heuristic cognitive rules and by emotions (instincts) obstructing rather than underpinning the decision process. In the TTP a current decline in profits is necessary to induce firms to make investments and strategy choices on rational grounds. The theory does not preclude the possibility that the profit fall may be temporary and modest, that is, no threat to the long-run profitability and survival of the firm. One possible consequence of a recent reduction of profits is that actors will then start collecting and processing information to find out whether the reduction in profits is temporary or permanent and, further, whether it reflects firm-specific or external circumstances.

A rational motive for first responding to an actual change in profits is provided by the option theory of investment under risk – by waiting, firms can attain more information about the extent and character of possible threats and opportunities (cf. Dixit and Pindyck, 1994, pp. 85 and 173). However, in this theory, and also in Robert Lucas's rational expectation theory of adaptive learning, profit expectations are based on profit observations during a long period, thus making it possible to differentiate between temporary and long-run changes (Lucas, 1986, S414-416). In contrast, the TTP suggests that recent profit development has strong weight when firms make up their investment and strategy plans. An actual reduction in profits works as an alarm clock

inducing the decision makers to become more rational although there is risk of overreaction because of a lingering propensity to respond to only actual outcomes.

The hypothesis that firms will not react to external threats until they appear does not depend on any specific assumption about risk and uncertainty. When (the probabilities of) future outcomes are relatively easy to predict, firms are supposed to ignore available information until the day of an actual fall in profits. In the case of genuine (Keynesian-Knightian) uncertainty firms cannot gain any reliable information by waiting until a specific threat has been realized. Yet, in the TTP, decision makers will first react to threats when observing an actual fall in profits. And they will not make any preparations in advance to meet genuinely unexpected negative events, for example, by extending the pool of investment alternatives or by taking precautions to increase flexibility.

The idea that decisions on investment and growth strategies are determined by current outcomes is not new in macroeconomics (see the theory of static or backward-looking expectations). But macroeconomists seldom refer to the underlying psychology. The importance of current profits may reflect that firm actors are governed by heuristic decision rules. People following *the peak-end rule* consider recent and exceptional events only (Kahneman, 2003; Do et al., 2008; Rubert and Wolford, 2008). Moreover, the impact of current profits on firm decisions can reflect the impact of *historical relativism*. The opinion that history is irrelevant can be seen as an heuristic rule but also as an expression of an emotional state characterized by a propensity to live in the present (cf. Shiller, 2001, pp. 1325-1328). By giving priority to current outcomes firm actors will strongly react to increases (or decreases) in actual profits, especially (see the peak-end rule) if the

upswing (downswing) results in a profit boom (depression). What is more, firm actors governed by current outcomes may even *extend* their use of heuristic rules in times of increasing profits.[24]

The prominence of current outcomes also conditions the emergence or strengthening of an *overconfident* (*underconfident*) attitude among firm actors in periods of increasing (decreasing) profits. Psychologists claim that overconfidence is common and will not be corrected by learning or by experts when predictability is low (thus when signals are ambiguous), as in financial markets and also in the non-financial business sector.[25] In psychology the degree of overconfidence is usually measured by Bayesian statistics. However difficulties in obtaining (more) accurate information about probabilities when the future is genuinely uncertain compel us to define overconfidence in terms of a specific mental state. In periods of increasing profits decision makers intoxicated by success will lose their sense of proportion when evaluating the profit prospects of a certain growth strategy or of the firm itself. CEOs and owners will also lose their sense of proportion when assessing their own skill and capability, for example to avert possible threats to the firm in the future.

[24] Adherents to "old" (Veblenian) institutional economics have suggested that heuristic rules and other expressions of bounded rationality are reasonable, reflecting a limited capability to identify, store and process information and to calculate and engage emotionally in deliberate decision making (Hodgson, 2007; Pagano, 2007). In line with this approach some psychologists have seen the use of heuristic rules as a strategy (often unconscious) to free people from the time-consuming and unpleasant task of maximizing (expected) utility (Shah and Oppenheimer, 2008). The TTP emphasizes, in line with Tversky and Kahneman (1974, 1986) and Leibenstein (1979, 1985), that heuristic decisions are irrational. The actors' focus on current outcomes and status-quo options in periods of increasing profits (see next section) is a threat to long-run profits and survival of the firm. However the TTP does not deny that external pressure will induce actors to switch from one heuristic principle to another increasing the chance of firm survival (see Section 6.4).

[25] In the case of CEO overconfidence, see Goel and Thakor (2008, pp. 2737-2741), DellaVigna (2009, pp. 342-343) and Galasso and Simcoe (2010, pp. 3-4).

Thus, in the TTP, a recent increase in profits has a strong impact on the investment and strategy of established firms governed by the peak-end rule and historical relativism. The salience of current outcomes is also contingent upon the appearance of overconfidence in periods of rising profits. The next section will argue that these psychological phenomena will lead not only to overinvestment but also to a choice or consolidation of a status-quo oriented growth strategy in a profit recovery.

6.3 The preference for the status quo

The TTP assumes that an increase in current profits has a decisively positive impact on investment by established firms. Thus, firms governed by myopic heuristic rules and emotions and suffering from overconfidence will spontaneously increase their investment as a response to a recent increase in profits. But more importantly, the TTP suggests that firms in a profit recovery will stick to their old technologies, products and organizations and particularly resist a radical transformation. Actors are then supposed to ignore or misread information about potential threats and historical profit trends challenging the status quo. And actors benefitting from a recent increase in profits are assumed to take fewer steps to search for and exploit investment and other opportunities aimed at transforming the company. The theory even provides room for the possibility that investment aimed at transforming the firm (for example R&D investments) will *decrease* in a profit recovery (see Section 6.1).

The proposition in the TTP that the psychology of good times is detrimental to transformation is not evident. It could be argued that overconfident and myopic actors blinded by the light of high current profits prefer a more radical and perhaps also riskier strategy. And overconfident CEOs may be more innovative (cf. Galasso and Simcoe, 2010). In the TTP, old firms will expand along established lines in a profit recovery because of a fundamental *status-quo bias.* This hypothesis is

supported by the psychological literature about a *confirmatory (myside) bias*. Suffering from a confirmatory bias both laymen and experts will underreact to (or even ignore) information rejecting an already chosen alternative and overreact to information verifying the chosen option. Some encouraging observations of higher profits may create or strengthen overconfidence in the current strategy given a confirmatory bias. Actors in established firms may then also become overconfident in their ability to ward off external threats when they appear (see Rabin and Schrag, 1999, Suen 2004 and Stanovich and West, 2006). The TTP adds that a confirmatory bias may be strengthened or even created in periods of increasing profits.

A status-quo bias can also reflect *hyperbolic discounting* (O'Donoghue and Rabin, 1999; Angeletos et al., 2001). Actors will postpone rationalizations and the introduction of new technologies, products and organizations if they are overwhelmed by short-term sacrifices and displeasures when approaching the day of action (Erixon, 2007, pp. 337-338). Neuroscience confirms that different brain activation processes are involved in the evaluation of immediate and delayed rewards namely the limbic and paralimbic cortial regions and the fronto-parietal regions respectively (Loewenstein et al., 2008, pp. 658-661; Wittmann et al., 2010). Moreover, a preference for the status quo can emanate from *habitual behavior*. Investment along a well-known path may reflect the development of learning-by-doing processes and organizational routines favorable to the productivity performance of individual firms and also for the society at large. But habits can simply reflect the obstinate use of heuristic rules and strong conservative emotions. Finally, a status-quo bias can be explained by *indecisiveness*. Firm actors' inability to make a choice may reflect a major affective deficit in rational calculation (Camerer et al, 2005, p. 29) or a stalemate between parallel decision processes (Spiegler, 2008, p. 518). A sensible

hypothesis is that the habitual behavior and indecisiveness working against a transformation will be strengthened in periods of increasing profits.[26]

6.4 Waken up by the alarm clock

The TTP suggests that firms become (more) rational when experiencing a sudden decline in profits. Fearing a substantial reduction in profits and even the possibility that the survival of the firm is at stake managers and owners will then intensify their search for and compilation of relevant information, including about alternative investment strategies, production slacks within the firm, historical profit developments and possible threats in the future. More rational actors will reduce the use of rules of thumb based on unreflective repetition and current outcomes weakening the impact of the peak-end rule and historical relativism. In neuroscientific terms unexpected explicit challenges will interrupt an automatic brain process favoring a more controlled process (see Camerer et al., 2005, p. 18). The TTP suggests that firms that are no longer (or to a lesser degree) driven by heuristic rules will undertake measures to increase productivity and perhaps also be more innovative.

Furthermore, in the TTP, a profit fall will disfavor a status-quo position by mitigating or even eliminating actors' overconfident belief in their own capacity to conquer external threats when they first show up and also in the profit prospects of their current growth strategy. A decline in profits is also supposed to alleviate a status-quo bias among firm actors by curing indecisiveness, weakening hyperbolic discounting and reducing conservative thinking. Thus, fewer psychological

[26] A status-quo bias is not explained above by ambiguity, regret or loss aversion. In fact, a status-quo strategy may have the most ambiguous outcomes and also the outcomes with the most likely losses.

anomalies are expected in the TTP to induce measures in established firms improving their productivity and maybe also their innovative performance.

The TTP comprises the possibility that firm actors will underreact to an actual decline in profits. The profit fall may not be sufficiently strong to eliminate overconfidence in the status quo in the eyes of a Bayesian observer or a neurologist. Furthermore, firms may have to face a substantial or long-lasting external challenge to combat the destructive influence of bad habits, indecisiveness and hyperbolic discounting. But the (unqualified) TTP also permits firm actors to overreact to a profit decline on psychological grounds (see Massey and Wu, 2005). By overreacting to a few discouraging observations of profits (the strength of evidence) actors may make too a drastic strategy change. Neuroscience confirms that people's response to new information can be abrupt and dramatic (Camerer et al., 2005, p. 25). Completely rational firms would perhaps have stuck to a growth strategy without any transformation at all (a case excluded from the TTP) or switched to a status-quo oriented growth strategy without any radical change in product composition, technology or organization. The readiness of actors to quit a status-quo strategy after a profit fall may reflect the persistent impact of current outcomes, thus the firms are still governed by the peak-end rule and historical relativism. A profit decline may also change attitudes to status-quo from overconfidence to underconfidence. Actors who earlier had been self-deceptive about their own judgments and capabilities will not become more sober and self-knowing but instead be seized with panic and feelings of inferiority leading to too little confidence in business as usual and in their own ability.

When analyzing the reaction by people to external pressure psychologists primarily focus on the effects of time pressure. Psychologists often make a distinction here between the effects on

alertness, decision quality and risk taking (see Payne et al., 1993). Psychological experiments generally demonstrate that people under time pressure will be more alert (anxious) but at the same time make poorer decisions and *extend* their use of heuristic rules. The need for quick decisions will, for example, increase encoding, that is reduce the number of information sources and exclude a systematic evaluation of each source (see the literature survey in Erixon, 2007, pp. 336-338 and 340). The quality of decisions under time pressure is mainly measured in psychological experiments by the capacity of people to solve some (often mathematical) problem, follow Bayes's rule or maximize (expected) utility (or the underlying axioms) in games with well-defined payoffs.

The general conclusion that people make decisions of lower quality and enlarge their use of heuristic rules under time pressure is a challenge to the TTP. But the duality between alertness and quality in psychology is not obvious in economics. For example, both the neo-Schumpeterian theory and the TTP suggest that stronger effort will reduce the gap between potential and actual productivity and perhaps also extend productivity potential per se. And more importantly, the general conclusion about a trade-off between effort and quality is rejected by many psychological studies showing that the quality of decisions will *improve* under time pressure (see Maule et al., 2000, p. 284, Drach-Zahavy and Erez, 2002 and Goodie and Crooks, 2004). For example, Svenson and Benson III (1993) maintain that framing effects (see the prospect theory) are weaker under time pressure. Psychological experiments have further demonstrated that time pressure will lead to more exchange of information within groups and to filtration (selection), a lexicographic heuristic process with a stronger concentration on informative (valenced) facts (Kelly and Loving, 2004, p. 197). Experiments have also confirmed that filtration under time pressure leads to a greater concern for potential threats and to intensified search for information about possible

negative outcomes (Huber and Kuntz, 2007, p. 418). Time pressure may even induce a negative emotional state leading to more controlled and less heuristic decision processes (Dunegan, 1993; Huber and Kuntz, 2007). The TTP interpretation of the results from psychological studies of behavior under stress is that firm actors will be more alert and also more deliberately concerned about potential threats and their consequences when the firm is exposed to a real external pressure. This reaction is supposed to favor a transformation of the firm although the higher arousal level (and the possible overemphasis on negative events) may induce actors to overreact, and thus to transform notwithstanding that a profit decline is no signal that the firm's existence is in danger.[27]

On the other hand, the psychological experiments showing that people under time pressure will heuristically limit their search for information and time spent on each information source suggest that firms will *underreact* to an external challenge. The conjecture that firms prefer a defensive transformation strategy under pressure is endorsed by experiments demonstrating that people under stress make stereotypical choices, reduce their openness to alternative strategies and focus on one problem-solving strategy.[28] However, the TTP allows that transforming firms in periods of falling actual profits may give priority to rationalization, mergers, acquisitions and only relatively minor changes in technologies, product compositions and organization rather than radical changes. Cautious transformation can indicate that firms are still suffering from

[27] It can be questioned that the literature on time pressure is relevant in the case of TTP. The analogy is based on the reasonable idea that actors become stressed by the threat of firm closure. But stress among firm actors is also a common ailment in periods with high product demand, thus in periods of easy external circumstances and high actual profits.

[28] See the literature survey in Erixon (2007, p. 341) and also in Byron et al. (2010, p. 202) and Huntsinger (2012, pp. 1-2). However, there are psychological studies showing that the change in decision rules under time pressure will result in more radical strategy changes (see Maule et al., 2000, p. 285).

overconfidence and other psychological biases favoring a status-quo oriented option (see above). But also fully rational actors may avoid a radical transformation when the firm is under external pressure. For instance, firms facing a threat to their existence in a recession because of imperfect capital markets will probably take action generating immediate profits. The hypothesis that firms take minor rather than radical steps to increase productivity in a profit recession is also supported by psychological experiments indicating that time pressure makes people more risk averse.[29]

6.5 Being creative under pressure

In the TTP firm actors are supposed to be less prone to follow static heuristic rules and less swamped by overwhelming emotions favoring the status quo when facing an actual decline in profits. But the theory also suggests that actors will then become more capable of creating and adjusting to new ideas. The phrase that necessity is the mother of invention captures the notion that harder external circumstances make people more innovative, or at least more able to discover and combine the insights by others. The idea of enlarged abilities among firm actors in bad times is akin to, and difficult to separate in practice from, the hypothesis that actors will be more alert and rational in periods of falling profits. A higher arousal level may be a necessary condition for a positive relationship between external pressure and creative thinking (see Byron et al., 2010, p. 202). But the TTP presupposes that hard external circumstances will affect the skill and creativity of firm actors whether they become more alert or not.

In standard neoclassical equilibrium models increases in factor prices will influence the combination of inputs and the character of new technologies. But the model does not say (without

[29] See Erixon (2007, p. 337) and Huber and Kuntz (2007, p. 423). As usual there are exceptions to the rule, see Davis et al. (1992, pp. 189-191), Mann (1992, pp. 201-202), Edland and Svenson (1993, pp. 30-33) and Maule et al. (2000, pp. 291-293 and 297-298).

some ad hoc assumptions) that higher input prices can stimulate the capacities and efforts of managers and owners and create a competitive advantage. Neo-Schumpeterian economists maintain that cost pressure may intensify the firms' search for new technologies, products and organization (cf. Zollo and Winter, 2002, p. 341). The neo-Schumpeterians have also incorporated the idea that higher (relative) factor prices, growing resource scarcity and regulations will stimulate the *development* of new technologies and innovations (Nelson and Winter, 1982, pp. 185-186; Dosi, 1988, pp. 1140-1148). The TTP takes this a step further by maintaining that higher factor prices and growing input scarcity may enhance technological progress and innovation by the associated decline in profits. And the TTP further assumes that the cognitive skill of firm actors will be enhanced by all kinds of pressure, thus not only by higher input prices.

It is difficult to disentangle the effects of variations in creativity and skill on individual behavior by laboratory experiments. Evolutionary games have shown that people may increase their ability to anticipate the actions by others and also learn by old mistakes. However, these games shed light on learning by doing, not on learning by hardship. Psychologists have conducted field studies of the relationship between time pressure and creativity and neuroscientists have used their brain imaging methods to distinguish whether better individual performance under external pressure reflects people becoming more alert and rational or more able to use and extend their memory capacity (see Section 8).

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Macroeconomics can be enriched by the TTP hypothesis that firm actors are strengthened by disrupting events and negative experiences. The catch-up literature emphasizes the possibility of copying foreign technologies and the high marginal productivity of capital at low development

levels. Thus, catch up is not explained by the possibility that political unrest, depressions, social trauma, natural catastrophes and wars make the population more creative and capable. The TTP may offer a possible explanation for why the countries defeated in World War II displayed a high per capita growth 1950-1973 in comparison with the 1913-1950 period and also in comparison with other countries (cf. Ferguson, 2007, pp. 121-122). The explanations representing the TTP encompass both the idea that devastating experiences are growth-enhancing by making people more creative and skilful and the pertinent idea in the previous section that such experiences will stimulate growth by challenging established organizations, habits and technologies (cf. Olsen, 1982; Hodgson, 1991).

7. Testing the theory of transformation pressure

Industrial studies of the impact of competitive pressure and regulations on R&D investments, innovations and productivity are highly relevant when assessing the validity of the TTP. Equally relevant are the studies in macroeconomics of the cyclical pattern of productivity growth and the relationship between exchange rates, investment and output. In fact, the TTP was developed in a period when some economists and politicians accused the devaluations in Sweden in the early 1980s of having delayed structural change and the renewal of firms and industries in the exposed sector (Erixon, 1991, pp. 353-356). This section surveys the results from studies of the effects of devaluations on investment and output. It will also recapitulate the results from a Swedish study scrutinizing the relationship between actual profits and productivity growth in the exposed sector. Finally the section summarizes the results from an experiment testing the TTP hypothesis that firms have a status-quo bias in periods of increasing profits because of bounded rationality.

Evidence from quantitative studies of the nexus between devaluations or depreciations and investments or GDP (GNI) per capita (in the short or long run) is mixed**;** most studies are concerned with developing countries**.** This ambiguity also applies to studies of lagged and cointegrated relationships.[30] Recent studies of developing countries have supported the argument that a weak currency is favorable to investment and per capita GDP growth.[31] However, inquiries into the possible harmful effects of depreciations on output and investment have focused on changes in the terms of trade, aggregate consumption (through changes in functional income distribution and real wealth), real interest rates, exchange-rate volatility (leading to uncertainty), foreign debt, nominal wages and prices of imported intermediates (Servén and Solimano, 1992, pp. 102-105; Servén, 2003; Ould-Mey, 2003). Thus, the literature under review does not consider the possible negative influence of devaluations and depreciations on productivity growth and innovation in the exposed sector. Some macroeconomists refer to a relationship between exchange rates, productivity growth and innovation (Paul 2006; Gala, 2007). But the underpinning theory is that depreciations or devaluations, by eliciting a profit boost in the exposed sector, will stimulate R&D investment or physical investment in a sector with large scale advantages and technological spillover effects. Besides, per capita GDP growth is still the dependent variable in the empirical analysis excluding a careful assessment of the effects of exchange rates on productivity and innovation.

A regression study based on data for 75 industries could not prove that the Swedish devaluations in the 1980s were harmful for (labor) productivity growth in manufacturing (approximating the

[30] See the literature surveys and empirical studies in Yiheyis (2006, pp. 23 and 30-32), Narayan and Narayan (2007, pp. 2591-2592) and Ratha (2010, pp. 2-3).

[31] Narayan and Narayan (2007, pp. 2594-2595); Gala (2008, pp. 283-286); Ratha (2010, pp. 6-7).

exposed sector). But nor was it possible to confirm the alternative hypothesis that the devaluations had been favorable to productivity growth (Erixon, 1991, pp. 345-348). The TTP hypothesis concerning a negative relationship actual profits and productivity growth was directly tested by a time series analysis (annual data) of Swedish manufacturing. The lagged negative relationships were actually stronger than the contemporaneous positive relationship in the 1954-1987 period. The negative TTP relationship between actual profits (different measures) and (labor) productivity was also confirmed for strategic export industries within manufacturing. However, falling profits were not the most important factor behind the postwar decline in productivity growth in Swedish manufacturing in the period under review (Erixon, 1991, pp. 351-356).

An experimental role play was conducted at Stockholm University on two occasions, Autumn 2009 and 2010, to shed light on the strategy choices and underlying psychological mechanisms in the TTP (Erixon and Johannesson, 2012). The experiment enrolled 136 first-semester students in macroeconomics (85 and 51 students respectively). The participants were asked to answer nine questions about investment, strategies and the underlying motives and psychological biases when acting as CEOs for an established company (more than twenty years old). The prime aim of the experiment was to test the TTP hypothesis that firms have a preference for status quo in periods of increasing profits and will first transform when their actual profits begin to fall. The students had the opportunity to choose between three growth strategies under varying profit conditions, a pure status-quo growth strategy without any transformation at all, a status-quo oriented transformation with rationalization and minor changes in technologies, products and organization and a radical transformation constituted by major changes in technologies, products and organization. The study was based on the psychological theories above, including that firms will

be more rational but possibly overreact in response to an actual fall in profits. The students were told that there were no financial restraints on firms' investment.

A specific object of the study was to investigate whether the students acting as CEOs became more status-quo oriented if an increase in profits during a couple of years turned into a profit boom with exceptionally high profits. The peak-end rule emphasizes the importance of exceptional events. The use of heuristic decision rules may also be extended in a profit boom. Moreover, the students were supposed to react faster to an actual profit decline if the firm had previously experienced a profit boom. Managers who chose only a specific status-quo option in a profit boom were expected to be less confident in this option and would therefore quickly upgrade their growth strategy when experiencing a profit fall.

Some questions in the role play had the intention to uncover the students' own view ex post of the psychological mechanism behind a certain strategy. The students could choose between several psychological explanations for their reaction to a specific change in current profits. However there were also opportunities for the participants to answer in accordance with consistently rational behavior. For example, a propensity to postpone a reaction until an expected threat is manifest (until profit actually falls) can reflect decision makers' wish to base their investment and strategy decisions on more information (see for example the option theory of investment under risk). In the TTP, the delayed reaction to a threat reflects the possibility that an actual profit decline serves as an alarm clock, not that the CEOs will then have a more solid ground for their decisions.

The sequential design of the role play made it possible to follow each student's strategy choices when profit varied over time (there was no possibility to revise the answers on earlier questions). For instance, we could distinguish whether any difference in the students' strategy during a profit boom and a normal increase in profits was decisive for their inducement to transform after a profit decline. Furthermore the sequential approach made it possible to identify whether the students' strategy choices and reported motives reflected consistent rationality, bounded rationality (in line with the TTP) or complete inconsistency.

The results from the two experiments were very similar notwithstanding the difference in time (one year). Thus it seems that the study succeeded in capturing some stable psychological mechanisms. The role play has only partially borne out the hypothesis that managers will switch to (more) transformation when the firm is hit by a profit decline after a couple of years with increasing profits. The students who had chosen a pure status-quo strategy during the upswing switched to one of the transformation alternatives after an actual decline in profits. On the other hand, the students who earlier had preferred a status-quo oriented transformation did not opt for a radical transformation when profits fell. The experiment supported the hypothesis that firm actors are more status-quo minded in a profit boom than in the normal profit recovery. But this behavior pattern was not decisive for the students' reaction to the following profit decline. Furthermore, most students legitimized their strategy choices ex post by reference to rational considerations. But the test for inconsistent behavior cast doubt on the assumption of consistently rational behavior. It actually provided strong support for the TTP hypothesis about bounded rationality. To summarize, our sequential experiment verified the assumption of selective rationality but only partly the specific hypotheses about strategy choices in the TTP.

8. A qualified theory of transformation pressure

By being reasonable, separable from other theories and testable, the TTP satisfies the criteria for being a fruitful theory about growth and the business cycle. At the same time there are both theoretical and empirical arguments for a modified version of the TTP. Industrial economists, psychologists and neuroscientists suggest that the relationship between external pressure and profits on the one hand and innovations and productivity growth on the other hand is conditional. We have in fact already attributed one conditional argument to the TTP – a profit decline may lead to defensive action by firms to increase productivity (including rationalization and mergers) rather than to radical changes in technologies, product compositions and organization. (Entry into new regional markets is not considered as an aspect of transformation in this article.)

Psychologists lean towards the conclusion that innovations and also productivity will be impeded by exceptionally strong or a long-lasting external pressure. Unexpected exceptional threats will paralyze people especially when they feel that events are uncontrollable (Sweeny, 2008, p. 63). Furthermore, permanent pressure may reduce not only the quality of decisions (see Section 6.4) but also people's energy by leading to exhaustion and blunting effects.[32] Neuroscientists have confirmed the blunting hypothesis - people's tendency to react more to changes from a reference point than to outcome levels (see the Kahneman-Tversky prospect theory) reflects a neural sensitivity to unexpected changes (Camerer et al., 2005, pp. 27-28; Loewenstein et al., 2008, p. 652). Neuroscientists have added that chronic pressure (stress) will lead to destructive impulsivity (lower response inhibition) and (at least temporary) to working memory deficits (Mika et al., 2012).

[32] Jaskowski et al. (2000, pp. 91 and 102-104); Maule et al. (2000, p. 297); Dragone (2009, pp. 552-554).

Psychologists have suggested an inverse U-shaped relation between perceived threats and the willingness to pay attention to and evaluate possible responses (Sweeny, 2008, p. 70). Moreover, in the 1980s, Leibenstein referred to the contemporary psychological literature about time pressure when arguing for an inverse U-shaped relation between external pressure and the quality of decisions.[33] Leibenstein's hypothesis is vindicated by psychological field studies elucidating that stronger time pressure will stimulate creativity but only up to a certain level.[34] Furthermore recent neuroscientific studies have demonstrated that memory persistence is enhanced by moderate stress (Hupbach and Fieman, 2012; Parfitt et al., 2012), Leibenstein's nuanced theory about the optimal external pressure also accords with the findings in industrial economics of an inverse U-shaped relationship between competition on the one hand and R&D investment, technical efficiency, innovation and productivity growth on the other (Scherer, 1992, pp. 1419-1420; Nickell et al., 1997, p. 787; Aghion and Howitt, 2009, pp. 7-8).

However, psychologists maintain that some organizational and personal conditions must be satisfied to even attain an inverse U-relation between external pressure and creativity (see Baer and Oldham, 2006). What is more, industrial studies have rejected the inverted U hypothesis (see above) even for mature industries (Scherer and Ross, 1990, pp. 645-651; Scherer, 1992, pp. 1423-1425). Competences, attitudes, personalities, technical opportunities and industrial composition (and possibly also the functioning of capital markets) seem to matter for the relationship between external circumstances (or profits) and firm performance at the national level. For example, the industrial composition probably explains why a weak currency was

[33] Leibenstein (1980, pp. 94-96), (1985, pp. 7-9), see also Mann (1992, pp. 210-211) and Payne et al. (1993, pp. 167-168).

[34] See the literature surveys and new results in Baer and Oldham (2006) and Byron et al. (2010).

positive for Swedish economic growth in some decades but not in others. In the 1930s devaluations (and depreciations) stimulated the development of dynamic industries and firms in Sweden by facilitating their self-financing ability and use of scale advantages. In the 1980s devaluations in the developed Swedish economy were less productivity-enhancing and perhaps negative for productivity growth particularly by slowing down the elimination of low-productivity firms and the incentives of established industries and companies to rationalize or alter their product pattern, technologies and organization (Erixon, 2007, pp. 343-344).

The qualifications above even put doubt on a conditional TTP that moderate pressure in each period is the most favorable condition for innovation and high productivity growth. A sensible alternative hypothesis, especially for a developed economy, is that the economic development is stimulated by periodic swings between hard and weak external pressure.[35] Exceptionally strong pressure may be needed to induce firm actors to abandon a dead-end growth path, for example, by forcing them to get rid of an overconfident and destructive habitual attitude to their current growth strategy. Furthermore the pressure on firms must perhaps be extreme in some periods to overcome the sunk costs of transformation and eliminate less productive vintages. In the subsequent period of easy external circumstances the selected firms can enjoy the virtuous circles of scale advantages, learning by doing, organizational routines and favorable self-financing conditions. And innovations and productivity growth may be enhanced in this period by the vanishing of exhaustion and blunting effects and the larger room for firm heterogeneity. In the 1920s, external pressure on firms in Swedish manufacturing was exceptional because of a strong currency and fierce foreign competition (through innovations and trade liberalization) leading to

[35] By reference to the psychological literature Tibor Scitovsky advocated an alternation between weak and strong stimuli over time – an optimal level of arousal will emerge if a period with a tendency to mental exhaustion is followed by a period of relaxation (Scitovsky, 1976, pp. 24-25).

the reconstruction of established export companies and the elimination of low-productive plants. In the 1930s, the expansion of the surviving firms was promoted by high home-market growth, inter-industrial technological diffusion and depreciations (Dahmén, 1998).

It seems near at hand to qualify the TTP further by highlighting the growth-enhancing role of both pressures and opportunities during a specific time period. Industrial economists regard the combination of large technological opportunities, scale advantages, industrial networks and intensive competition and the coexistence of large and small firms as favorable to R&D investment and innovation. In fact, the simultaneous appearance of large technological opportunities and strong competitive pressures explains why countries specialized (like Sweden) in ICT products displayed high productivity growth from the mid-1990s until the mid-2000s (Erixon, 2011, pp. 308-312). The *origin* of a change in actual profits is probably also important for productivity development. One aspect of overconfidence is that people will credit themselves for favorable outcomes that are largely the result of chance or beyond their control in general. It is likely that a profit increase through devaluation has a stronger preservative effect on company development than a profit boost through innovation. Devaluations are likely to generate an illusion of control and a too strong trust in a status-quo strategy while successful innovators have a more realistic view of the prospects of “old” innovations and the risk of following a status-quo strategy.

9. Conclusions

Many industrial economists refer to the high turnover in the group of the largest companies in industrialized countries. But it would be equally legitimate to highlight the high share of old companies, for example, on the Fortune Magazine list over the 500 largest US companies. In fact,

four-fifths of the companies on the 2009 list were formed before 1970, thus well before the IT revolution (Stangler and Kedrosky, 2010, p. 14). Old companies managed to survive notwithstanding fierce competition, for example from new products, and other severe external conditions. A plausible hypothesis is that established firms are revitalized by harder external circumstances.

Perhaps surprisingly for some, the idea that innovations and productivity within firms are stimulated by external threats is peripheral in works by the neo-Schumpeterians and by Schumpeter himself. They focus on opportunities rather than on pressures and, in the pressure case, on creative destruction rather than on enforced innovation and productivity changes. The idea that productivity is enhanced by bad external condition is more influential in neoclassical Schumpeterian economics. But the neoclassical Schumpeterians restrict the positive relationship between market competition and innovation or productivity growth to established firms close to the technological frontier and specialized in high-tech sectors. And they are unwilling to unmask the underlying psychological mechanism.

The unqualified theory of transformation pressure (TTP) shares the idea with neoclassical Schumpeterian theory that productivity growth, and possibly also innovation, are stimulated by negative external circumstances. But the TTP finds support in the psychological literature for the hypothesis that firm actors will first transform after an actual reduction in profits. Decision makers will then become more anxious, creative and also more calculating weakening the impact of heuristic rules and strong emotions favoring the status-quo. But transformation may reflect that firms are overreacting to an actual reduction in profits. Actors suffering from underconfidence and other psychological distortions may implement productivity-enhancing measures after a

profit fall even without any threat to their survival and even if the firms are not listed on the stock exchange (exerting a pressure on them to be profitable in the short run).

The unqualified TTP gives unambiguous answers to central questions in macroeconomics. It suggests, for example, that productivity growth moves countercyclically and is muted by depreciations. But evidence is inconclusive in both cases. Besides, the sign of the relationship between actual profits (independent variable) and productivity growth seems to be industry specific. An experiment testing the hypotheses in the TTP about the strategy choices and underlying psychological mechanisms confirmed that firms are governed by bounded rationally but only partly that they will upgrade their growth strategy in a profit recession. There is convincing evidence in both industrial economics, psychology and neuroscience that productivity growth can be obstructed by an exceptionally strong external pressure. According to a qualified TTP, productivity growth is maximized under moderate pressure or through a sequential process where periods of strong pressure are followed by periods with large opportunities for the firms.

By highlighting the struggle for firm existence and the cognitive processes and emotions governing firm behavior under different external conditions, the TTP is easily placed within a universal Darwinian framework. Notwithstanding this compatibility, the main ideas in the TTP were formulated without any references to the Darwinian literature. And the separation between negative and positive driving forces is not explicit in universal Darwinism. Yet, Darwinian economics may easily adopt the idea that shocking negative experiences may, for example, force established firms to abandon a dead-end growth trajectory. The Darwinian ontology and concepts are relevant for economic analysis and might even lead to new insights. The ultimate ambition of this article was to contribute to a Darwinian analysis of central issues in macroeconomics.

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