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ROBERT TORRENS ON TECHNOLOGICAL PROGRESS*

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In the present paper I analyse and evaluate Robert Torrens's contribution on the causes and effects of technological progress and its relation to economic growth. In formatting a unitary interpretation and assessing his contribution on such an issue, his various ideas and arguments will be compared with those advanced by his contemporaries and with some relevant empirical findings of the period. The main conclusion is that although his place in the general histories of economics may be in a rather low-standing position, in the special histories of the phenomenon of technological progress and its various effects, he rightly deserves a much higher position.

0. Introduction

Robert Torrens (1780-1864), although not a leading figure of the Classical School as Edwin Seligman (1903, p. 71) and Lionel Robbins (1958, pp. 1, 10, 73) have shown, nevertheless had an adequate analytical ability which led him to advance pioneering ideas and suggestions in various subjects. The existing literature in the field (e.g. Seligman 1903; Meenai 1955, 1956; Robbins 1958; de Vivo 1985) has analysed Torrens' main ideas and theories on specific issues, such as the theory of rent, the theory of comparative advantages, the banking theory, etc., but has left room for other considerations of his inquiries. More specifically, among the issues where Torrens really developed an original and contributory analysis are the various effects of technological progress or of the "machinery question", as it has been labeled in the literature (see Berg 1980).

The main goal of the present paper is to present and assess Torrens' intellectual achievements through a close textual analy-

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sis of his writings as a whole on the issue of technological progress and its effects, which are really scattered in a number of his different writings or in different chapters of the same work. In formatting a unitary interpretation and assessing Torrens' contribution to the subject of technological progress, his ideas and arguments will be compared with those advanced by his contemporaries and with some relevant empirical findings of the period. Thus Brewer's (1991, p. 10) comment that Torrens "deals with technical change more thoroughly and more explicitly than any other classical writer of the time" would be justified.

The analysis of this paper is conducted on the following lines: In the first section, Torrens' microeconomic analysis of the stimulus to, and effects of, the new technology will be investigated. Then, in the second section, his views in regard to the effects of technological progress on economic growth will be advanced. In the third section, his arguments for the effects of the introduction of the new labour-saving technology on labourers' welfare will be analyzed.

1. The microeconomics of technological improvements

Torrens (1821, pp. iv-v) criticized the extreme use of abstraction or empiricism as a proper methodological procedure in economics, employed by his contemporaries Ricardo and Malthus, and proposed the fertile mixture of deduction and induction[1]. He not only proceeded to his inquiries, as he noted (1821, p. iii), by advancing a theoretical scheme, but also by checking it with experience, as he acknowledged "in the fullest extent, that it is the business of philosophy to account for facts, and that no theory, however plausible, nay, however demonstrative it may appear, is entitled to attention, unless its conclusions coincide with general experience" (1821, p. 398; see also 1815, pp. 268, 357). Upon this mixture of methodological instruments and the empirical examination of his theoretical conclusions, he

1. Torrens analytically presented his methodological views in his article "Introduction in which the Deductive Method as presented in Mr. Mill's System of Logic is applied to the solution of some controverted questions in Political Economy" (1844, pp. iii-lii).

developed his ideas and arguments for the technological effects o*n* the function, structure and development of economy.

He was engaged with the "question of machinery" from his early work, *An Essay on the External Corn Trade* (1815), and his speech to the "London Tavern"[2]. In his early work of 1815 he revealed a Smithian theory for the effects of the division of labour on technological progress[3], stressing that:

> "as wealth and population increase, the effective powers of manufacturing industry rise; and new divisions of employment, and improved machinery, enable the same quantity of material to be wrought up with a less expenditure of food".
>
> (1815, p. 76; see also ibid., p. 80)[4]

In his later works (e.g. 1821, pp. 90, 167), although he repeated the above idea for the improvement of technology, he also advanced some other supply-push and demand-pull factors influencing the direction and introduction of technological progress[5]. In regard to the first factor, he recognized (1834, p. 124) that the scarcity of the means of subsistence which is produced by a detrimental economic policy (e.g. the Corn Laws) is

2. It is mentioned in his informal letter (September 11, 1817) to his friend Francis Place (quoted in MEENAI 1956, p. 51).

3. This Smithian thesis in regard to the population effect on induced technology seems to be verified by experience. As a modern historian claimed, the increase of population in early 19th century England "led to a more rapid absorption of existing technical knowledge and therefore increased the chances of making further technical progress" (HABAKKUK 1963, p. 614). This idea has been employed by Ester Boserup in her book *Population and Technological Change* (1981) where she shows that exogenous mortality changes during British industrialization determined the population changes which, in turn, propelled technological progress. For an empirical justification of such a demographic theory, see TSOULOUHAS (1992).

4. A similar argument is used in the article "Mr. Owen's Plans for Relieving the National Distress" (1819, pp. 93-9) against Owen's plan for self-sufficient "villages" — an article written by an anonymous writer who according to most prevailing modern views - is probably Torrens and not McCulloch (see GROENEWEGEN 1984, pp. xvii-xvm). Some of the arguments in this article regarding the effects of technological progress are reproduced in a slightly different form in Torrens' other works (mentioned in our references) and especially his 1821 work, a fact which reinforces the argument for Torrens' authorship of this article.

5. Upon relevant ideas of other economists of the early 19th century relating to those factors influencing the direction and the rate of technological progress, see KARAYIANNIS (1998a).

the main cause for the introduction of new technology. For the second factor influencing technological progress, he invoked (1821, p. xii, ft.) the expected rate of profit as the main motive for the introduction of new technology.

The rate of profit, for Torrens (1821, p. 24), was not only the prime motive for the functioning of competition and the optimum distribution of the factors of production according to the dictates of demand. Additionally, he conceived (1821, pp. 51, 54) of it as a surplus remaining after the complete replacement of the inputs of production or "the capital advanced", and created by the function of the active capitalist. He treated the function of such a productive agent as the leading figure in the "manufacturing system". He clearly distinguished between the "dormant capitalists" and the "active capitalists", where "the former not engaging in the business of production, ... [are] ... drawing their incomes from rent or interest / the latter pursuing the occupations of agriculture, manufacture, or trade, ... [are] ... drawing their incomes from profit" (1844, p. 147; brackets added). He distinguished also between the activities of the "active capitalists" and those of "speculators" who "have a preference for those hazardous trades in which extra risk is paid for by extraordinary gain" (1844, p. 3; see also 1815, pp. 321-2; 1821, pp. 400,418-9).

Profit as a created surplus, according to Torrens (1834, pp. 34-5), did not necessarily vary inversely with wages as Ricardo claimed, but actually rewarded rewards the "active borrower of the capital [...] for his labour, his skill, his risk, and his connection" (1815-1829, p. 329; see also Seligman 1903, p. *77).*

From these entrepreneurial characteristics and activities, he acknowledged (1844, p. 87) the quantity of capital and the various social and economic relations to be the main sources of differential rate of profit in various production processes. Besides, he pointed out that its differential rate was justified by the innovative actions of the active capitalist, which was a fruitful activity for the whole economy:

> "When the individuals engaged in any trade obtain a higher rate of profit, not by advancing their prices, but by effecting a reduction in the cost of production, then the increased return upon their capital is not acquired at the expense of the consumer, and is a clear addition made to the wealth of the community".
>
> (1821, p. 214)

Therefore,

> "it is only when the experimental farmer discovers the means of raising a given produce at a less expense, that he throws the limits of prosperity to a greater distance, and is entitled to be regarded as a public benefactor".
>
> (1821, p. 143)[6]

However, Torrens does not deserve recognition for being the first theorist to understand the role of the innovative entrepreneur. Such a role was observed and documented by other economists prior to Torrens, such as Say (1803, pp. 86-7, 89-90) and Lauderdale (1804, pp. 162-5, 168-9, 228).

Torrens (1815, p. 17; 1821, p. 33) adopted the Smithian free market competitive mechanism for the equalization of profit rates not only in a closed but also in an open or world economy. He held (1815, pp. 157-8, 342) that the diffusion of the new technology among the industrial nations through the function of the manufacturers "who prepare implements and machinery" (1821, p. 110), would determine a world-wide rate of profits (1815, p. 158; 1819, p. 89), the rate of which will be discussed below.

The role of profits and technology in Torrens' analysis differs somewhat from the relevant Ricardian one. In the preface to the third edition of his 1815 book (February 17, 1826), he turned (1815, pp. x-xi) against Ricardo's and James Mill's thesis of the inverse relationship between wage and profit rate[7]. His main argument was based upon the effects of a rather capital saving technological progress. He held that if by the "improvements in agriculture" the cost of production is decreased, while the amount of production and employment remain the same, then "the proportions, or proportional wages remain unchanged, yet

6. HENDERSON'S (1984, p. 86) comment that Torrens "did not explain in any fashion how its creation (i.e. of profits) came about", seems to be rather harsh.

7. TORRENS in his later works (e.g. 1844, pp. xxxvi-xxxvii), changed his views and accepted the Ricardian theory of the inverse relationship between the rate of wages and profits, by mentioning that his own theory was an extension of, and complementary to, Ricardo's in terms of empirical situations and facts. ROBBINS (1958, p. 55) considers that Torrens changed his mind with respect to Ricardo's theory of profits because Longfield advanced a much more empirically correct approach.

profits have risen" (1815, p. xvii). To put it differently "profits might continue to rise while inferior soils were resorted to, provided the operation of this cause were counteracted by improvement in agriculture or in manufactures" (1815, p. 110)[8]. He had explicitly discussed such a possibility by using the *ceteris paribus* clause regarding the effects of three variables - which Ricardo would not deny - on the level of profits:

(a) "the natural productiveness of the land";
(b) "the degree of skill with which labour is applied"; and
(c) "the real rate of wages"(1815, p. 94).

In fact, he concluded that the main variables in determining the rate of profits are the first two, which "exert a much more powerful influence than the third" (1815, p. 117; see also 1819, p. 87)[9].

Torrens' main assumption was that through the competitive mechanism and the role of profit equalization, technological effects would be extended to the whole economy, viz.:

> "the amount of the return which the capitalist obtains, does not depend wholly upon the productive powers of the industry which he immediately carries on, but also on the productive powers of all the other branches of industry from which any of the ingredients of his capital are derived. A diminution in the cost of raising raw produce raises manufacturing profits, and an improvement in manufacturing skill raises the rate of profit in agriculture. The same causes also influence rent".
>
> (1815, p. 134)

8. About the mutual increase of the profit and wage rate in the early decades of 19th century Britain, Torrens seems to be closer to reality than others. TREVELYAN (1942, pp. 471-2) had shown that the wage rate of agricultural labour "was no worse off in 1824 than it had been thirty years before, taking the average of the country as a whole". And, "the average standard of life was almost certainly higher than in the previous century, if all regions and all classes are taken into account". Similarly, DEANE & COLE (1962, p. 27) concluded that there was a negligible improvement of labourers' welfare in the Napoleonic war years, and "an upward trend in the immediate post-war years (though this may have been outweighed by post-war unemployment), [and] an unprecedentedly rapid improvement in the second quarter (which might also be modified on the basis of unemployment data)".

9. In the same tone, MCCULLOCH (1825, pp. 456-9) had argued that the rate of profit varies proportionally with the rate of productivity and inversely with the rate of wages and taxes. However, he recognized (ibid., pp. 459, 466) that because of the increased rate of productivity due to technological progress, the rate of profits and wages are both increased.

Drawing upon this argument, he reasons that the interest of the landlord is promoted by technological progress, both in agriculture and manufacture. He contends (1815, pp. 138-9, 143) that rent is the result of the appropriation of land and the increased demand and price for agricultural products, and not an effect of the property of diminishing returns. In other words, he holds that the rent of land is a result of the absolute and not of the relative scarcity of land[10]. He assumed (1815-1829, pp. 134-5) that "when society is in a progressive state" the amount of capital and population and thence the demand for agricultural products would be increased, which in its turn, would increase prices, profits and rents in this sector - a similar argument repeated later on by Jones (1831, pp. 212-3) and used in 1843 by the members of the Manchester School for the repeal of the Corn Laws (in Hirst 1903, pp. 163, 168-9).

Thus, the interest of the landlord is harmonized with that of the rest of community only in the long-run, because as Ricardo has shown (1817, pp. 79-80, 335) - and Torrens found this "reasoning [...] quite perfect" (1844, p. 263) - in the short run the improvements in agriculture will diminish the rent of land, and thus the interest of the landlord will be contrasted with that of the others[11].

Apart from the effects of technological progress on the rate of profits, Torrens also specified its effect on the level of cost and prices. Though he had framed (1821, pp. 18-9) a supply-demand determination of the short-run level of prices or the exchangeable value of goods, he explained its long-run determination on the basis of the cost of production (1815, p. 275; 1821, pp. 28-9) or the quantity of capital employed (1818, p. 81; 1821, pp. 38-43, 99). Thus, he considered that, in the long-run, the in-

10. Torrens claimed that rent is the result of increased demand for agricultural goods, both "necessities" such as corn and "superfluities" such as "the lands which supply fresh meat, fresh butter, milk, vegetables, hay, and all those things not strictly component parts of subsistence" (1815, p. 172).

11. MCCULLOCH (1825, pp. 426, 429-30) opposed the argument of Ricardo, emphasizing that both in the short and the long run, there is harmonization of interest between landlords and the rest of the community in regard to the introduction and extensive use of technological and other improvements in agriculture. The argument for the harmonization of interests of landlords and the rest of the community was shared also by JONES (1831, pp. 182, 208, 212, 244) and CHALMERS (1832, pp. 476-7, 555).

troduction of new labour-saving or capital intensive technology, by raising labour's productivity, would decrease the cost of production, thereby decreasing the prices of the so produced goods[12]. This main technological effect, which was mentioned by Smith (1776, pp. 260-1, 676), has been stressed also by other writers of the early 19th century, such as Lauderdale (1804, p. 289), J. Mill (1821, p. 199), Senior (1831, p. xii), Babbage (1832, pp. 121-2), Scrope (1833, pp. 189, 194) and Longfield (1833, pp. 219-20).

Torrens recognized that the reduction in the level of prices produced by the use of a new technology would not be equal to the various production processes. He goes on to point out (1821, pp. 101-2) that the diminution of prices depends on the capital-labour ratio employed in the relative production process; namely, the price of goods of the labour-intensive industry, after the introduction of a labour-saving technology, will be decreased much more than that of capital-intensive goods.

However, there are some other factors determining the rate of price reduction after the labour-saving technology, such as the price elasticity of demand, consumers' income and preferences, etc. Torrens did not proceed further in elaborating such factors in his analysis of the influence of new technology on the equilibrium rate of price, although he was well aware (1808, pp. 65-6; 1815, pp. 15, 278-9; 1821, pp. 46-7) of the role of the price elasticity of demand in the case of necessary and/or luxury goods[13]. Malthus (1820, p. 352) seems to have been first in emphasizing the relation of price elasticity to the determination of the rate of demand for goods and, by extension, to labour after the introduction of a new labour-saving technology. Senior (1831, p. 45; 1836, pp. 156-6, 166), similarly, gave emphasis to the

12. Torrens, in his earlier works (1815, pp. 72, 101-2; 1821, p. 101), was speaking mostly about labour-saving technology; while in his later work and in a formal "Letter to the Right Hon. Lord Stanley on Colonization" written on January 6, 1842 (1844, pp. 88-9), he describe a capital-intensive technology producing the same results.

13. It is worth noting that Torrens fairly well described price expectation as a process for the establishment of the market equilibrium: "Under the impression that prices would continue to fall, all became solicitous to sell, and averse to buy; and the force of public opinion, more, perhaps, than the actual excess of the supply beyond the consumption of the season, continued to depress the value of land and of its produce" (1815, p. 278).

elasticity of demand, stressing that when the introduction of a new technology brings a reduction of price of a good with high price elasticity, employment in such an industry will not be decreased but, on the contrary, will be increased.

2. Technological progress and economic growth

Torrens extensively analysed the direct and indirect effects, on the economy as a whole, of the labour-saving technological progress which would take place in the three main branches of production (agriculture, manufacture and trade), as

> "in the work of production, the different kinds of industry unite, and reciprocally augment each other's effective powers".
>
> (1821, p. 133)

However, for reasons of exposition, it seems appropriate to analyse separately all these structural effects of technological improvements.

Let us start with one of the main issues that drew Torrens' interest to economics, namely the question of *agricultural production.* As is known, he was one of the first, along with West, Ricardo and Malthus, who independently developed the theory of diminishing returns in agriculture, caused by extensive and/or intensive cultivation (1815, pp. ix, 135-6, 142-3; 1821, pp. 113-5, 118-9; see also Meenai, 1955, pp. 701; Robbins, 1958, pp. 38-41). He used this theory as the cornerstone of his analysis of various subjects such as the effects of technological progress, the emergence of rent, the free trade argument, etc. In regard to the subject in question, he recognized two direct (i.e. upon its level of production) and two indirect (i.e. upon other sectors of production) effects of "improvements in agriculture":

(a) In regard to the first direct effect, he makes it clear that the innovative farmer, influenced by the profit motive, will introduce "a better quality of seed and of manure" and/or a new machine "enabling the same number of labourers to execute a greater quantity of work" (1821, pp. 124-5)[14]. By such activity,

14. In his later work, Torrens described as real agricultural improvements

as he stressed, the point of emergence of diminishing returns will be pushed back (1815, pp. 119-20; 1821, pp. 122-3, 126, 142) - an effect described also by Read (1829, pp. 254 fn., 304 fn.) and Scrope (1833, pp. 265-6)[15].

It is worth noting here that Torrens in discussing the effects of new technology in agriculture argued that large production units (i.e. large farms) are more efficient not only in utilizing the available resources, but also in using new technology more effectively: "the employment of more efficacious machinery, and the more economical application of labour, [...] are found admissible into large concerns" (1821, p. 140; see also Berg 1980, p. 88)[16]. This argument, that large units of production are much more efficient in introducing a new technology which decreases the cost, was extended later on by Sismondi in his "Introduction to Inquiries into Political Economy" (ed. 1847, p. 147) and by Babbage (1832, pp. 217-24; see also Romano 1982, p. 394, fn. 42).

(b) A second direct effect of technological progress in agriculture is that the number of intra-marginal agricultural firms are increased and "new land" enters into cultivation (1821, pp. 132-3).

Both of the above-mentioned direct effects of technological progress in agriculture will have as an ultimate outcome the increase of the level of production with the same amount of land and labour. In modern parlance we would say that by the introduction of new technology, the production possibility curve of the economy has shifted to the right. This outcome is related, according to Torrens into a dynamic context with the indirect effects produced by the introduction of a new labour-saving technology in agriculture.

that which took place "on Scotland farming in the Lothians" (1844, p. 256), and "consists in economy of management, shown in division of employment, confining the attention of the farmer to as few points as possible — in a due rotation of crops, so as to have no land lying idle or unproductive; and in the use of machines and horses instead of manual labour, wherever circumstances admit of it" (1844, p. 259).

15. The data on the productivity of agriculture in wheat production after the Napoleonic Wars supports this claim of Torrens. JONES & HEALY (1962), using data gathered by Thomas Tooke and Joseph Sandars, show that during the period of 1815-1859 the general mean yield per acre of wheat production in England was substantially increased. This increase is attributed to the extension in the application of artificial fertilizers and other improvements such as field-drainage, etc. Similarly, MCCLOSKEY (1981, p. 57) showed how technological and other improvements of the factors of production drastically postponed the emergence of diminishing returns in the British economy during and after the Industrial Revolution.

16. COURT (1954, pp. 23, 30, 37) discussed how the large farm was much more productive than the small one during those periods in British agriculture.

(c) Torrens explicitly specifies (1821, pp. 129-30) the argument - whose roots are to be found in Smith's analysis (1776, pp. 287-8) - that the remaining amount of capital and labour would be transferred, by seeking a more profitable employment, to other production processes, such as manufacture, where its level of production would be increased[17].

(d) Another indirect effect of technological progress in agriculture, and a consequence of the previous one, is the postponement of a declining profit rate in manufacture. Torrens, by using the Ricardian argument for the declining rate of profit in manufacture caused by diminishing returns in agriculture[18], pointed out the possibility of the postponement of profit reduction for further portions of capital and labour, namely:

> "Improvements in agricultural science, as throwing to a greater distance the point beyond which cultivation can be neither heightened nor extended, necessarily remove to a greater distance the point beyond which manufacturing capital can be no farther accumulated".
>
> (1821, p. 128)

Therefore, "Contrivances, such as threshing machines, for the abridging of labour, though to a hasty observer they may seem calculated to diminish the demand for workmen, have in reality a directly contrary operation. They allow additional por-

17. HOBSBAWM (1962, p. 52) clearly shows that, in the early decades of the 19th century, British agriculture increased its production and released a labour force to be employed in manufacture.

18. The emergence of a stationary economy may be postponed, according to RICARDO (1817, pp. 77-8, 156), through the introduction of new technology which will increase the rate of productivity and will decrease the real wage rate (in terms of corn). Torrens was in agreement with Ricardo in stressing the price of corn as a barometer of general welfare. He regarded (1815, pp. 259-60) an increase in the price of corn as detrimental for the whole economy. Thus, ROBBINS (1958, p. 238) concludes that "the essential Ricardian idea of profits depending upon the productivity of agricultural production was completely accepted by Torrens". DE VIVO recently (1985; 1996) makes it clearer that Torrens' corn-ratio theory of profit is Ricardian in origin and inspiration.

tions of capital to be applied to all old lands ... [and] ... they increase the surplus produce of the soil, and thus furnish the means of employing an increased manufacturing population" (1821, p. 139; brackets added)[19].

Torrens, however, recognized that there is a possibility that the force of the diminishing returns in agriculture might outweigh the benefits of the new technology. This case could take place in the long-run and if - as he claims (1815, pp. 340-1, 382-3, 427) - the British government continued the damaging policy of Corn Laws in restricting the importation of agricultural products[20]. As a solution to such a detrimental situation, he proposed the establishment of free trade, as Ricardo had suggested[21].

It may be deduced from the previous analysis that the ultimate effect of the introduction of new technology in agriculture is the increase of the total production of the economy. And in the long-run, as Torrens emphasized, by so increasing the level of population, the beneficial effects of the increased division of labour (1821, pp. 155-6) and mechanization of production (1821, pp. 248-9), are higher than the detrimental effects produced by the cultivation of inferior soil[22]. In other words, he endorsed (1815, pp. 119-20) the concept that by the progress of society in

19. Arthur Lewis reached a similar conclusion in analyzing the effects of technological progress in a dual economy: "If we assume technical progress in agriculture, no hoarding, and unlimited labour at a constant wage, the rate of profit on capital cannot fall. On the contrary it must increase, since all the benefits of technical progress in the capitalist sector accrues to the capitalists" (1954, p. 154).

20. He emphasized (1815, p. 332) that the restrictions of free trade, particularly in agricultural goods, will sooner or later cause the migration of skilled labour and capital to other countries for the purpose of seeking more profitable employment.

21. RICARDO (1817, p. 133) shows that the positive economic effects derived by the use of new technology are similar to those of foreign trade where provisions are freely imported.

22. A similarly optimistic conclusion was drawn by McCulloch who argued: "Frequently, however, these improvements [i.e. in machinery and agriculture] more than compensate, during lengthened periods, for the deterioration in the quality of the soils successively cultivated, and occasion a fall of prices and rise of profits; and when the increase of population has again forced the cultivation of still poorer lands, new improvements may again restore prices to their old level, or sink them to a lower" (1825, p. 467; brackets added).

terms of wealth, population and technology[23], the decrease of the cost of production in manufacture will be higher than the increase in the cost of agricultural production, and as a consequence the equilibrium rate of profits would be increased[24].

Torrens also examined the introduction of new technology in *manufacture* and recognized the following two effects - one direct, the other indirect:

(a) The main direct effect of the introduction of a new labour-saving technology in manufacture, according to Torrens (1821, pp. 134-6), is the increase in labour productivity. He then went on to point out the possibility of increasing returns in manufacture - also recognized in similar fashion by McCulloch (182, pp. 121, 419) - after the introduction of new technology, viz.:

> "there are no natural limits set to the effective powers of manufacturing industry; but that, on the contrary, an increase in the quantity of labour and capital applied, leads to the use of improved machinery, and to a more perfect subdivision of employment, and thus enables a given number of workmen to produce a greater quantity of goods".
>
> (1821, p. Ill)

(b) The indirect effect of the introduction of new technology im anufactures is, for Torrens, a reverse of the above case (c) produced by a technological improvement in agriculture. He considers as an "important principle" that:

> "As improvements in agriculture increase the quantity of capital which can be employed in manufactures; so improvements in manufactures remove to a greater distance the ultimate limits of agricultural prosperity, and admit of additional applications of capital to the soil".
>
> (1821, p. 133; see also 1819, p. 88)

He justified such a principle by considering that by the introduction of new technology which cheapens "the wrought goods" used as means of production in agriculture the cost of

23. He seems to consider (1815, p. 284; 1821, p. 121) that only through a successive advancement of technological progress the unavoidable effects of diminishing returns could be continuously postponed.

24. He showed (1815, p. 283) that, for the British economy, a similar case took place during the Napoleonic Wars.

producing corn is decreased (1815, pp. 134, 386) and thus the amount of capital and labour released by manufacture may be profitably employed in agriculture (1821, p. 138).

He, moreover, examined the various effects of technological improvements in *trade* or in "commercial industry" (1821, pp. 72-3, 160). He explicitly recognized one direct and one indirect effect of mainly internal trade which, however, could equally take place in the case of external trade as well (1821, p. 207).

(a) The direct effect of improvements in transportation and trading practice, according to Torrens (1821, pp. 187, 192, 207), is the diminution of transaction cost in terms of capital used and/or time consumed, and thus the level of prices of traded goods is decreased - an argument repeated also by McCulloch (1825, pp. 89-90)[25].

It is noteworthy that Torrens had recognized and favoured the positive effects of economies of scale produced by the large-scale operation in trade, just as he had in the case of agriculture. By contradicting "the prejudice against [...] the employment of large trading capitals in trade" (1821, pp. 192-3), he pointed out that the ultimate result of the large business in a competitive environment would be the increase of total production (1821, pp. 194-5). This does not mean that he applauded monopolies. On the contrary, he was opposed to them and condemned (1821, pp. 213-6) any long-run monopoly which would decrease the volume of production and increase the level of prices and rate of profit.

(b) The indirect effect recognized by Torrens (1821, pp. 187, 191-2) is similar to that produced when technology was firstly applied in other sectors of the economy, namely it resulted in a release of capital and labour from trade activity, which then could be profitably employed in other sectors of production.

Apart from the above effects which may be produced mainly in internal trade, he stressed that similar effects are generated by foreign trade. Torrens, who independently from Ricardo developed the principle of comparative advantage in foreign trade in his *External Corn Trade* (1815, pp. 39, 42-3, 49, 184-5, 401-3)[26], argues (1815, pp. 185, 311) that by the introduction of a new technology which increases the "productive power" and under the operation of free trade, the consumption and production possibilities of the country are advanced.

The crucial mechanism of the above-described indirect effects of technological progress upon those branches of production where progress did not originally take place seems to be, for Torrens, the investment behaviour of capitalists. Only under the functioning of Say's law[27] and the law of diminishing returns in agriculture would the fruits of technological improvements in one sector be diffused to the whole economy. If the extraordinary profits generated by the introduction of new technology were hoarded, then there could be no indirect effect on any other production process[28]. Furthermore, if there were no branch of production functioning under constant and/or increasing returns, the capital saved by increasing profits caused by the introduction of new technology would not be concentrated in any specific branch and would be transferred to all production processes.

3. The "theory of labourers' compensation"

Karl Marx, in his Capital (1867, vol. I, ch. 13, sec. 6), placed Torrens as one of the main protagonists of the "theory of

25. Torrens, in his earlier economic essay (1808, p. 11), stressed another positive effect of technological improvements in trade operation, namely the increase of division of labour and thence the increase of production: "improvements in roads, canals, and navigation, by facilitating the intercourse between man and man, perfect the division of labour, and consequently, enrich a nation".

26. THWEATT (1976, pp. 208, 211-2) has shown that Torrens in his 1808 paper and James Mill in his book *Commerce Defended* (1808) developed independently of each other, in the same year, the comparative advantage principle of foreign trade.

27. As has been observed by historians of economic thought (e.g. ROBBINS 1958, pp. 179-82; THWEATT 1974, p. 437; O'BRIEN 1988, p. 205), Torrens, could not be considered either as a rigorous and firm advocate for, or as an opponent of, Say's Law.

28. As modern economic historians have shown, during the early decades of the 19th century the rate of profits was increased (DEANE 1973, p. 222), and thus the majority of capital investment in manufacture was supplied out of savings of private individuals and reinvested profits (COURT 1954, pp. 85, 87; HOSELITZ 1955, p. 124).

labourers' compensation", which stated that labourers will be compensated "for initial sufferings, incident to the introduction of a labor-saving machine, by favorable ulterior effects" (Schumpeter 1954, p. 683)[29].

Torrens participated in this "theory" by criticizing the strict Ricardian thesis that the adoption of new labour-saving technology would ultimately result in increased unemployment by which the living standard of the labourers would be worsened. Before proceeding to Torrens' ideas and arguments for the beneficial effects of new technology on labourers' welfare, we briefly present Ricardo's propositions on the matter in question[30].

Ricardo in the first edition of his magisterial *On the Principles of Political Economy and Taxation* (1817, pp. 133, 156, 335), advanced a theory stressing the benefits to the labourer of technological progress. In the third edition (1821), he introduced a new chapter "On Machinery" where he demonstrated the negative, rather than the positive, consequences of the introduction of new technology on the living standard of the labour class. As he state: "I am convinced, that the substitution of machinery for human labour, is often very injurious to the interests of the class of labourers" (1817, p. 388).

Then, he went on to deduce two general conclusions with respect to the effects of technological progress on the labourers' welfare: (i) by the use of "machines" and keeping the rate of profits and rents at the same level, total production is decreased and therefore the wage rate and/or the demand for labour diminishes (1817, p. 388); and (ii) without decreasing the volume of production, the ratio of circulating to fixed capital is decreased and thus the demand for labour diminishes (ibid., p. 390). Ricardo, after analyzing the spending and investment behaviour of capitalists and its consequences in introducing the

29. Marx comments ironically about this theory: "sooner or later, therefore, the capital and the workmen must come together again, and that, then, the compensation is complete [...] the sufferings of the workmen displaced by machinery are therefore as transient as are the riches of this world" (1867, p. 414).

30. For a scholarly analysis of Ricardo's views on the various effects of the introduction of new technology and the way those views were developed through correspondence with his contemporaries, see HOLLANDER (1979, pp. 339-75); BERG (1980, ch. 4).

new "machines", suggested it not be "discouraged in a State, for if a capital is not allowed to get the greatest revenue that the use of machinery will afford here, it will be carried abroad, and this must be a much more serious discouragement to the demand for labour, than the most extensive employment of machinery" (1817, p. 396).

Torrens, in a footnote to the preface of his 1821 work, noted Ricardo, "that most original and profound economist ... [has] ... retarded the progress of the science for which he has achieved so much" (1821, pp. x-xii; brackets added). The main faults of Ricardo which "have retarded" the progress of economics, for Torrens, were his absolute dismissal of induction and "his recent deviations from his original doctrines", particularly in regard to the effects of "machinery" (ibid.). Torrens considered "altogether wrong" Ricardo's doctrine "that the introduction of machinery occasions a permanent diminution in the demand for labour" (1821, p. xi, ft).

Torrens' (1821, pp. xi-xii, ft.) counter-argument to Ricardo's thesis was that when the capitalist, instead of using his net profit in luxury consumption, invests in new technology and, at the same time, sustains the same labour force, then through the increased productivity of labour, the total production of the economy will be increased. In such a case, the capitalist will receive - without altering the general level of prices and wages - a higher profit, which he could use in increasing the demand for labour. Although Torrens recognized (1844, pp. 262-3) the well-circulated argument for the short-run unemployment produced by labour-saving technology as Ricardo also had claimed[31], he denied (1821, p.

31. Ricardo, had noticed not only those cases where the introduction of machines may be proved detrimental to the labourer, but the additional one: "of the possibility of an increase in the amount of the net revenue of a country, and even of its gross revenue, with a diminution of demand for labour, and that is, when the labour of horses is substituted for that of man" (1817, p. 394). Torrens accepted such a possibility, mentioning that "by the employment of steam and horse power and mechanical inventions for performing on the land the work now executed by manual labour, the demand for that labour must be diminished" (1844, p. 260). However, the argument that the introduction of a new labour-saving technology would generate short-run unemployment had been put forward by the time of Sir James STEUART (1767, vol. 1, pp. 122-3; see also KARAYIANNIS 1994, p. 43) and continuously stressed by other writers, such as SAY (1803, pp. 87-8); MCCULLOCH (1825, p.

xi, ft) the negative long-run effects on the labourers' welfare as having "never yet occurred".

Torrens advanced more arguments and ideas in regard to the various effects of "machinery" on the labourers' welfare in his treatise of 1834, where he used the second chapter titled "On the effect of machinery upon wages" (1834, pp. 33-44) to justify his idea that, by the introduction of new technology in the production process, the welfare of the labourers is increased. By considering the general welfare as synonymous with the labourers' welfare and receiving as its simple index the real wage rate, he examined (1834, pp. 1, 5) in detail the various effects of technological progress on such an index. He lay it down explicitly that by "whatever degree the employment of machinery may diminish the cost of production, it must in the same degree raise maximum or possible wages" (1834, p. 33)[32]. In proving this thesis, he used (1834, pp. 33-5) lengthy arithmetical examples to describe the consumption and investment behavior of the active capitalists. He considered that by the introduction in the production process of a new labour-saving technology, the cost of production is decreased (namely, a given quantity of goods is produced by less labour) and the rate of profits is increased - an argument already stressed by McCulloch (1825, pp. 142-4, 148) who used it against Malthus' theory of "glut"[33]. Then, the capi-

153); SENIOR (1831, p. 43); BABBAGE (1832, pp. 334-5) and CHALMERS (1832, p. 474).

32. He defined as the "maximum of wages" the difference between total production minus the minimum rate of profit which is that amount "for the sake of which he will [i.e. the capitalist] carry on his business" (1834, p. 8, brackets added; see also 1844, p. 108). This rate of profit is related by Torrens to the "fundamental principle" that the minimum supply price must include the capital employed in production with "an adequate surplus" (1815, pp. 314-5). For Torrens, "the maximum of wages may be raised, either by the cultivation of land of a better quality, or by improvements in the effective power of industry" (1844, p. 109). However, in a free trade economy, as he noticed in his formal letter to Sir R. Peel written in 1842, world competition (namely the demand for exports and the price of imports) will determine this "maximum" wage rate: "In a country in which any considerable portion of the people are dependent upon foreign trade for employment, and the means of subsistence, foreign competition fixes the maximum beyond which money-wages cannot rise, while home competition determines the minimum, to which they may fall" (1844, p. 238).

33. MALTHUS (1820, pp. 352-4, 358-9) considered that it is possible for the introduction of new technology not to increase the rate of demand for goods and labour, and particularly where: (a) there is inelastic demand for the products and

talist will either spend his extra profit in consuming home and/or foreign goods or will invest it in the same or another production process.

In the case where extra profits resulting from the introduction of new technology are used by the active capitalist "productively", namely "if habits of frugality amongst the opulent classes continued to convert revenue into capital" (1834, p. 22), then "increasing profits always occasion a more rapid accumulation of capital, and an increase of productive expenditure" (1834, p. 36). In such a case (1834, pp. 25, 39), by the re-investment of profits (in the same and/or other sector of production), the dismissed labourers caused by the introduction of "machines" will be re-absorbed, namely: "The diminished demand for agricultural labour will be balanced by the increased demand for manufacturing labour, and the aggregate demand will remain undiminished [...] after the new proportions, between the agricultural and manufacturing populations, have been adjusted, the same number of labourers will be employed at the same rate of wages as before" (1834, p. 35)[34]. The re-absorbtion process of unemployment is reinforced, as Torrens claimed, by the increase of the funds destined for the labourers (i.e. the wage fund)[35], as the extra profits from technology are invested (1834, pp. 15-7, 40), and there is no idle hoarding - such an argument had been previously stressed by Senior (1831, p. 43); Babbage (1832, p. 335) and Chalmers (1832, p. 475).

In order for labourers to actually realize the positive effects of the new technology as described by Torrens, the following corollaries - under the mould of Classical analysis- must take place: (i) the level of prices will be decreased without altering the

thus the demand for labour is not increased; and/or (b) there no longer exists any more equal rate in profit opportunities for the employment of the additional capital and thus labour demand would be decreased.

34. Pigou noted a similar effect in relating the effects of labour-saving technology with the saving-investment behavior of the capitalists: "when the indirect effect is to increase savings, it may benefit labour even though it is both labour-saving and also concerned with some product which does not enter at all into workpeople's consumption" (1920, p. 679).

35. He had clearly defined "wage fund" as: "the ratio between population and capital, or more correctly, between the quantity of labour and the quantity of the ingredients of capital destined for its maintenance, [which] determines the intermediate point at which actual wages settle" (1834, p. 22; brackets added).

money wages, and thus the rate of real wage or the income share of the labourers will be increased; and/or (ii) the rate of investment arising from the extra profits because of the new technology is sufficient to employ many more labourers than those dismissed. Torrens (1834, pp. 38-40) incorporated in his analysis both these assumptions (although not very clearly) and concluded that "the permanent interest of the working classes must always be promoted by the substitution of a cheaper for a more expensive instrument of production" (1834, p. 43).

If the capitalist spends his extra profits in consumption goods then, as Torrens understood (e.g. 1815, pp. 299, 308; 1821, p. 347) because of the fundamental role that demand and purchasing power play in determining supply, the demand for goods and labour would increase. The re-absorption of unemployed labour would take place also in the case where the capitalist is consuming his extra profits in imported goods, because trade, as Torrens emphasized, exists only in "reciprocal benefits"[36], and thus an increased demand for exports must take place in order to balance foreign trade:

> "Should he expend them unproductively upon foreign luxuries, they will go to pay the wages of the additional number of labourers, required to produce the additional quantity of home-made goods, with which the additional supply of foreign luxuries must be purchased".
>
> (1834, p. 35)[37]

He claimed to verify the above argument for the positive effects of the new technology in the case of an open economy, by examining the consequences of foreign trade on the state of the British economy during the first three decades of the 19th century.

36. He was an advocate of "reciprocal" foreign trade: "A rate of prices universally high, cannot encourage exportation, because it checks importation; and commerce being reciprocal, the one cannot exist without the other" (1815, p. 223). Thus, "in economical science, no principles are more strictly demonstrable than, that commerce is an exchange of equivalents; and that whatever checks exportation, operates as a check upon importation" (1815, p. 228).

37. He pointed out that in the case of a negative and/or positive balance of trade, the specie-flow mechanism will take effect and, by altering the level of prices in traded goods, will reestablish international equilibrium (1815, pp. 224-5, 413) - a mechanism which he described in his 1808 work (1808, pp. 36-7) and which, later on, had been fully developed by RICARDO (1817, pp. 137, 140-1).

pity. He was a pioneer in advancing the theory of comparative advantage[38], and upon such a theory he contended that England, having the comparative advantage of manufacturing goods [mainly cotton, woolen and iron products, 1844, pp. 70, 230-1), had gained an increase of the general real wage rate. In his formal "Letter IX to the Right Hon. Sir R. Peek, Bart., M.P. on the condition of England and on the Means of Removing the Causes of Distress" written during 1842, he concluded:

> "The superior advantages which have hitherto rendered the produce pf a given quantity of English labour, more valuable than the produce of the same quantity of foreign labour, and which have consequently enabled the English to command higher wages than the continental operative, are mechanical inventions, manual dexterity, and productive coal mines".
>
> (1844, p. 234)[39]

Torrens (1815, pp. 248-8), following Smith, was, generally speaking, opposed to the doctrine of state intervention in economics on the grounds that economic efficiency is diminished by not channeling economic resources to the most profitable employment[40]. Moreover, he was (1815, pp. 49-50; 196-7, 312-3; 1821, pp. 158-60) an advocate of the free trade doctrine following the Smithian line and arguing that by the extension of the internal and foreign market, the division of labour in some production processes as well as the "territorial one" is expanded

38. Torrens maintained in the preface to the third edition of his *External Corn Trade* written on February 17th, 1826 (1815, p. vii), that he is the real pioneer for the establishment of the principle of comparative advantage of foreign trade.

39. Recent evidence seems to support this conclusion. IRWIN (1991) confirms that the theory of immiserizing growth (i.e. if a country's growth is concentrated in its export sector, its terms of trade could deteriorate, thereby reducing the national welfare) did not fit the case of England's industrialization period. Irwin makes it clear that during the Industrial Revolution Britain never faced the prospect of reduced national welfare resulting from growth in the production of its exported goods.

40. Torrens was an advocate of the idea for systematic migration to the colonies. He explicitly advanced his arguments in favour of systematic migration and colonization in his formal "Letter IV to the Right Hon. Lord Stanley on Colonisation considered as a means of removing the causes of National distress" written on January 6, 1842 (1844, pp. 79-102), and "Letter V to the Right Hon. Elliot on Colonisation" written on February 10, 1842 (1844, pp. 103-38).

and production is increased[41]. Notwithstanding, he had supported the laws against the exportation of technological inventions (Berg 1980, p. 217), and in his speech on December 6th, 1826 in the House of Commons rejected the abolition of the "ban on the export of machinery [...] on the ground that it would mean the surrender of a valuable and exclusive advantage enjoyed by England" (Meenai 1956, p. 55)[42]. Perhaps this seemingly inconsistent position may be explained as an example of Torrens "nationalism" reinforced by his military career as Fetter has shown (1962, pp. 161, 165).

However, during the general attack (during 1830's) on the repeal of the Corn Laws, Torrens changed his mind in regard to the effects of technological diffusion to other countries. He seems to be aware of the "Manchester Petition against the Corn Laws" of 1838 in which the cotton manufacturers and merchants described the manner in which the new cotton production technology had been diffused by the machine-makers all over Europe . Thus, he explicitly urged that in a free world trade and under peaceful conditions, the diffusion of scientific and technical knowledge could not be prevented:

41. Torrens' priority in advancing the principle of "territorial division of labour", first developed in his 1808 work (1808, pp. 9, 22-3), and its effect on increasing productivity, had been acknowledged early on by MCCULLOCH (1825, p. 85).

42. It was illegal prior to 1843 for British machine makers to export many types of machinery (MACLEOD 1992, p. 287). However, there is evidence that it had taken place. At least, three reports of the Select Committees of the House of Commons on the export of artisans and machinery during 1824 and 1841 supported the free export of machines (KINDLEBERGER 1975, pp. 45, 47). The ban on the migration of artisans was lifted in 1824, while the restrictions on the exports of machinery were lifted in 1843 (BLOOMFIELD 1978, p. 631).

43. In "The Manchester Petition against the Corn Laws" submitted by the Manchester Chamber of Commerce in 1838 to the House of Commons, the process of technology diffusion to other countries is adequately described: "the rapid progress in manufacturing industry going on upon the Continent is afforded in the fact that establishments for the making of all kinds of machinery for spinning and weaving cotton, flax, and wool, have lately been formed in nearly all the large towns of Europe, in which English skilled artisans are at the present moment diligently employed in teaching the native mechanics to make machines, copied from models of the newest invention of this country, and not a week passes in which individuals of the same valuable class do not quit the workshops of Manchester, Leeds, and Birmingham, to enter upon similar engagements abroad".

(in HIRST 1903, p. 141)

"if the exportation of our machines could be prevented, the makers of our machines would be induced to emigrate; and in the long run, we should lose the advantage of manufacturing superior machines for the foreign market, without being able to secure their exclusive application".

(1844, p. 236)[44]

In such an open world trade economy situation, he argued (1844, p. 233), that due to the diffusion of new technology to other countries by the producers of technological instruments and by scientists[4] , the terms of trade would be changed against the exporting technology country. Namely, in the case where a country "in the employment of machinery, and in the efficacy of manual labour, [...] cannot continue to retain any market superiority over other manufacturing countries" (1844, p. 236), then it loses its competitive advantage and/or the terms of trade are changed against it. In such a case of free trade, he shows that the level of wage rate will be decreased (1844, pp. 231, 236-7), reaching a level unavoidably determined by the forces of world competition:

"No combination amongst labourers, no liberality on the part of capitalists, and no interference on the part of the legislature, could by possibility avert these results. In a country extensively engaged in manufacturing for foreign markets, no artificial mounds can be created for damming up money-wages above the level determined by foreign competition".

(1844, p. 237)

Torrens, apart from the above positive effects of technological progress on productivity and labourers' welfare, also mentioned two short-run problems.

44. McCulloch recognized and stressed the unavoidable diffusion of technology among countries in his work *On Commerce* (1833) (see BLOOMFIELD 1978, p. 613) and he also stated the importance of machine makers for technological improvement: "Tools and machines are the result of the labour and ingenuity of the tool and engine manufacturer; and without their aid, it is impossible that any sort of labour should ever become considerably productive" (1825, p. 120). According to historical data, in the early decades of the 19th century there already had been established various branches of mechanical engineering in Britain, while its output of all kinds of machinery and equipment rose faster than the output of consumer goods (COURT 1954, pp. 180-1).

45. In regard to the agent of diffusion, Torrens was right, as MACLEOD (1992) recently proved by pointing out that the "maker-inventors" promoted the diffusion of technological progress in the 19th century.

The first shortcoming of technological progress is that of structural unemployment and the shifting of labourers from one sector of production to another. When unemployed labourers are shifted to new employment, he argued that such a process not only is time-consuming but also results in productivity loss: "The new distribution of employment will, for a considerable period, be accompanied by great privation and distress" (1834, p. 37). He was well aware that when the unemployed workers are dismissed by a sector of production (e.g agriculture), although they would find employment in other sectors (e.g. manufacture), their productivity would be decreased as they do not possess the necessary skill and dexterity in their new employment, viz.:

"The agricultural labourers [...] who had been employed upon the land thus thrown out of tillage, would lose all the benefits of the skill and dexterity they might have acquired in their accustomed calling; and, deprived of their moral capital, would be driven to seek employment in which their productive powers must be lowered".

(1815, p. 205)[46]

Torrens (1815, p. 374) makes explicit that when the wage rate and the living standard of the labourers decline, because of the prohibition of free importation of agricultural goods, their work effort or their willingness for struggle and work are also restricted. By having recognized such effects of short-run unemployment and, in addition, his disposition that the art of economics "could not be divorced from the science" (Meenai, 1955, p. 160), he suggested, as Scrope also had done[47], the establishment of a national fund for the unemployed:

46. He had defined a labourer's "moral capital", as "consisting in the skill and dexterity he had acquired in his trade" (1815, p. 201). This "moral capital" may be increased, as he claims, by technological progress, namely: "by the mechanical division, each person acquires, in his peculiar calling, an expertness and skill which would otherwise be unattainable" (1821, p. 249).

47. In regard to this proposition, SELIGMAN (1903, p. 73) comments that "It is interesting to find him advocate for the first time the idea of a national insurance fund to be applied to the alleviation of such misery". However, Seligman seems to disregard Scrope's similar and more fully analysed suggestion published a year earlier than Torrens'. More specifically, SCROPE (1833, p. 192) had already proposed such an idea by suggesting: "these sufferings [...] to be mitigated at the expense of society, by direct relief, but still more by the adoption of means for facilitating the transition of labourers from one branch of employment [...] to other employments or places". And he suggested the establishment of "a mutual insurance fund" by the manufacturers for the relief of those unemployed by the introduction of new technology (1833, pp. 316-7).

"It also appears, that the general good which results from the employment of new improved machinery is accompanied by partial evil. While (he public acquires additional wealth, the individuals who are supplanted in their accustomed occupations are reduced to poverty. Humanity and justice demand, that those who thus suffer for the public good should be relieved at the public expense. Whenever a new application of mechanical power throws a particular class of operatives out of employment, a national fund should be provided, to aid them in betaking themselves to Other occupations".

(1834, p. 44)

Torrens suggested such a measure not only from humanitarian feelings, but also having in mind his earlier idea (1808, p. 43) that through unemployment the "effectual demand" is decreased and thus the rate of national product and wealth is also reduced.

After his analysis of the effects of technology on labourers' welfare, he proceeded to unfold his approval for technological progress (1834, p. 44). And, in his later work, where he was especially persuasive in the distinction between the long-run and short-run effects of technological progress on the labourers' welfare, concluded:

"The *ultimate effect* of every new application of mechanical power, causing the same quantity of work to be executed by fewer hands, is to increase national wealth, and to enlarge the field of employment. The *immediate effect* of every such improvement is to diminish the demand for labour in the particular trade to which it is applied".

(1844, p. 260).

4. Conclusions

From the previous analysis it may be deduced that Torrens showed an original and penetrating examination of technological progress relevant to the following subjects:

(1) He showed the distinctive link of entrepreneurial mo-

tives, activities and characteristics with the process of technological progress.

(2) He stressed that the ultimate effect of the introduction of a new technology under specific assumptions would be the absolute increase of all the distributive shares in the economy.

(3) He extensively investigated the structural effects of technological progress under a general, rather than a partial, analysis.

(4) He developed the idea of the international diffusion of new technology through businessmen and specialized labourers.

(5) He stressed that, in an open world trade economy, the labourers' welfare depends on the size of natural endowments and the stage of technological progress.

(6) He recognized that the short-run unemployment generated by the introduction of a new technology would diminish labourers' productivity due to a lack of experience with a different employment.

(7) He proposed the establishment of a special fund as a remedy for the relief of those being unemployed by technological progress.

Torrens' comprehensive analysis of the various effects of technological progress, far from being his main concern, seems rather to be a by-product of his capital theory of value, or the "quantity of capital outlay theory" as Robbins called it (1958, p. 239). That is why, more than the other representative Classical writers of the period such as Ricardo, Malthus, McCulloch, etc. he elaborated on the subject of entrepreneurial decisions and its effects on capital accumulation and investment processes. Although he very often changed his views about significant economic subjects such as the wage-profit relationship, the role of money and banking, etc. (see Robbins 1958, pp. 5-6, 53-4, 74), in the case of technological effects, his ideas and views remained the same from the beginning to the end of his works, namely: he advanced the argument that the introduction of new technology is the main factor of economic growth.

Robbins' painstaking analysis of Torrens' economic ideas did not give special mention to his arguments in regard to the subject of "machinery". In estimating his originality and importance regarding the main "themes" of classical economics, such as the theory of value, distribution, money and international relations, Robbins concluded that "as an economist he was not in the first rank [...]. But among the men of the next grade his standing was not negligible" (1958, p. 258). On the other hand, Seligman (1903, p. *77)* and Dorfman (1965, p. 17) were anxious that modern historians of economics should attribute a higher estimation to Torrens' contributions to economics. The truth seems to be in the middle: although Torrens's place in the general histories of economics may be in a rather low-standing position, in the special phenomenological histories[48], and especially those analysing the issues of technological progress and economic growth, he rightly deserves a much higher position.

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48. For the distinction of these histories of economics, see KARAYIANNIS (1998b).

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