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Original Research

Environmental Profit and Loss of Industry: the Case of Textile Industry in Jiaxing

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Abstract

The textile industry is a typical energy-intensive and water-intensive industry, causing a large amount of greenhouse gas emission and wastewater discharge. How to evaluate the environmental degradation caused by textile industry more intuitively and objectively has aroused great concern in recent years. The Environmental Profit and Loss (EP&L) is a method to evaluate the environmental impact intuitively as it converts different environmental impacts into a unified social marginal cost. In this paper, EP&L methodology and an innovative indicator, which is Environmental Profit and Loss intensity ($EP\&L_{in}$), were applied to evaluate the environmental impacts caused by carbon dioxide emission and water consumption of textile industry in Jiaxing from 2011 to 2018. The results showed that the total EP&L value converted from carbon dioxide emission of textile industry in Jiaxing presented an upward trend from 2011 to 2018. The maximum EP&L value due to carbon dioxide emission reached to US$ 729 million in 2018. The total EP&L value of water consumption was increased from US$ 0.4 million in 2011 to US$ 0.5 million in 2018. During this period the $EP\&L_{in}$ of textile industry in Jiaxing went up from 0.1090 to 0.1283, and the $EP\&L_{in}$ of carbon dioxide emission was much larger than that of water consumption. Additionally, among the three sub-sectors (manufacture of textile, manufacture of chemical fibers and manufacture of textile, wearing apparel and accessories), the manufacture of textile sector's EP&L value converted from carbon dioxide emission and water consumption accounted for approximately 60% of the total EP&L value of textile industry in Jiaxing, much larger than that of the other two sub-sectors. The manufacture of chemical fibers sector had the largest $EP\&L_{in}$ from 2012 to 2018. This result indicated that manufacture of chemical fibers

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in Jiaxing had a greater impact on the environmental degradation caused by carbon dioxide emission and water consumption.

Keywords: carbon dioxide emission, water consumption, Environmental Profit and Loss, social marginal cost, textile industry

Introduction

Currently sustainability receives much attention. In September 2015, the UN General Assembly adopted the 2030 Agenda for Sustainable Development as a ‘plan of action for people, planet and prosperity’, which ‘seeks to strengthen universal peace in larger freedom’. As part of the 2030 Agenda for Sustainable Development, the United Nations announced 17 Sustainable Development Goals (SDGs) and 169 targets measured by over 200 indicators [1]. Among the 17 SDGs, SDG 6 was specifically dedicated to water and sanitation, and SDG 13 combated climate change and its impact [2-3].

The impact of climate change on the socioeconomic system is one of the major issues that the world has to manage in the 21st century [4]. On 12 December 2015, the Paris Climate Conference adopted the Paris Agreement to combat global warming, the long-term goal of which was to limit the increase in global average temperature to 2ºC compared to the pre-industrial period and to strive to limit the increase to 1.5ºC [5]. As of 12 June 2020, 125 countries have committed to achieving carbon neutrality by the middle of the 21st century [6]. Besides, at least one-fifth of the world’s 2000 largest public companies have net zero emission commitments so far [7].

Water consumption represents freshwater withdrawals which are evaporated, incorporated in products and waste, transferred into different watersheds, or disposed into the sea after usage [8]. Textile industry is one of the major consumers of water and it ranks among the top ten water-consuming industries [9]. To make just one pair of denim jeans, 10000 liters of water were required. In comparison, it would take one person 10 years to drink 10000 liters of water [10]. Industrial consumption of water reduces the amount of water available for other uses, which will have impact on the environment and human beings.

For the textile industry, sustainable development has been a burning issue for many related concerned bodies [11]. Textile industry is one of the longest and most complicated industrial chains in the manufacturing industry. The manufacturing process is characterized by high consumption of water, fuel, and a variety of chemicals in a lengthy process that generates a significant amount of waste. The main environmental problems associated with the textile industry are air pollution and water resource waste [12]. Textile industry is the pillar of fashion industry, which generates around 2 to 8 percent of global greenhouse gas emissions and consumes large amounts of water for various unit operations [13-14]. As the largest textile producer and exporter in the world, China provides more than 30 milliontons of high-quality fiber products every year [15]. Therefore, the carbon dioxide emission and water crisis have been two major environmental challenges in China [16].

In order to achieve the sustainable development goals, the quantitative assessment of environmental impacts caused by the textile industry has gained more and more attention. Single index methodologies, such as water footprint, carbon footprint have been proposed and widely applied in environmental impact quantitative assessment of textile products [17]. However, each environmental impact category has different units, so the comprehensive comparison and analysis cannot be achieved. The Environmental Profit and Loss (EP&L) methodology, which converts different environmental impacts into a unified social marginal cost, were proposed as a management tool to provide an in-depth analysis of the environmental impacts that a company activities have [18]. It is an innovative tool which makes the environmental impacts caused by industrial production visible, quantifiable and comparable [19]. Puma, True Price, and some other corporations have used the EP&L method to assess the environmental impact of their products [20-22].

Although some EP&L reports have been published for textile products, there are few studies related to EP&L of textile industry. To address this research gap, this paper has applied the EP&L method to quantify and evaluate the environmental impacts of textile industry in Jiaxing city, which is located in the center of the Yangtze River Delta in China. In Jiaxing the textile industry is one of the most important traditional pillar industries. More importantly, among the five cities around Taihu area, textile industrial output value in Jiaxing accounts for the largest proportion of its total industrial output value which up to 33% [23]. Additionally, Environmental Profit and Loss intensity ($EP\&L_{in}$) is proposed in this paper to improve the understanding of the degree of environmental degradation caused by industrial activities. This article also provides details on the related research methods, data, and results of the case study, which enables the reader to evaluate its scientific quality.

Material and Methods

EP&L Value of Carbon Dioxide Emission ($EP\&L_c$)

At present, the linkages among social dynamics, economic development and climatic variability have been proved by many studies. Climate change exerts wide-ranging influences on natural flows and the economy, including agriculture, transportation, tourism, human health and so on [24]. Carbon dioxide emission contributes to the greenhouse gas concentrations, which affect radiative forcing and give rise to higher global temperature [4]. The social cost of carbon (SCC) is the monetary value of the marginal damage caused by carbon dioxide emission. The SCC has become the core tool for formulating climate change policies, especially concerning regulatory policies related to greenhouse gas emissions [25]. Richard has estimated national SCC for many countries and indicated that large, poor countries would impose the highest carbon taxes if acting in the national self-interest [26].

This paper used the estimated SCC of the Price waterhouse Coopers (PwC) methodology to calculate the $EP\&L_c$. The PwC methodology gives two results on SCC: mean value (US\$78/tCO_2e) and median value (US\$62/tCO_2e). The mean value takes more account of very high estimates derived from potentially catastrophic climate scenarios and therefore reflects a more precautionary approach to potential climate change impacts. The median value, by contrast, is less affected by very high values. Therefore, it could reflect the consensus view, but takes little account of catastrophic scenarios. In this paper, the median value was taken into account for subsequent calculation [27].

The calculation method for EP&L value of carbon dioxide emission is described as follows:

$$CDE_{textile} = \sum_{i=1}^{n} M_i \times f_i \tag{1}$$

$$EP\&L_c = CDE_{textile} \times SCC \tag{2}$$

where, $CDE_{textile}$ is the carbon dioxide emission of textile industry (tCO_2); i represents the energy category; M_i is the consumption amount of energy i (ton standard coal equivalent (SCE)); f_i is carbon dioxide emission factor of the energy i; $EP\&L_c$ is Environmental Profit and Loss value of carbon dioxide emission (Million USD); SCC is the social cost of carbon (US\$62/tCO_2e).

EP&L Value of Water Consumption ($EP\&L_w$)

Water cannot be substituted for other goods or services such that its worth is infinite and beyond the bounds of economics. However, on the basis of meeting the basic needs, the marginal value of water can be understood and quantified [27]. Water consumption of industrial production leads to a reduction in available clean water for other users reliant on the same source, which will arouse some societal impacts, such as malnutrition, water-borne diseases, resource depletion and so on [27]. Pfister et al. and Motoshita et al. have investigated the impacts of water consumption on environment and human health, which provide the basis for calculating the social marginal cost (SMC) of water consumption [8, 28].

PwC methodology applies the SMC method to estimate malnutrition impacts associated with corporate water use. The standard metric of Disability Adjusted Life Years (DALYs) is used to estimate the extent of water consumption to human health [29]. DALYs measures the overall burden of disease, combining years lost due to premature death and ‘healthy’ years lost to ill health or disability. The number of healthy years lost is calculated by multiplying the length of time the disease occurs and a disability weighting based on the severity of the disease. The number of cases of malnutrition is converted into DALYs using a regression of country level malnutrition cases and DALYs associated with malnutrition. The monetary value of DALY is calculated based on the value of a statistical life (VSL) and the lost DALYs associated with the VSL estimate [27].

In this paper, the value of DALY (US\$185990) in PwC methodology and the characteristic factor (2.02×10^{-8} DALY/m^3) were used to calculate the SMC of water consumption [28]. The calculation method for SMC of water consumption is described as follows:

$$CF_{malnutrition} = WSI \cdot WU_{\%textile} \cdot \frac{HDF_{malnutrition}}{WR_{malnutrition}} \cdot DF_{malnutrition} \tag{3}$$

$$VOD = \frac{VSL}{NDL} \tag{4}$$

$$EP\&L_w = SMC_{consumption} = WU_{consumption} \cdot CF_{malnutrition} \cdot VOD \tag{5}$$

where $CF_{malnutrition}$ is the characteristic factor of malnutrition caused by water consumption (DALY/$m^3_{consumption}$); WSI is the local water stress index; $WU_{\%\ textile}$ is the fraction of water use in textile industry; $HDF_{malnutrition}$ is the human development factors associated with malnutrition; $WR_{malnutrition}$ is the water requirement per capita to prevent malnutrition (m^3); $DF_{malnutrition}$ is the damage caused by malnutrition; VOD represents the cost loss per unit of disease burden (US\$/DALY), which relates the VSL to the number of DALY lost (NDL); $SMC_{consumption}$ is the social marginal cost of water consumption (Million USD), which is equivalent to the EP&L value of water consumption ($EP\&L_w$) in this paper; $WU_{consumption}$ is the water consumption of textile industry (m^3) [28].

EP&L Intensity

EP&L intensity was proposed to express the relationship between the value of environmental impact and value added of industry (VAI) intuitively. The calculation method of EP&L intensity is as follows:

$$EP\&L_{in} = \frac{EP\&L}{VAI} \qquad (6)$$

where $EP\&L_{in}$ is the Environmental Profit and Loss intensity of industries; $EP\&L$ is the Environmental Profit and Loss of environmental impacts (Million USD), such as carbon dioxide emission, water consumption; VAI is value added of industry in relative industry (Million USD).

Data Sources

The data about value added of industry (2012-2018), various energy consumption and water consumption of textile industry in Jiaxing from 2011 to 2018 were obtained from Jiaxing Statistics Bureau [30]. According to industrial classification for national economic activities in China (GB/T 4754-2011), the textile industry includes three sub-sectors: manufacture of textile (MT), manufacture of chemical fibers (MCF), and manufacture of textile, wearing apparel and accessories (MTWAA). The calculated carbon dioxide emission of the three sub-sectors in Jiaxing from 2011 to 2018 is illustrated in Table 1. Table 2 shows water consumption of the three sub-sectors in Jiaxing from 2011 to 2018. The VAI of the three sub-sectors in Jiaxing just cover from 2012 to 2018 due to the data deficient, as shown in Table 3. We have converted the CNY into USD with yearly average currency exchange rates.

Results

Fig. 1 presents the EP&L value of carbon dioxide emission. $EP\&L_c$ of textile industry in Jiaxing shows an increasing trend between 1.9% and 6.9% annual growth rates from 2011 to 2018. It reached to US$729 million in 2018 with an increase of 34% over 2011. The $EP\&L_c$ of MT took the largest share (more than 60%) of the total value, followed by MCF (35%) and MTWAA (5%). The $EP\&L_c$ of MT and MCF kept an increase trend and grew by 30% and 45% from 2011 to 2018, respectively. The $EP\&L_c$ of MTWAA jumped up to US$37.28 million in 2012, with an increase of approximately 49% compared to $EP\&L_c$ in 2011. After 2012, the $EP\&L_c$ of MTWAA showed a slow downward trend and reached its lowest point in 2018.

Table 1. Carbon dioxide emission of the three sub-sectors (MT, MCF, MTWAA) from 2011 to 2018.

Carbon dioxide emission (t)	2011	2012	2013	2014	2015	2016	2017	2018
MT	5515228.37	5699922.05	5856023.40	6233619.72	6463684.94	6829188.72	7070163.11	7173810.84
MCF	2872781.42	3098172.76	3175087.08	3334793.55	3569722.93	3687180.50	3846846.17	4178853.18
MTWAA	402973.11	601301.20	543432.90	501997.03	524173.85	510913.08	448909.47	403093.27

Table 2. Water consumption of the three sub-sectors (MT, MCF, MTWAA) from 2011 to 2018.

Water consumption (10000 cu.m)	2011	2012	2013	2014	2015	2016	2017	2018
MT	9817	10074	10289	10439	10682	10705	11418	11159
MCF	635	691	638	718	766	755	801	763
MTWAA	987	1326	1255	1074	1062	1058	924	817

Table 3. Value added of industry of the three sub-sectors (MT, MCF, MTWAA) from 2012 to 2018.

Value added of industry (million USD)	2012	2013	2014	2015	2016	2017	2018
MT	2312.1175	2579.3931	2880.3960	3065.8622	2970.6799	3055.8408	3309.2189
MCF	713.3517	850.3214	997.9998	956.8643	1193.0939	1386.6748	1459.5794
MTWAA	1521.5427	1599.7694	1852.6884	1746.8804	1656.3470	1511.4010	1568.3936
Total	4547.0119	5029.4839	5731.0842	5769.6069	5820.1207	5953.9166	6337.1919

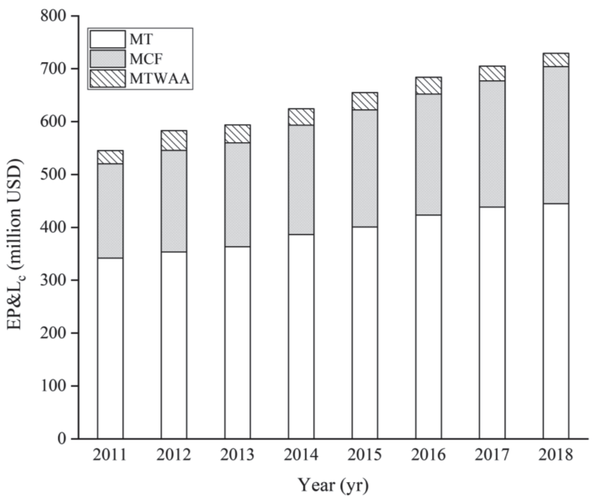

Fig. 1. EP&L value converted from carbon dioxide emission ($EP\&L_c$) of the three sub-sectors (MT, MCF, MTWAA) in Jiaxing from 2011 to 2018.

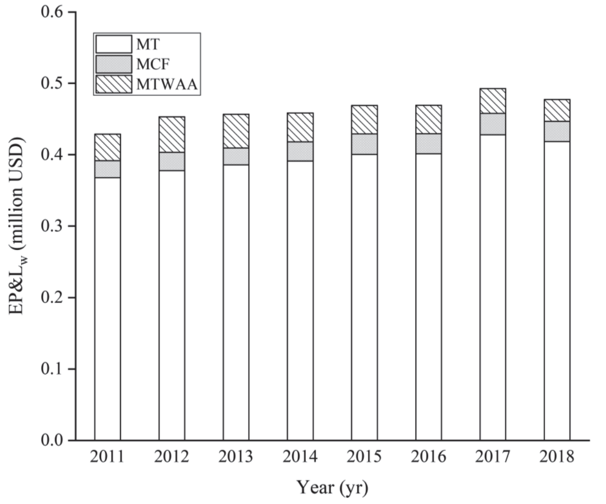

Fig. 2. EP&L value converted from water consumption ($EP\&L_w$) of the three sub-sectors (MT, MCF, MTWAA) in Jiaxing from 2011 to 2018.

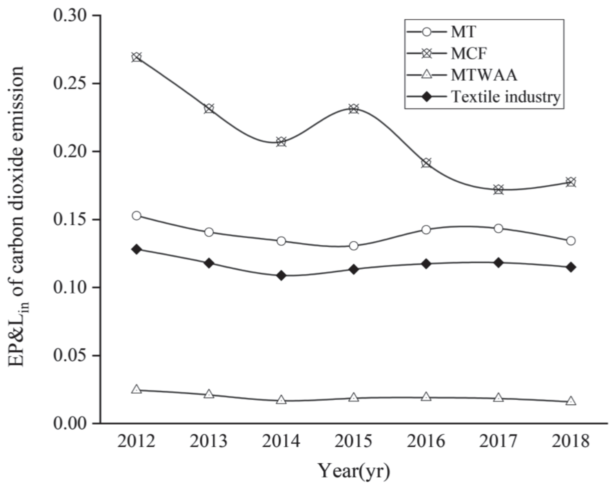

Fig. 3. EP&L intensity of carbon dioxide emission of textile industry and three sub-sectors (MT, MCF, MTWAA) in Jiaxing from 2012 to 2018.

The EP&L value of water consumption is shown in Fig. 2. The $EP\&L_w$ of textile industry presented a floating upward trend from 2011 to 2018. The maximum level of $EP\&L_w$ was US\$0.5 million in 2017, and the minimum one was US\$0.4 in 2011. The average $EP\&L_w$ of textile industry in Jiaxing exceeded US\$0.46 million/yr from 2011 to 2018. Among the three sub-sectors, the $EP\&L_w$ of MT accounted for more than 85% of the total value, followed by MTWAA (9%) and MCF (6%). Besides, the $EP\&L_w$ of MT and MTWAA presented yearly fluctuation during the period under study. The $EP\&L_w$ of MCF fluctuated around US\$0.025 million and kept to a stable level from 2011 to 2018.

The calculated total EP&L values of textile industry in Jiaxing and the three sub-sectors are listed in Table 4. The trend of total EP&L values from 2011 to 2018 were similar to that of $EP\&L_c$. This was mainly because the $EP\&L_c$ of textile industry in Jiaxing was much larger than that of $EP\&L_w$, which took more than 99% of the total EP&L value. Table 4 shows that the total EP&L value of MT was twice larger than that of MCF, and ten times larger than that of MTWAA.

The trend of $EP\&L_{in}$ caused by carbon dioxide emission of textile industry in Jiaxing is presented in Fig. 3. The $EP\&L_{in}$ of textile industry was fluctuated around 0.13 and kept a steady trend. The $EP\&L_{in}$ of MCF and MT were above the overall level of textile industry. The $EP\&L_{in}$ of MCF showed an obvious variation which dropped from 0.27 in 2012 to 0.18 in 2018. It jumped up to 0.23 in 2015, with an increase

Table 4. Total EP&L value of carbon dioxide emission and water consumption of the three sub-sectors (MT, MCF, MTWAA) from 2011 to 2018.

EP&L value (million USD)	2011	2012	2013	2014	2015	2016	2017	2018
MT	342.3121	353.7727	363.4591	386.8757	401.1488	423.8109	438.7781	445.1945
MCF	178.1362	192.1126	196.8793	206.7841	221.3515	228.6335	238.5345	259.1175
MTWAA	25.0213	37.3304	33.7399	31.1641	32.5386	31.7163	27.8670	25.0224
Total	545.4697	583.2157	594.0783	624.8239	655.0389	684.1607	705.1796	729.3344

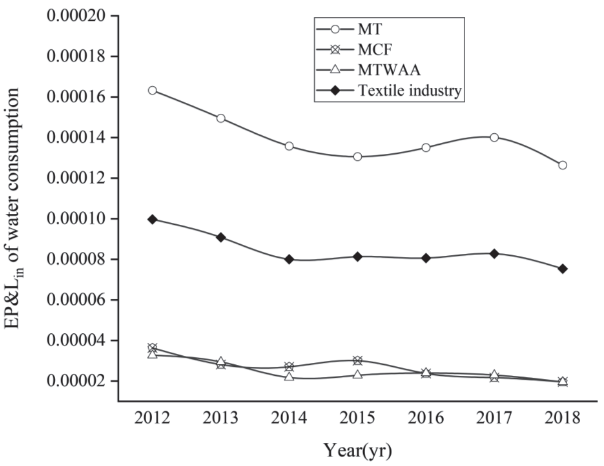

Fig. 4. EP&L intensity of water consumption of textile industry and three sub-sectors (MT, MCF, MTWAA) in Jiaxing from 2012 to 2018.

of approximately 12 percent compared to EP&L_{in} in 2014, and then decreased gradually. The original data showed that the growth of EP&L_{in} could be attributed to the increased EP&L_c and decreased VAI of MCF from 2014 to 2015. The EP&L_{in} of MTWAA was below the overall level of textile industry, and its EP&L_c just accounted for approximately 3% of the VAI.

Fig. 4 illustrates the trend of EP&L_{in} caused by water consumption of textile industry in Jiaxing. As is shown in Fig. 4, the EP&L_{in} of textile industry and the three sub-sectors presented obvious downward trend from 2012 to 2014. The EP&L_{in} caused by water consumption of textile industry dropped from 9.97×10^{-5} in 2012 to 7.53×10^{-5} in 2018. Among the three sub-sectors, the EP&L_{in} of MT is above the overall level of textile industry. It decreased approximately 23% from 2012 to 2018. In 2017, the EP&L_{in} of MT increased slightly, which was caused by the considerable increase of EP&L_w. The EP&L_{in} of MTWAA and MCF were similar, and both were below the overall level of textile industry.

EP&L_{in} of textile industry in Jiaxing and the three sub-sectors are demonstrated in Table 5. The total EP&L_{in} of textile industry in Jiaxing fluctuated between 0.1090 and 0.1283. In other words, the environmental impacts value of textile industry accounted for 10.90% to 12.83% of the VAI. Table 5 also shows that the MCF had the largest EP&L_{in} from 2012 to 2018, which meant the EP&L value of MCF took a high percentage of its VAI. In comparison, MTWAA had a lower EP&L_{in}, accounting for only one tenth of the EP&L_{in} of MCF. Amongst the three sub-sectors, the EP&L_{in} of MCF showed a significantly decrease (34%) from 2012 to 2018, while the variation of MT industry and MTWAA were more moderate.

Discussion

After years of rapid development, textile industry in Jiaxing has owned completed industrial production chains and has a big industrial cluster. Meanwhile, the increasing demands for energy and freshwater are also inevitable. MT is a major component of textile industry in Jiaxing, and most sub-processes of industrial production such as spinning, weaving, and clothing are concentrated on MT. These processes use amount of energy and freshwater bound to generate massive carbon dioxide emissions and wastewater, which are responsible for the largest EP&L value of MT [31].

In the textile life cycle, the industrial production stage answers for the highest carbon emission contributions. Wang et al.'s study manifested that spinning and weaving process in the manufacturing stage contributed a lot to the carbon footprint [33]. Luo et al. indicated that the carbon footprint of cotton jeans in industrial manufacturing stage accounted for 95.51% of the impact throughout the whole life cycle [32]. By tracing the emission source of GHGs, it was found that energy consumption, especially of electricity, is the main contributor to the carbon emissions of textile products [32-33]. Liu et al. pointed that in the process of melange yarns manufacturing, the consumption of electricity in the spinning stage accounts for 83% of the whole manufacturing stage [34].

The results of EP&L caused by carbon dioxide emission and water consumption in this study have indicated that the total EP&L_c of textile industry is much higher than that of EP&L_w. Several reasons can be identified for it. MCF and MT are listed as two of the eight high-energy consumption industries in Jiaxing. While industrial output of the textile industry in Jiaxing increased annually from 2011 to 2018, energy consumption grew with corresponding increase of

Table 5. Total EP&L intensity of carbon dioxide emission and water consumption of textile industry and three sub-sectors (MT, MCF, MTWAA) from 2012 to 2018.

EP&L intensity	2012	2013	2014	2015	2016	2017	2018
MT	0.1530	0.1409	0.1343	0.1308	0.1427	0.1436	0.1345
MCF	0.2693	0.2315	0.2072	0.2313	0.1916	0.1720	0.1775
MTWAA	0.0245	0.0211	0.0168	0.0186	0.0191	0.0184	0.0160
Textile industry	0.1283	0.1181	0.1090	0.1135	0.1176	0.1184	0.1151

carbon dioxide emission. Especially the large amount use of raw coal, heating power and electric power of textile industry in Jiaxing which lead to the tremendous emissions of carbon dioxide has a significant impact on the result of $EP\&L_c$. According to the research of Chen et al., the carbon emissions of cashmere fabrics in manufacturing process is two orders of magnitude larger than water consumption per functional unit [35] Besides, social marginal cost of unit water consumption lower than the social cost of carbon is also a big factor to the EP&L value. The high social marginal cost of carbon reflects that people attach more importance to carbon dioxide emission, which leads to a high estimate value of SCC.

Kering's 2020 Group EP&L value was estimated from raw material production to end of life stage which is to be €515.9 millions. Among the six life cycle impact categories evaluated, the EP&L of GHGs accounted for 35% and water consumption made up 7% [36]. According to Puma's EP&L result, the negative environmental impact in 2019 was valued at €711 millions. The EP&L of carbon emission accounted for 37% and water use took the proportion of 18% [37]. These results revealed that the value of carbon emissions dominated the EP&L value.

Different from the $EP\&L_{in}$ proposed in this paper, Kering defines their EP&L intensity as EP&L (€) per €1000 revenue. From 2016 to 2020, Kering has decreased their EP&L intensity from 58 to 35, achieving a 39.6% reduction [36]. The EP&L intensity of Jiaxing's textile industry decreased by 10.3% between 2011 and 2018. It reflects that textile industry in Jiaxing still have a lot work to do to reach a better environmental performance, while that doesn't mean there have no progress over the years. From the yearly data about textile industry in Jiaxing listed in Table 3 and Table 4, we can inform that the total EP&L value and AVI of textile industry were increased while the $EP\&L_{in}$ was decreased. It indicates that the increase rate of AVI is larger than that of total EP&L value. It also revealed the measures enterprises taken, which were adjusting their internal product structure and, improving the technical innovation, have made a difference to the increase of output value in unit energy consumption. The MCF sector had the largest $EP\&L_{in}$ among the three sub-sectors from 2012 to 2018, which means the environmental impacts values took a big share of its VAI. Therefore, it could play a major role for textile industry in Jiaxing to change the development mode of MCF and advocate green production.

The modern technologies related to energy saving, wastewater reuse and recycle developed in these years are effective to reduce the energy and water consumption. Many policies and standards on

Table 6. Policies on energy consumption and freshwater intake in textile industry

Energy consumption:
FZ/T 07001-2013 Calculation directives for comprehensive energy consumption of cotton spinning and weaving industries
DB33/683-2012 The quota & calculation method of comprehensive energy consumption per unit production for polyester (filament, staple) fiber
DB33/685-2013 The quota & calculation method of comprehensive energy consumption per comparable unit production for printed and dyed fabric
DB33/678-2015 The quota & calculation method of comprehensive energy consumption for viscose (filament yarn & staple) fiber
DB33/962-2015 Emission standard of air pollutants for dyeing and finishing of textile industry
The 12th five-year plan for textile industry
Implementation opinions of energy dual control (2012)
ZJFC00-2013-0021 The 12th five-year plan for controlling total energy consumption work program of Jiaxing
Implementation plan for controlling total coal consumption of Jiaxing (2014~2017)
Energy supervision plan of Jiaxing (2016)
Water intake:
GB 4287-2012 Discharge standards of water pollutants for dyeing and finishing of textile industry
GB/T 18916.4-2012 Norm of water intake – Part 4: Dyeing and finishing of textile industrial product
GB/T 18916.14-2014 Norm of water intake – Part 14: Wool textile product
GB/T 18916.24-2016 Norm of water intake – Part 24: Long vegetable fibre production
GB/T 18916.25-2016 Norm of water intake – Part 25: Viscose fiber products
Several opinions on accelerating the work of water environment governance (2012)
The 12th five-year plan for textile industry

restrictions of energy and water consumption issued by the government play an important role (see Table 6). The policies implemented in Jiaxing, such as 12th five-year plan for total energy consumption control program and ‘Five water treatment’, have achieved remarkable effects. However, there is still a long way to go to achieve the cleaner production goals. Environmental sustainability of textile industry should be constantly controlled with the aim of minimizing its environmental impacts without compromising the competitiveness of this productive sector.

Conclusions

The textile industry has serious environmental impacts in terms of climate change, resource depletion and water pollution. The EP&L method could evaluate the environmental impacts in monetary terms to make the environmental impact more visible, quantifiable and comparable. This study adopted the estimated value of SCC and SMC in PwC methodology to evaluate the EP&L value caused by carbon dioxide emission and water consumption of textile industry in Jiaxing. Environmental Profit and Loss intensity ($EP\&L_{in}$) was proposed in this paper as an innovative indicator to reflect the relationship between environmental impact and value added of industry.

In the case of textile industry in Jiaxing, the EP&L value converted from carbon dioxide emission accounted for more than 99% of the total EP&L value. Therefore, the control of carbon dioxide emission of textile industry in Jiaxing is an important factor to promote the environmental improvement. Among the three sub-sectors, MCF has the largest $EP\&L_{in}$. It indicates that the environmental impacts value of MCF accounts for a higher proportion of its VAI than the other two sub-sectors. Thus it is important to improve the environmental impact of MCF which will promote the sustainable development of textile industry in Jiaxing considerably.

This study can be used as an example for further research on EP&L value of industrial production in other industries. The $EP\&L_{in}$ proposed in this paper could be regarded as a tool to compare the environmental impacts with value added of industry in the monetary level. Although the value added of industry is a highly reliable indicator to reflect the economic performance of an industry, it ignores the non-market economy especially the environmental impacts caused by economic growth. $EP\&L_{in}$ gives a clear perspective on the consequences of economic progress by quantifying the cost of environmental degradation and then making a comparison with value added of industry. Finally, it was concluded that the environmental quality shouldn’t be sacrificed to achieve higher growth rates and higher benefits of standard economic features. The methodology will be further studied.

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Conflict of Interest

The authors declare no conflict of interest.

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