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Analysis

Higher Wages for Sustainable Development? Employment and Carbon Effects of Paying a Living Wage in Global Apparel Supply Chains

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ABSTRACT

In this paper we explore how paying a living wage in global supply chains might affect employment and carbon emissions: Sustainable Development Goals 8 and 13. Previous work has advocated using wage increases for poorer workers to increase prices for wealthier consumers, thereby reducing consumption and associated environmental damage. However, the likely effects of such an approach remain unclear. Using an input-output framework extended with income and demand elasticities, we estimate the employment and carbon effects of paying a living wage to Brazilian, Russian, Indian and Chinese (BRIC) workers in the Western European clothing supply chain. We find negligible effects on carbon emissions but a substantial increase in BRIC employment under 3 scenarios of consumer behaviour. Changes in Western European consumption lead to small decreases in global carbon emissions and BRIC employment. However, the increase in BRIC wages increases demand in BRIC. This increased demand increases production which largely cancels out the carbon savings and generates net increases in BRIC employment. We conclude by arguing that paying higher wages in global supply chains represents a good but not sufficient step toward achieving the Sustainable Development Goals.

1. Introduction

The starting point of this paper is that sustainable development requires two simultaneous but potentially conflicting actions: that rich people buy less and poor people buy more. Put another way, sustainability requires real economic growth in poorer countries and lower material consumption in wealthier countries. The potential for conflict here comes from the interconnected nature of the global economy: all else equal, a reduction in consumption in wealthier parts of the world might damage growth prospects in poorer parts of the world.

We can frame our concerns in terms of the Sustainable Development Goals. In order to meet Goal 13 (Climate Action), limits on consumption are almost inevitable. Continued economic growth and a 2 degree warming limit can only be achieved through a rate of technological decarbonisation that is entirely unprecedented (Jackson, 2017). Consequently, we do not think that it is prudent to rely on technological innovation alone. Some reduction in consumption is likely to be needed, particularly in the richest economies. The catch-22 of the Sustainable Development Goals is that actions that help us avert ecological crisis may also risk our social goals. The tension comes from the fact that economic growth and job creation in poorer countries is currently tied to demand in wealthy countries (e.g. Alsamawi et al., 2014; Simas et al., 2014). Consequently, reducing consumption in wealthy countries risks destroying jobs and worsening poverty (Goals 8 and 1), even as it reduces greenhouse gas emissions.

Therefore, to meet the Sustainable Development Goals we have to seek out approaches that actively attempt to meet multiple goals simultaneously; to find some way to reduce carbon emissions while also providing decent jobs for all. In short, approaches to sustainable development must enable the richest economies to reduce their impacts while improving living and working conditions in less affluent countries (Tukker et al., 2008; Jackson, 2011).

In this paper we explore the potential for supply chain living wages to play such a role. It has been suggested that increasing the wages of workers in less affluent countries could contribute to both social and environmental sustainability (Clift et al., 2013; Mair et al., 2016). The core idea here is that passing the wage increases onto consumers in the richer countries should reduce consumption and in this way reduce carbon emissions (Goal 13). At the same time, paying higher wages will increase the income of workers, helping to raise them out of poverty (Goal 1). However, these assertions are highly contested. There are several ways in which consumers might respond to price increases. Will they reduce their clothing consumption, reduce other types of consumption, or a mix of both? Different consumer responses might have different impacts on employment and carbon emissions, but there is very little evidence to suggest whether we should expect these to be net positive or net negative in terms of sustainability.

In this paper we contribute the first systematic analysis of the sustainability impacts of fairer wages in global supply chains. We do this by modelling the carbon and employment effects of an increase in the wages of workers in Brazil, Russia, India, and China (BRIC) within the Western European clothing supply chain. Our model incorporates a

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range of consumer responses. In all cases we find that despite reductions in Western European consumption, employment in the BRIC countries increases overall. This is because the higher wage rates stimulate an increase in local demand and this generates more jobs than are lost from the reduction in Western European spending. However, this same dynamic reduces the effectiveness of the intervention in terms of carbon emissions: increased spending in BRIC largely cancels out the carbon savings associated with reduced consumption in Western Europe. These results highlight the importance of economic geography, particularly the importance of the relative carbon and employment intensity of a dollar in different parts of the world.

2. Higher Wages and Their Relationship to Sustainability

In this section we elaborate on the debates that motivate our paper. First we introduce the concept of a living wage, then we highlight recent work in the Industrial Ecology and Sustainable Fashion literatures that argues raising wages could be good for both the environment and our social goals. Finally we link this to debates in the economics literature over the effect of wage increases on employment.

2.1. Fair and Living Wages

All proposals that aim to increase wages to a 'fair' level share a longstanding ethical concern with the conditions of work. This concern is older than modern sustainability debates: in 1881, Engels wrote that "*A Fair Day's Wages for a Fair Day's Work… has now been the motto of the English working-class movement for the last fifty years*". And we can trace the roots of modern debates even further back. For example, in Book V of *The Wealth of Nations* Smith (1776) writes that workers need to be able to afford certain goods in order to live with dignity, and argues that the cost of these goods needs to be factored into wage levels. The same sentiment underlies the modern concept of 'living' wages (Clary, 2009).

A living wage is the amount a worker needs to earn in order to be able to afford a decent, but not luxurious standard of living (Pollin et al., 2008). Estimates of living wages represent a quantified measure of fairness based on normative judgements around what constitutes a 'decent' life (Mair et al., 2018). As a result, estimates of living wages vary over time and space. For example, in *The Wealth of Nations* Smith (1776, Book V, Chapter II, Part II) argues that the ability to afford a linen shirt and leather shoes were defining characteristics of a socially acceptable life in 18th century England. While more recent studies in the UK also discuss clothing, this is now in the context of being able to afford multiple outfits from low cost shops, and school uniforms (Davis et al., 2018).

In relatively poor countries, living wages often imply a substantial wage increase for many workers. For garment workers in apparel supply chains (who often live and work in countries much poorer than the countries where the clothes they make will be sold), living wages are roughly equal to around a doubling of workers' wages (Pollin et al., 2004; Miller and Williams, 2009; Mair et al., 2018).

In this study we use the living wages estimated by Mair et al. (2018). Interested readers are directed there for a more extensive discussion of the precise definition of fairness being used. In brief, Mair et al. (2018) estimate living wages for Brazil, Russia, India and China. Importantly, their estimates include an allowance so that a worker can support dependents, and is able to make savings (providing financial security). Also, they add in the cost of labour taxes in each country, to ensure that the worker's pay is sufficient for a better than subsistence life after taxes.

2.2. Higher Wages for Sustainability: Industrial Ecology and Sustainable Fashion

Recent work in Industrial Ecology combines the moral arguments for living wages with an environmental argument: that improved labour conditions could reduce the environmental burden of consumption. This position was developed by Clift et al. (2013), building on work by Girod and de Haan (2009, 2010). Girod and de Haan find that some Swiss consumers choose to buy higher quality goods rather than more of them. Because these higher quality goods have higher unit prices, consumers with quality-oriented spending patterns also spend less on high emission consumption items. Consequently, they have relatively low carbon footprints. Clift et al. (2013) extended this by arguing that 'quality' could be redefined to mean products with more socially equitable supply chains. The key argument is that improving working conditions in a variety of ways, including higher wages, could lead to higher unit prices, reducing levels of consumption in affluent countries while simultaneously improving the livelihoods and working conditions of workers in less affluent countries. This argument is taken up by Mair et al. (2016) who suggest that a 'better-rather-than-more' strategy could be used to make clothing supply chains more equitable and reduce levels of consumption.

Clothing serves as an interesting case study because the tensions between the social and environmental aspects of sustainability are highly visible in its supply chains. Clothing production is a substantial contributor to greenhouse gas emissions (Mair et al., 2016), solid waste (Claudio, 2007), and water use (Muthu et al., 2012). However, the clothing industry has historically been at the forefront of economic development, bringing increases in both wages and employment in some of the poorest economies in the world (Keane and Willem te Velde, 2008). More recently, changes in global trade agreements have led to consolidation of production in clothing supply chains and this benefitted a few major producers at the expense of smaller (and often poorer) nations (Moazzem and Sehrin, 2016). Indeed, China is the big winner here: in 2017 it supplied more than 30% of global apparel exports, while its nearest competitor, Bangladesh, supplied only 7% (ITC, 2018). In addition, the process of economic development associated with the clothing industry is not unproblematic. It has historically been driven by retailers chasing the lowest production costs. As a result, global clothing supply chains face systemic issues including very low wages, unsafe working conditions and human rights abuses (Pickles et al., 2015; Mair et al., 2018). Perhaps because of these issues, there is a line of thought in the sustainable fashion literature that also pursues a 'better rather than more' approach to sustainability based on better wages.

One such strand of work coming out of sustainable fashion is focused on alternative business models, built around the purchasing and selling of fewer higher value and higher quality clothes. With her concept of 'Slow Fashion', the designer and academic Fletcher (2007, 2010, 2015) argues that to be sustainable, fashion requires a wholesale shift in our relationship with clothing. Rather than consuming fashion, Fletcher argues that we should try to remove fashion from a purely commercial framing. This (in part) means producing, buying and discarding less, and doing more repair work. It also means rethinking how we value clothing. The combination of these ideas gives rise to a system in which clothes might still be manufactured in factories, but where workers are paid fairly, clothes priced more highly and kept for longer. The connection to 'better rather than more' ideas from industrial ecology is through the belief that value and quality can be increased by paying workers fair wages and generally improving working conditions (Fletcher, 2015, Jung and Jin, 2014).

In both Industrial Ecology and Sustainable Fashion, raising wages in clothing supply chains aims to overcome the tension between development and environmental damage. In this paper we consider whether this is feasible. To date the evidence either way is limited, particularly in relation to global supply chains.

2.3. Two Understudied Dynamics: Multipliers and Consumer Responses to Price Increase

There are major gaps in our understanding of the economic mechanisms that drive the environmental and social impact of wage increases. On the one hand there is simply very little research on the environmental impact of wage increases. On the other hand, the employment impact of minimum wage increases is one of the most researched empirical questions in economics. Most empirical studies find that increasing the minimum wage has a negligible impact on employment (Schmitt, 2015; Broecke et al., 2017). But despite the relative consensus around this finding, there is little consensus on the mechanisms that cause it (for example, Hirsch et al., 2015, and Heise, 2017 offer two competing explanations). Consequently there is a need to explore the dynamics through which wage increases might impact the wider economic environment (Neumark, 2017). This need is even more acute if we are to understand initiatives that are broader than local minimum wages: while there is lots of research on minimum wages, there is very little on extra-legislative wage increases in the context of global supply chains (Mair, 2016).

As a starting point, we can turn to the debates around raising the wages of 'sweatshop' workers. Coakley and Kates (2013) identify two dynamics that have been insufficiently explored in assessments of sweatshop wages and employment:

1. Interactions between wages, prices and consumer behaviour: The increase in wages increases the cost of production, increasing affluent country prices. In turn, consumers in affluent countries may reduce or restructure their consumption. The choices they make will affect carbon emissions and employment in different ways.
2. Employment multiplier effects: The wage increase gives sweatshop workers additional income, which they then spend, potentially generating additional employment. From an environmental perspective, we should note that this may also deliver higher carbon emissions in the producing country.

The outcomes of these dynamics will have a major effect on any sustainability assessment of proposals to increase sweatshop wages. But there has been very little research on either of these two dynamics, and less on their potential interactions.

The partial nature of this evidence base can be seen in research that examines the impact of wage increases on prices and subsequent effects on affluent country consumption. Several studies estimate that paying sweatshop workers in apparel supply chains a 'living wage' (equivalent to around twice their usual wage) would result in only a small price increase (typically 2–7%) for consumers (e.g. Pollin et al., 2004; Miller and Williams, 2009). However, these studies do not systematically examine potential consumer responses to the price increase. Rather, they rely on reference to 'willingness to pay' studies. Often, such studies suggest that many consumers are willing to accept a premium for socially responsible goods (Tully and Winer, 2014). But this is not always the case (Prasad et al., 2004; Hiscox and Smyth, 2006).

Perhaps more importantly though, just because consumers are willing to pay the increase in prices, does not mean there would be no side effects of them doing so. Consumers have constrained budgets, and so to accommodate price rises they either have to purchase fewer clothing goods, or reduce spending in other sectors of the economy. Depending on how consumers accommodate the price increase we might expect very different social and environmental consequences. Therefore a key focus of our model will be on the impacts of a range of consumer responses.

There is also a lack of evidence around employment multiplier effects. Coakley and Kates (2013) raise employment multipliers to support their argument for increasing sweatshop wages. They contend that those who oppose increases in sweatshop wages have ignored the potential existence of such a multiplier. In a response article, two prominent critics of raising sweatshop wages, Sollars and Englander (2016), confirm that this is the case. Indeed, we are only aware of that one study that considers employment multipliers in a sweatshop context. Magruder (2013) provides both theoretical and econometric evidence to show that employment in Indonesia increased following implementation of a minimum wage. We are not aware of any work looking at 'carbon multipliers' in this context.

In the following section we build a model to begin to explore the changes in affluent consumer spending, and carbon and employment multipliers. The model also allows us to explore first order interactions between the two mechanisms.

3. Modelling Framework

As a first attempt to explore the dynamics of consumer response and employment multipliers, we opt for a relatively transparent and simple model framework. We assume constant proportions of labour hours, capital, and intermediate goods with respect to physical output, no constraints on the factors of production, no relocation of capital and that production instantaneously meets demand. We also assume that directly impacted firms and retailers increase their profit margins in response to the wage increase, and that firms spread their increased costs across all their goods. While some of our assumptions mark a clear departure from reality, they allow us to isolate (see Mäki, 2009) the two causal mechanisms of most interest:

1. **The effect on employment, income and carbon emissions of changes in the volume and composition of Western European consumption**: A core assumption in our model is that a price increase associated with the living wage will result in some restructuring of consumer spending because consumers have constrained budgets. We model the impacts of three alternative responses that Western European consumers might have to the clothing price increases. Each scenario assumes a different level and mix of changes in the consumption of clothing goods and other goods based on a variety of literatures.
2. **The effect on employment, and carbon emissions of changes in the volume and composition of global demand (respending effects)**: The second core assumption of our model framework is that because of the interconnected nature of the economy, changes in Western European demand arising from the change in clothing price will affect the income of workers around the world. In turn this will influence global consumer demand. Therefore, our model explores the ways that income outside Western Europe might impact employment and carbon emissions.

To further simplify the modelling, we only consider changes in the wages and prices within the Western European clothing supply chain. The wages and prices of all other goods are assumed to remain constant.

Fig. 1 is a schematic overview of the Modelling Framework. Each of the next four sections describes a part of the schematic in more detail.

3.1. Price Increase

The first step in the modelling process is to estimate the change in Western European clothing prices. To do this we use living wage estimates by sector for Brazil, Russia, India and China (BRIC) in an input-output price model. Input-output price models have been used to elsewhere to study the price effects of minimum wages (MaCurdy, 2015; Saari et al., 2016). In the general case, the price model defines a relationship between changes in the components of value added, and changes in the price of output from each sector in the economy (Miller and Blair, 2009),

$$\Delta\mathbf{p} = \Delta\mathbf{v}'(\mathbf{I} - \mathbf{A})^{-1} \quad (1)$$

Here, and throughout this paper, bold lower case letters are vectors

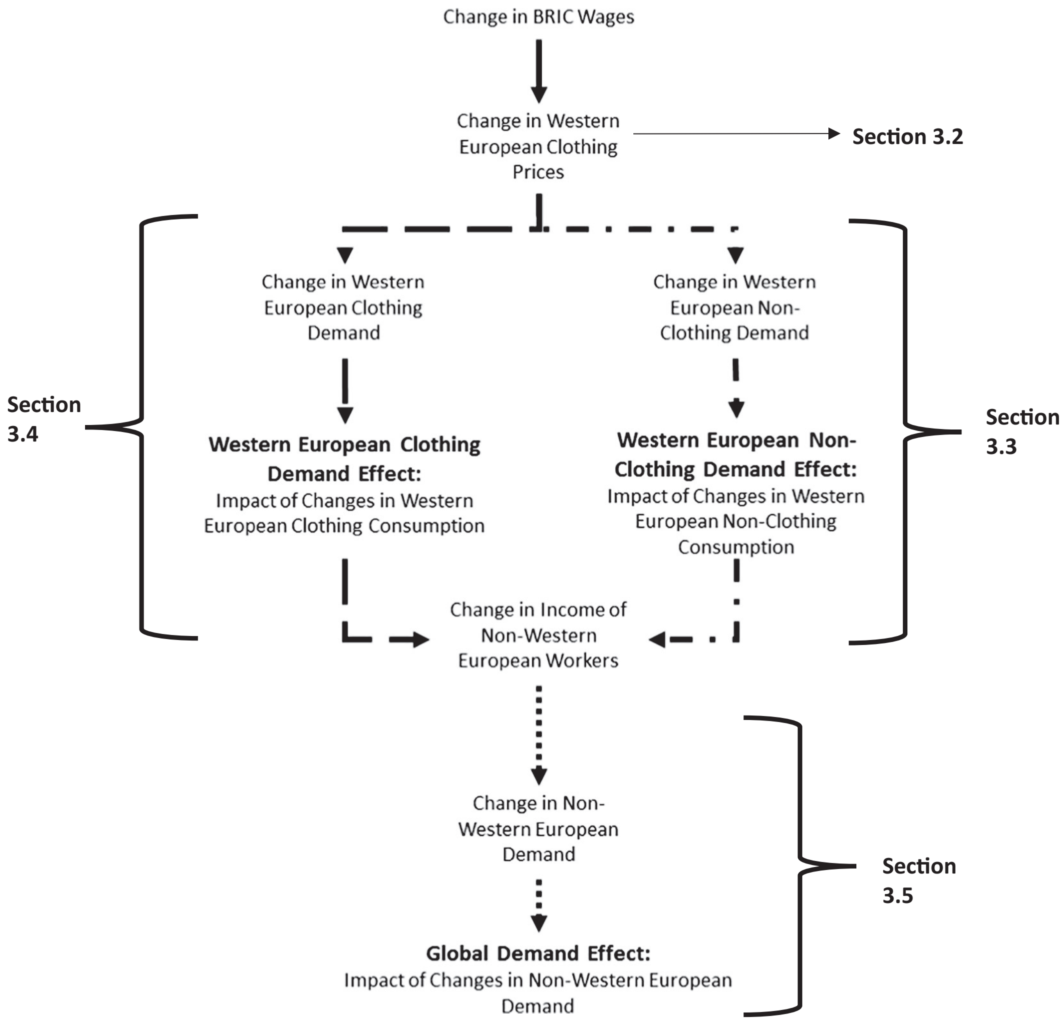

Fig. 1. Schematic of the modelling framework and where its component parts are discussed.

and bold uppercase letters are matrices. Therefore, $\Delta\mathbf{p}$ is the relative price increase by sector, $\Delta\mathbf{v}'$ is the row vector of changes in the unit cost of value-added by sector, $\mathbf{A}$ is a matrix of technical coefficients, where each column represents the production requirements of a sector, and $(\mathbf{I}-\mathbf{A})^{-1}$ is the Leontief inverse, describing the interactions between different economic sectors. The logic of Eq. (1) is that increases in either the cost of labour or the return on capital are passed along as price increases at every stage of the supply chain.

We estimate the change in value added via a two-step process. First, we estimate the change in in labour cost as the difference between the labour compensation vector from the World Input-Output Database (see Section 3.6) and the living labour compensation vector from Mair et al. (2018). We then estimate the change in returns to capital, taking this as a proxy for profits. We assume that the firms directly affected by the wage increase wish to maintain the same labour compensation/return to capital ratio before and after the wage increase. Therefore, $\Delta\mathbf{v}'$ is equal to $\Delta\mathbf{w}' + \Delta\mathbf{r}'$:

$$\Delta\mathbf{p} = (\Delta\mathbf{w}' + \Delta\mathbf{r}')(\mathbf{I}-\mathbf{A})^{-1} \tag{2}$$

where, $\Delta\mathbf{w}'$ is the change in the unit cost of wages and $\Delta\mathbf{r}'$ is the change in the unit return to capital given by:

$$\Delta\mathbf{r}' = \Delta\mathbf{w}' \otimes \mathbf{d}\hat{\mathbf{x}}^{-1} \tag{3}$$

where $\otimes$ denotes entrywise (element by element) multiplication, $\mathbf{d}$ is a vector made by dividing the elements of the return to capital vector by elements of the labour compensation vector (before the wage change), and $\hat{\mathbf{x}}$ is the diagonalised vector of output by sector.

Multiplying the original Western European consumer demand bill by the relative price change ($\Delta\mathbf{p}$) we can estimate the change in the Western European clothing demand bill, $\Delta\mathbf{Y}_{wc}$, before retail margins, transport margins and net taxes (i.e. the change in the value of demand at basic prices):

$$\Delta\mathbf{Y}_{wc} = \widehat{\Delta\mathbf{p}}\mathbf{Y}_{wc} \tag{4}$$

where $\widehat{\Delta\mathbf{p}}$ is the diagonalised vector of relative price changes, and $\mathbf{Y}_{wc}$ is the matrix of household expenditure from the world input-output table (see Section 3.6), with elements corresponding to clothing consumption in Western Europe left with their original values, and all other elements set to zero. Consequently, $\Delta\mathbf{Y}_{wc}$ contains the changes in Western European expenditure and zeros.

To estimate the final change in consumer prices we add in additional changes in retail, wholesale, and transport margins and net taxes (i.e. we convert from basic to purchaser's prices). This is important because, as Miller and Williams (2009) note, changes in labour costs further down the supply chain are likely to increase the intermediate costs of retailers and therefore affect their net taxes and profit margins. As a result, the change in the final consumer price is greater than the change in labour costs alone.

Therefore, we estimate $\Delta\mathbf{f}_{wc}$, a vector showing the Western European clothing final demand bill in each of our Western European countries after incorporating proportional adjustments in taxes and retail margins,

$$\Delta\mathbf{f}_{wc} = ((\mathbf{D}\Delta\mathbf{Y}_{wc})\otimes\mathbf{M})\mathbf{i} \quad (5)$$

where $\mathbf{D}$ is a matrix converting $\Delta\mathbf{Y}_{wc}$ from the WIOD classification to the Classification of Products by Activity (CPA),[1] $\mathbf{M}$ is a matrix converting from basic to purchaser's prices (Appendix B), and $\mathbf{i}$ is a vector of ones and zeros used as a summation function. The new Western European final demand bill for clothing is then,

$$\mathbf{f}^{*}_{wc} = \Delta\mathbf{f}_{wc} + \mathbf{f}_{wc} \quad (6)$$

where $\mathbf{f}_{wc}$ is the original Western European clothing final demand bill in purchaser's prices in the CPA classification system. The percentage price change in clothing consumption for each of the Western European countries ($\mathbf{g}_{wc}$) is found by dividing each entry in $\Delta\mathbf{f}_{wc}$ by the original consumer expenditure on clothing in the respective country. In matrix symbolism we have:

$$\mathbf{g}_{wc} = \Delta\mathbf{f}_{wc}\oslash\mathbf{f}_{wc} \quad (7)$$

3.2. Western European Clothing Demand Effect

The Western European clothing demand effect describes how the changes in Western European demand for *clothing* goods impacts on our indicators. Combining the percentage clothing price increase in each of the Western European countries ($\mathbf{g}_{wc}$), with own-price elasticities of demand for clothing in each Western European country we can estimate the change in expenditure for clothing in Western Europe ($\Delta\mathbf{j}_{wc}$),

$$\Delta\mathbf{j}_{wc} = \mathbf{g}_{wc} \otimes \boldsymbol{\varphi}_{wc} \otimes \mathbf{f}^{*}_{wc} \quad (8)$$

where $\boldsymbol{\varphi}_{wc}$ is a vector of the own price elasticities for Western European clothing by country, and $\mathbf{f}^{*}_{wc}$ is the vector of the expenditure of Western European clothing by country following the wage increase in BRIC and $\otimes$ represents element-by-element multiplication. The own price elasticity values vary by scenario.

$\Delta\mathbf{j}_{wc}$ is the change in expenditure for the COICOP clothing category valued at purchaser5s prices in Western Europe. To use this for impact analysis we convert $\Delta\mathbf{j}_{wc}$ into the WIOD classification at basic prices using bridge matrices (Appendix B). This gives us $\Delta\mathbf{y}_{wc}$, a vector of the change in Western European expenditure on clothing goods valued at basic prices in the WIOD classification following the BRIC living wage price increase.

$\Delta\mathbf{y}_{wc}$ is used as an input to a price adjusted quantity input-output model.

$$\mathbf{e}_{wc} = \widehat{\mathbf{u}^{*}}(\mathbf{I} - \mathbf{A}^{*})^{-1}\Delta\mathbf{y}_{wc} \quad (9)$$

where: $\mathbf{e}_{wc}$ is a vector of the effects that occur due to changes the final demand bill in either labour compensation or employment or carbon emissions caused by the change in Western European demand for clothing goods following the BRIC living wage price increase; $\widehat{\mathbf{u}^{*}}(\mathbf{I} - \mathbf{A}^{*})^{-1}$ is a matrix of impacts per unit of final demand, as is as usually found in environmentally or socially extended input-output analyses (Miller and Blair, 2009). The only difference is that the impact intensities ($\mathbf{u}^{*}$) and technical coefficients ($\mathbf{A}^{*}$) are derived from economic output and transaction parameters that reflect the new price of clothing following the living wage increase in BRIC. The derivation of $\mathbf{Q}^{*} = \widehat{\mathbf{u}^{*}}(\mathbf{I} - \mathbf{A}^{*})^{-1}$ is given in Appendix C and follows Choi et al. (2010) in using the price index described above to make the relevant adjustments. For each of the three output measures we estimate a different $\mathbf{e}_{wc}$ vector, based on different impact intensity vectors ($\mathbf{u}^{*}$).

3.3. Western European Non-clothing Demand Effect

To estimate the percentage change in demand for non-clothing goods in Western Europe ($\Delta\mathbf{J}_{wo}$), we multiply the cross-price elasticities of demand with respect to clothing ($\boldsymbol{\Psi}_{wc}$) for 8 consumption categories[2] by the clothing price increase,

$$\Delta\mathbf{J}_{wo} = \mathbf{G}_{wc}\otimes\boldsymbol{\Psi}_{wc} \otimes \mathbf{F}_{wo} \quad (10)$$

where $\mathbf{G}_{wc}$ is a matrix made by repeating $\mathbf{g}_{wc}$ 8 times and $\mathbf{F}_{wo}$ is the final demand bill for all Western European non-clothing goods in purchaser's prices. As with the own price elasticities of demand the cross-price elasticities of demand with respect to clothing ($\boldsymbol{\Psi}_{wc}$) vary by scenario (see Section 3).

As above, we then convert $\Delta\mathbf{J}_{wo}$ to the WIOD classification and to basic prices. This gives us $\Delta\mathbf{y}_{wo}$, a vector of Western European demand for non-clothing goods following the BRIC living wage price increase in the Western European clothing supply chain. $\Delta\mathbf{y}_{wo}$ can be used as an input to a standard quantity input-output model for impact assessment,

$$\mathbf{e}_{wo} = \hat{\mathbf{u}}(\mathbf{I} - \mathbf{A})^{-1}\Delta\mathbf{y}_{wo} \quad (11)$$

where: $\mathbf{e}_{wo}$ is a vector of impacts (changes in labour compensation, employment or carbon emissions) resulting from the change in Western European demand for non-clothing goods following the BRIC living wage price increase and $\hat{\mathbf{u}}(\mathbf{I} - \mathbf{A})^{-1}$is the matrix of impacts per unit of final demand. Note that we do not use the price adjusted quantity input-output model as the price of goods in all supply chains other than Western European clothing are assumed to remain constant.

3.4. Global Respending Effect

The global respending effect describes how the changes in Western European demand drive changes in global demand, which have their own impacts. Most obviously, we would expect a change in the demand of the BRIC countries where total income is likely to change substantially as a result of both the changes in wage rates and the change in Western European demand. However, we would also expect some changes in demand in other countries due to the interconnected nature of the global economy.

To estimate these effects, we make two simplifying assumptions. First we assume that percentage changes in labour compensation are equivalent to the resulting change in income. Second we assume that there is no change in income in Western Europe. These assumptions allow us to multiply the percentage change in labour compensation in the Non-Western European countries ($\mathbf{H}_{g}$, derived from Eqs. (9) and (11)) by the relevant income elasticities of demand ($\boldsymbol{\Phi}_{g}$),

$$\Delta\mathbf{J}_{g} = \mathbf{H}_{g}\otimes\boldsymbol{\Phi}_{g} \otimes \mathbf{F}_{g} \quad (12)$$

where $\mathbf{F}_{g}$ is the Non-Western European final demand bill. Note that, unlike for Western European price elasticities of demand, the elements of $\boldsymbol{\Phi}_{g}$ are constant between scenarios (taken from Muhammad et al., 2011).

Finally, as for the previous two effects we convert $\Delta\mathbf{J}_{g}$ to WIOD classification and basic prices. This gives us $\Delta\mathbf{y}_{g}$, a vector of the change in all non-Western European final demand following the BRIC living wage price increase in the Western European clothing supply chain. Put another way, $\Delta\mathbf{y}_{g}$ is the final demand associated with non-western European incomes estimated in Eqs. (9) and (11). It does not include higher order effects as this would require a dynamic model. This can be used as an input to the standard quantity input-output model,

$$\mathbf{e}_{g} = \hat{\mathbf{u}}(\mathbf{I} - \mathbf{A})^{-1}\Delta\mathbf{y}_{g} \quad (13)$$

where: $\mathbf{e}_{g}$ is a vector of impacts (changes in employment or carbon emissions) resulting from the change in Non-Western European demand following the BRIC living wage price increase in the Western European

[1] We convert to CPA because WIOD provides final demand data at both purchasers and basic prices in the CPA classification allowing us to convert between the two price concepts. See Appendix B for more detail.

[2] As defined by Meade et al. (2011): Food Beverages and Tobacco; Gross Rent, Fuel and Power; House Furnishings; Medical Care; Transport and Communication; Recreation; Education; Other.

clothing supply chain.

3.5. Data

Our framework is built around the global multi-regional input-output model described in Mair et al. (2016, 2018). We use the same country classification system. Living wage estimates are taken from Mair et al. (2018). All input-output data comes from the World Input-Output Database (Timmer et al., 2015). All other data sources are described in the text below. All data are for 2005, as these are the only available sectoral, comparable, living wage estimates available for the BRIC countries.

3.6. Scenarios

For the analysis we simulate 3 scenarios of Western European consumer responses to the price increase associated with paying BRIC workers in Western European Clothing supply chain a living wage. The first two scenarios, **Slow Fashion** and **Willing to Pay** draw on a different expectations of consumer behaviour that are grounded in the industrial ecology/sustainable fashion and labour economics literatures respectively. They are designed to reflect consumer reactions to the increased clothing costs associated with fairer wages, that different groups consider plausible and desirable. The third scenario, **Business as Usual,** uses statistical descriptions of consumer behaviour, and assumes that the 'fairness' element to this price increase does not factor into consumer decision making. By comparing all three scenarios of consumer behaviour we aim to address a range of literatures and approaches to the problem at hand.

Table 1 shows the characteristics that are shared between all the scenarios. These assumptions primarily serve to isolate the effects of the causal factors we are most interested in. Although some are quite strong, we believe that they serve a useful purpose in simplifying the model and allowing us to focus only of the mechanisms of particular interest. However, they do limit the generalisability of our results.

3.6.1. Slow Fashion

The key characteristic of our **Slow Fashion** scenario is that shifts in consumer preferences lead to consumers spending approximately the same amount of money, but purchasing fewer physical goods. This scenario is the one most closely linked to the idea of 'better rather than more' as discussed in Section 2. The following quote from the designer Fletcher (2008, P. 173) captures the spirit of this scenario:

> "*Garments are still mass produced, but they are done so in supplier factories that pay living wages and maintain high standards… Quality normally comes at a price … slow fashion pieces will cost substantially more than they do today… This will result in us buying fewer high value, slow-to consume products and bring key resource savings*"

Table 1
Characteristics shared across all scenarios.

Characteristics shared across all scenarios
All scenarios see the same wage increase for workers in BRIC. This is approximately equal to a doubling of the average BRIC wage.
~12.5% price increase, resulting from the paying BRIC workers in the Western European clothing supply chain a living wage (including profit margin increases for directly impacted firms, wholesalers, and retailers).
At the aggregate (COICOP) level, all cost increases are passed to the final consumer in their entirety (full price pass-through).
Consumers face a general increase in clothing prices at the COIOP level, rather than at the individual country-sector level. This can be interpreted either as retailers spreading the price increase evenly across all their goods, rather than passing increases on at the garment level, or as constant consumption technology.
Constant production technology (i.e. no returns to scale or substitution between inputs).
Unconstrained factors of production (i.e. no limits on labour, capital or natural resources).
The same income elasticities of demand for the non-Western European countries.

In essence, **Slow Fashion** should represent what might happen if consumers decide to buy fewer, more expensive clothes in a conscious effort to lead more sustainable lives.

To operationalise **Slow Fashion** in our model, we set Western European own-price elasticity of demand with respect to textiles and clothing goods values as -1. This means that Western European nominal spend on textile and clothing goods remains constant, while the physical quantity of textile and clothing goods drops proportionally with the price increase. As Western European consumers accept the complete price increase and fund this by purchasing fewer clothing goods, there is no Western European non-clothing effect in this scenario (cross-price elasticity values are set to zero).

3.6.2. Willing to Pay

The key assumption of **Willing to Pay** is that consumers will accept the price increases and will not reduce the quantity of textiles and clothing goods that they demand. Where **Slow Fashion** drew from the industrial ecology and sustainable fashion literatures, **Willing to Pay** draws from past work in labour economics which has tended argue that consumers will be willing to pay a premium for sweatshop free goods (e.g. WRC, 2005; Tully and Winer, 2014). However, (as discussed in Section 2.3) such studies have not included systematic examination of such a response. **Willing to Pay** is a first attempt to think about how the willingness to pay more for clothing goods might spillover into other consumption areas.

Willing to Pay is modelled by setting Western European own-price elasticity of demand with respect to clothing goods to 0. However, we assume Western European consumers have fixed budgets and so will have to reduce spending in other categories in order to finance their increased expenditure on clothing goods. We treat the increased expenditure on clothing goods as analogous to a decrease in real disposable income (following Chitnis et al. (2013, 2014)). This allows us to use income elasticity of demand values in the relevant matrix of elasticities in the model framework. The Western European income elasticities of demand are taken from Muhammad et al. (2011).

Business as Usual assumes no substantial deviation from estimated consumer responses to historical price changes. Therefore, whereas the previous scenarios assumed a shift in consumer preferences (**Slow Fashion**) or that consumers respond differently to price increases motivated by concern for workers than to other price increases (**Willingness to Pay**), **Business as Usual** assumes that historical consumer responses to price changes are a good approximation of how consumers would react to the proposed living wage price change. In this way **Business as Usual** offers a kind of baseline scenario, assuming no special change in consumer behaviour.

To model **Business as Usual**, we take the Cournot-uncompensated own-price and cross-price elasticity values for 9 consumption categories[3] from Meade et al. (2011) and Muhammad et al. (2011) respectively. On average, the Western European own-price elasticity of demand for textiles and clothing goods is approximately -0.7, while the cross-price elasticity values vary between -0.006 and -0.02.

4. Results

This section presents key results from our analysis. First we present the estimated price increase, then how this price impacts jobs and carbon emissions in the three scenarios, before breaking the net employment and carbon impacts into their component effects. A full list of model outputs can be found in Appendix A.

[3] Food Beverages and Tobacco; Clothing and Footwear; Gross Rent, Fuel and Power; House Furnishings; Medical Care; Transport and Communication; Recreation; Education; Other.

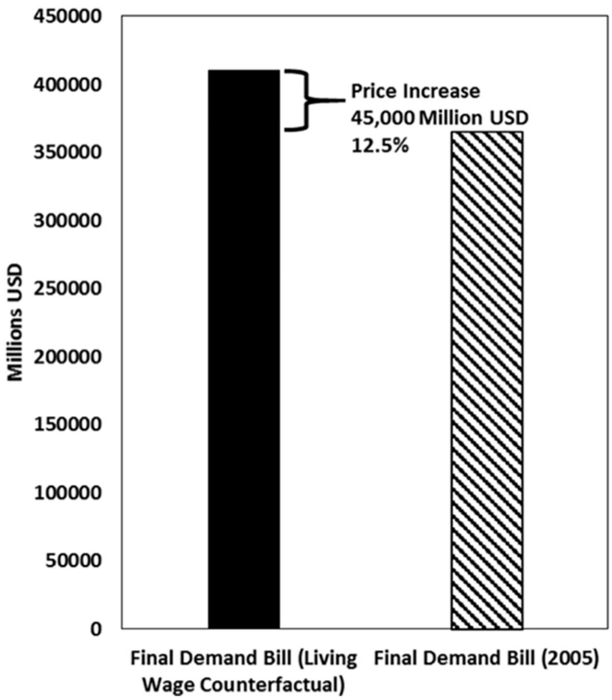

Fig. 2. Western European final demand bill after the living wage is applied (left) and before living wage is applied (right). All values are in Market Exchange Rates.

4.1. Price Increase

Fig. 2 shows that paying BRIC workers in the Western European clothing supply chain a living wage rate would have added 45 Billion USD to the Western European clothing final demand bill, assuming full pass-through of cost increases at every stage of the Western European clothing supply chain and proportional increases in retail, wholesale, and transport margins, and net taxes. This is equal to ~12.5%, of Western European Clothing Demand in 2005.

4.2. Net Changes in BRIC Employment and Global Carbon Emissions

For each scenario, Fig. 3 shows how BRIC employment changes relative to that which was supported by the 2005 Western European clothing supply chain. Likewise, Fig. 4 shows how global carbon emissions change relative to global carbon emissions embodied in the 2005 Western European clothing supply chain. BRIC employment increases in all three scenarios, while global carbon emissions remain roughly constant. On the other hand, there is a substantial difference between the two indicators BRIC employment varies between a 36% and 60% increase, while global carbon emissions vary between a −0.5% increase and a 2% decrease.

4.3. Explaining the Change in BRIC Employment

In all scenarios the large increase in BRIC employment is caused by the global respending effect. Fig. 5 shows how each of the three effects (Western European clothing demand, Western European non-clothing demand and global respending) contributes to the net increases in BRIC Employment. The changes in Western European clothing consumption (Western European Clothing effect) reduce employment in BRIC by around 10% in both **Slow Fashion**, and **Business as Usual**. There is no Western European clothing effect in **Willing to Pay** as physical consumption remains constant. Changes in Western European non-clothing consumption (Western European non-clothing effect) reduces employment in BRIC by less than 5% in all scenarios. Conversely, changes in

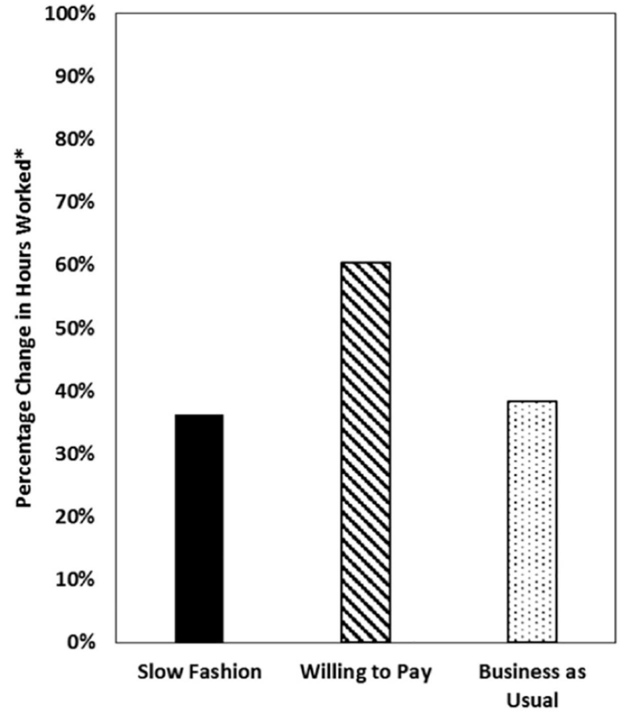

Fig. 3. Total change in BRIC employment (*relative to the BRIC employment supported by the 2005 Western European clothing supply chain), as a result of paying BRIC workers in the Western European clothing supply chain a living wage and passing all costs through to Western European consumers in three scenarios. Figures account for the impact of changes in Western European consumption (Western European clothing demand and non-clothing demand effects) and the impact of changes global consumption (global respending effect). 0% = no change. Positive values are increases, negative values are decreases.

global expenditure (global respending effects) increase BRIC employment (compared to BRIC employment previously supported by Western European clothing consumption) by approximately substantial amounts in all scenarios: 36% in **Slow Fashion**, 59% in **Willing to Pa**y, and 38% in **Business as Usual**.

We see the big employment multiplier effects in BRIC because the living wage shifts spending power from a location that generates comparatively few BRIC jobs, to a location that generates substantial numbers of BRIC jobs. Most of the change in global demand is an increase in BRIC spending. In all scenarios, the net effect of paying BRIC workers in the Western European clothing supply chain a living wage and then passing all costs through to Western consumers is to substantially increase BRIC labour compensation (relative to the BRIC labour compensation provided by the 2005 Western European clothing supply chain) (Fig. 6; Table 2). Moreover, a dollar spent in Western Europe generates fewer jobs within BRIC than a dollar spent directly in BRIC itself. Furthermore, we would expect a dollar spent in BRIC to stimulate substantial economic activity within BRIC, and to purchase more goods than a dollar in Western Europe, because price levels in BRIC are lower than in Western Europe.

The Western European Clothing and Non-Clothing effects have only limited impacts on BRIC employment because the changes in Western European demand are only small. This is a result of the relatively small price increase which averaged 12.5% across the Western European countries, which is then combined with elasticities of demand. The lowest elasticity of demand valued used was −1 (**Slow Fashion**), all other elasticities of demand values were greater than −1. Consequently, the largest possible reduction in Western European demand in our model is 12.5% in **Slow Fashion**, with **Willing to Pay** and **Business as Usual** seeing smaller reductions in demand by definition.

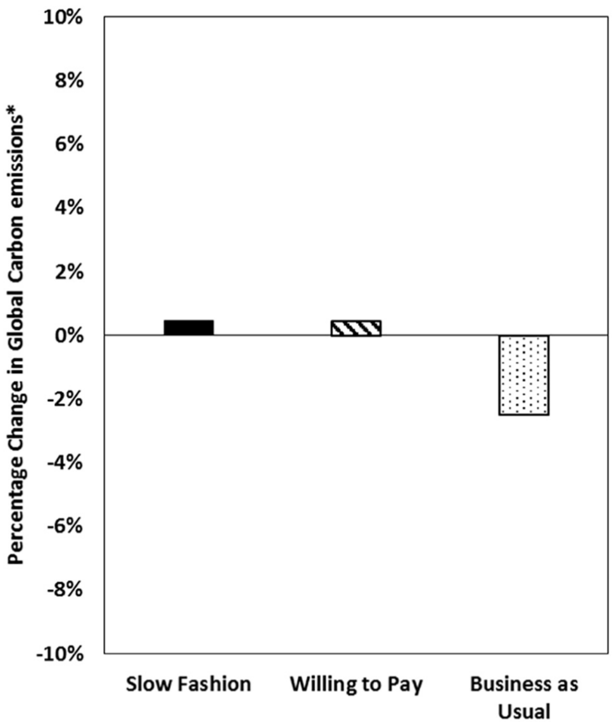

Fig. 4. Total change in global carbon emissions (*relative to the carbon emissions embodied in the 2005 Western European clothing supply chain) caused by paying BRIC workers in the Western European clothing supply chain a living wage and passing all costs through to Western European consumers in three scenarios. Figures account for the impact of changes in Western European consumption (Western European clothing demand and non-clothing demand effects) and the impact of changes global consumption (global respending effect). 0% = no change. Positive values are increases, negative values are decreases.

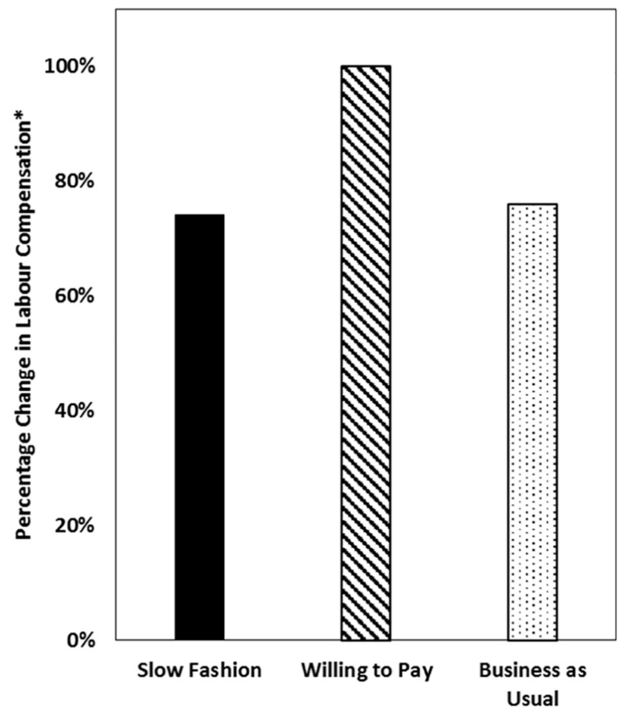

Fig. 6. Total change in BRIC Labour Compensation (*relative to the BRIC labour compensation provided by the 2005 Western European clothing supply chain) caused by paying BRIC workers in the Western European clothing supply chain a living wage and passing all costs through to Western European consumers in three scenarios. Figures account for the impact of changes in Western European consumption (Western European clothing demand and Western European non-clothing demand effects). Note that unlike other figures, respending is not accounted for here. 0% = no change. Positive values are increases, negative values are decreases.

4.4. Explaining the Change in Carbon Emissions

The relatively small changes in global carbon emissions are also the result of the global respending effect. Fig. 7 shows how each of the three effects contribute to the total change in carbon emissions. The global respending effect has the largest influence, increasing carbon emissions by between 10% (**Slow Fashion**) and 16% (**Willing to Pay**) in all scenarios. In all scenarios the combined Western European Clothing and Western European Non-Clothing effect reduces carbon emissions by between −10% (**Slow Fashion**) and −5% (**Willing to Pay**).

There are several reasons why we might expect the global respending effect to cancel out the carbon savings coming from reduced Western European consumption. These all concern the relative spending power and carbon intensity of BRIC consumption vs Western European clothing consumption. Table 3 shows that the only region to see increases in carbon emissions is BRIC. This makes sense, because BRIC was the only region to see an increase in income (Table 2). In addition, a dollar has more spending power in BRIC to than a dollar in Western Europe, and so we would expect a dollar of spending in BRIC to be more carbon intensive than a dollar spent in Western Europe. Furthermore, the largest carbon savings come from reductions in Western European clothing consumption (Fig. 7), a category known to be less carbon intensive than other consumption categories (Tukker and

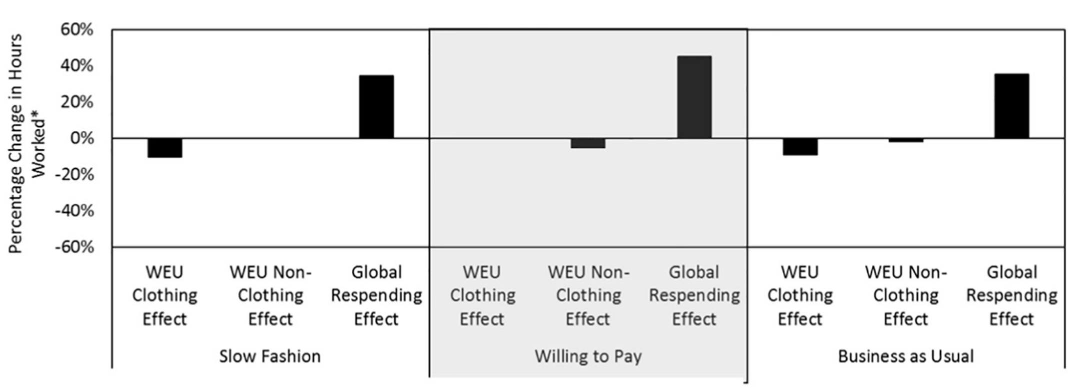

Fig. 5. How the three effects (WEU clothing, WEU non clothing, global respending) influence BRIC employment *relative to the BRIC employment supported by the 2005 Western European clothing supply chain in our three scenarios. BRIC = Brazil, Russia, India, China; WEU = Western Europe, OEU = Other Europe, OAC = Other Affluent Countries, OLAC = Other Less Affluent Countries. 0% = no change. Positive values are increases, negative values are decreases.

Table 2
Change in Labour compensation relative to that provided by the 2005 Western European Clothing supply chain by world region in each scenario BRIC = Brazil, Russia, India, China; WEU = Western Europe, OEU = Other Europe, OAC = Other Affluent Countries, OLAC = Other Less Affluent Countries. Figures account for the impact of changes in Western European consumption (Western European clothing demand and Western European non-clothing demand effects). Note that respending is not accounted for here. 0% = no change. Positive values are increases, negative values are decreases.

	Slow fashion	Willing to pay	Business as usual
BRIC	74%	96%	77%
WEU	−9%	−25%	−16%
OEU	−10%	−4%	−8%
OAC	−11%	−14%	−14%
OLAC	−11%	−7%	−7%

Table 3
Change in Carbon emissions relative to those embodied in the 2005 Western European Clothing supply chain by world region in each scenario. BRIC = Brazil, Russia, India, China; WEU = Western Europe, OEU = Other Europe, OAC = Other Affluent Countries, OLAC = Other Less Affluent Countries.

	Slow fashion	Willing to pay	Business as usual
BRIC	15%	29%	16%
WEU	−9%	−29%	−17%
OEU	−17%	−5%	−17%
OAC	−11%	−8%	−14%
OLAC	−13%	−2%	−13%

Jansen, 2006; UNEP, 2010). Conversely the BRIC workers who receive additional money are assumed to spend this across all 9 consumption categories. Consequently, the average carbon intensity of their consumption is likely to be greater than the average carbon intensity of Western European clothing consumption.

5. Discussion

5.1. Evidence for Employment and Carbon Multipliers

The principal result from this analysis is evidence supporting the idea of employment and carbon multipliers associated with paying higher wages to workers in poorer countries. These multipliers have substantial potential for offsetting both the unemployment effects and carbon savings associated with any decreases in consumption that result from higher wages. All our scenarios find that paying living wages in BRIC increases BRIC income, despite reductions in Western European consumer spending. Spending of this income leads to an overall increase in employment and negligible net changes in carbon emissions (holding all else equal).

In both cases the key to our result is the global nature of the model, and the impacts of economic geography. In fact the central mechanism of our model is a simple one: the purchasing power of one dollar is very different in Western Europe than in BRIC, as are the relative labour and carbon intensities of that dollar. The result is that in a global supply chain the a wage increase in poorer parts of the world will have a much smaller impact on consumer prices in wealthy parts of the world than it will have on the relative income of the workers whom receive it. In turn, this suggests that such wage increases are likely to stimulate more, rather than less, consumption at the global scale.

There is a caveat to this point which is about the decisions made by firms and the power they wield. That a large wage increase leads to a small price increase is true for aggregate consumption categories: doubling wages in BRIC (and allowing for increases in profit margins), will only lead to a 12.5% price increase in the total clothing final demand bill. However, the cost of individual garments may increase by much more than this. If firms choose to pass on the increased costs on a garment by garment basis, consumers may respond differently than our results suggest (though this is not strictly certain, as even with substantial price increases such goods could conceivably remain the cheapest on the market). Our scenarios all assumed that firms would pass the price on via an increase in their general price level. It is worth emphasising two things First, this depends partly on whether firms feel they are able to do so, which will depend on the extent to which they engage in price based competition. Second, the effect the wage increase has on workers and the environment, is likely to depend on the choices made by firms (Schmitt, 2015).

Our findings are significant for two reasons. First, there is debate over the existence of the employment multiplier effect if sweatshop wages are increased (Coakley and Kates, 2013; Sollars and Englander, 2016). Second, the global respending effect leads to an overall increase in environmental impacts, due the enhanced development in BRIC. The question is: to what extent does the global respending mechanism within our model have real world credibility?

The employment multiplier from wage increases has some limited precedent in the literature. Drawing on the work of Hall and Cooper (2012), Schmitt (2015) includes “increases in demand” in his list of potential channels of adjustment for higher minimum wages in the USA. Additionally, Magruder (2013) examines data from 1990s minimum wage increases in Indonesia and finds evidence that the minimum wage increases in Indonesia increased full time waged employment by creating additional demand in Indonesia.

There is also evidence to suggest that our model misses mechanisms that might enhance the actual impact of respending on both BRIC employment and global carbon emissions. Our model treats all outputs from a given sector as homogenous. However, in reality there are differences in the production technology of goods for export and for domestic markets (e.g. Jiang et al., 2015). Studies that distinguish between the production for domestic markets and production for exports,

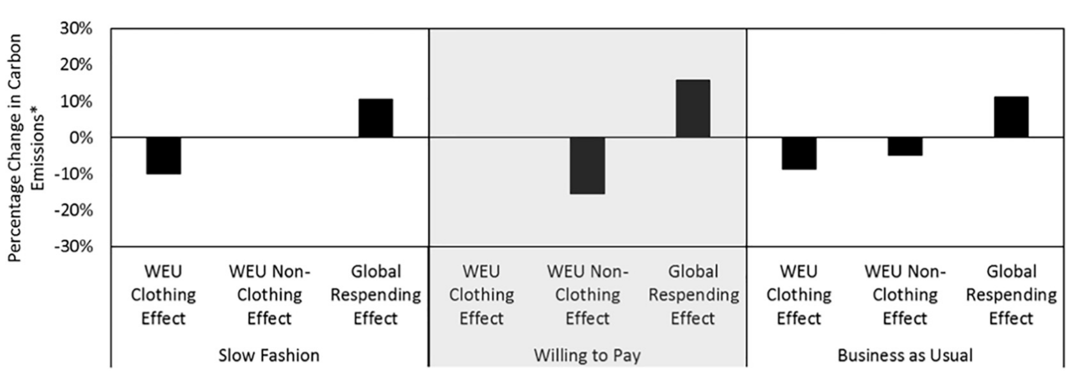

Fig. 7. How the three effects (WEU clothing, WEU non clothing, global respending) influence global carbon emissions *relative to the carbon emissions embodied in the 2005 Western European clothing supply chain in our three scenarios.

typically find that production for domestic markets generates more employment, more value added and more carbon emissions than goods for export. For example, research on China finds that exports generate less domestic value added and less employment than production for domestic markets, because production for domestic markets in China use substantially fewer imported intermediate goods than production for exports (Chen et al., 2012). Moreover, this discrepancy is even greater in processing exports of which make up a major part of China's involvement in the clothing supply chain (Ngai, 2007; Chen et al., 2012). Likewise, Dietzenbacher et al. (2012) show that distinguishing between processing exports and normal production reduces the carbon footprint of Chinese exports.

5.2. Implications for Supply Chain Living Wages as Sustainable Development Strategy: Good but Not Sufficient

The finding that respending effects have only negligible effects on global carbon emissions is potentially problematic for the idea that more equitable distributions of income can constitute a sustainable consumption strategy (Fletcher, 2008; Clift et al., 2013) because the sustainable development goals require dramatic decreases in emissions. Our finding suggests that the rebound effect is a relevant consideration in evaluating global redistribution schemes. What we call respending is effectively a macro-economic rebound effect where an action intended to reduce environmental damage frees up money to be spent elsewhere in a way that either completely or partially negates the environmental savings (Druckman et al., 2011).

However, there are two caveats to be made here. First, a key driver of our results is our choice of case study: the clothing supply chain. Clothing is a relatively low carbon intensity consumption category (Tukker and Jansen, 2006; UNEP, 2010). If we were to repeat this study using a more carbon intensive sector, such as food, it is possible that we may see a substantial decrease in emissions. However, clothing is also relatively labour intensive, and so the net gain/loss is not completely clear. The second caveat may be more important: once we account for equity the case for increasing wages in global supply chains as part of the sustainable development goals is substantially strengthened.

In fact we would suggest that paying higher wages in global supply chains does look like a good first step toward the sustainable development goals once equity is taken into account. At the top of this paper we argued that in order to meet the sustainable development goals we need initiatives that reduce the impact of affluent country consumption, in order to make space for increased consumption in poorer countries. In our analysis the increase in emissions all occurred within BRIC itself. There is a case to be made that per capita carbon emissions should be allowed to increase in BRIC in order to create a more equitable sharing of the global carbon budget (Elzen et al., 1992; Pan et al., 2015). From this perspective, our finding of negligible net changes in carbon emissions but substantial increases in BRIC employment may well suggest that global redistribution via wages is in line with the sustainable development goals. Put another way, all of our scenarios lead to substantial increases in BRIC employment relative to that originally supported by Western European consumption of clothes for no net gain in carbon emissions (relative to those originally attributable to Western European clothing consumption). Therefore, we are seeing substantial social benefit for a relatively low carbon cost. The issue is not that paying higher wages is incompatible with the sustainable development goals, just that it isn't enough on its own.

One possible alternative is for developing and emerging economies is to 'leapfrog' from their current production and consumption systems to more sustainable ones (Tukker, 2005, Schäfer et al., 2011). The premise of these arguments is that developing countries are not yet as locked in to unsustainable systems as developed countries, and in many cases are going through a period of investment in infrastructure that will shape the future of the society. This provides a leverage point to make future production and consumption more sustainable. If supply chain living labour compensation is part of a suite of initiatives including some that reduce the environmental impact of BRIC production and consumption, then the increased carbon associated with respending effects could be substantially reduced.

It is also interesting to note that there was relatively little difference across all indicators between our slow fashion scenario and our business as usual scenario. This potentially indicates two things. First, as above, our slow fashion scenario was too narrowly defined. The literature on slow fashion typically emphasises additional "quality" gains leading to greater (perceived) durability and therefore potentially larger reductions in real consumption than we modelled (Clark, 2008; Lundblad and Davies, 2016). On the other hand, it suggests that living wage strategies can be employed with relatively little need to bring consumers on board. That is, the 'business as usual' scenario suggests that current behaviours would be sufficient to increase BRIC employment at relatively low carbon cost.

5.3. Limitations and Future Research

Finally, it is worth commenting on the limitations of this analysis. Taken at face value, the scenarios we consider are highly specific, focusing on the simplified scenario that Western European firms will enforce living wages on their own accord, pass all associated costs to consumers and that their suppliers will not change their production technology. The first problem here is that it is very difficult to enforce wages in the supply chain, no matter what country the work is located in. For example, Bernhardt et al. (2008) provide an interesting overview of research finding numerous wage violations in apparel factories in the United States of America, while Rani and Belser (2012) estimate that 33% of all waged workers in India 2009–2010 received less than the minimum wage. The second problem is that the examples we have of living wages being paid in clothing supply only extend as far as garment factories chains (McMullen et al., 2014; Egels-Zandén, 2015).

Secondly, it is conceivable that firms would respond differently than we assume. Our analysis showed that price increases would be likely to lead to reductions in consumption, unless there was a substantial deviation from our **Business as Usual** scenario. There are therefore incentives for firms not to pass costs through to consumers and instead to try to maintain physical sales. Similarly, the channels of adjustment framework (Schmitt, 2015; Hirsch et al., 2015) proposes multiple ways firms respond to labour cost increases of which price pass through is only one. Different firm responses would change our analysis, with effects on all indicators. Future research could expand the simple framework presented here and examine the impacts of different firm level choices.

Lastly, the assumption of constant production technology is suspect. In the literature there are typically two views are held to be more likely than constant production technology. First, proponents of minimum and living wages argue that efficiency wage models of the labour market are most relevant and that workers on minimum or living wages will be more productive and therefore firm output will increase, dampening unemployment effects (for example, Arnold and Hartman, 2005). Conversely, opponents of living wages tend to argue that the living wage removes the incentive to produce in low wage countries by making automated processes more attractive (Powell and Zwolinski, 2012). Both these issues are interesting and important, but beyond the scope of this paper. However, we would point out that in both cases the labour productivity gains would have to be very large in order to override the effect of substantially increased income and demand from those workers whose wages do increase.

6. Conclusions

In this paper we used an input-output framework to explore how paying supply chain living wages might impact on the sustainable development goals. More specifically we estimated how paying BRIC workers in the Western European clothing supply chain a living wage would impact carbon emissions and employment. This constitutes the first systematic exploration of living wages as a strategy for sustainable development.

The most striking result of our analysis is the large employment multiplier effect. Our model estimated that respending of the additional income from the living wage payments could generate substantial additional employment in BRIC. The central mechanism driving this is that a dollar has much greater purchasing power in Western Europe than in BRIC. This implies that in a global supply chain a wage increase in poorer parts of the world is likely to increase wages by more than it reduces consumption. In turn, this suggests that such wage increases are likely to increase net consumption levels and support more jobs overall. Our paper is not conclusive evidence of the presence of the employment multiplier effect, but it does suggest that respending effects could be important and require further investigation.

Our interpretation of our results is that overall, initiatives to improve the social conditions of workers in the clothing supply chain are likely to redistribute environmental impacts more equitably, rather than reduce them. First, there are only likely to be marginal reductions in the environmental impact of affluent consumption as a result of increasing supply chain wages. We estimated that Western European clothing prices would increase by only around 12.5%. This is a relatively small price increase for a doubling of BRIC wages and a commensurate increase in profit margins. We would expect a small price increase to lead to relatively small reductions in Western European consumption across a range of consumer responses. Consequently, we would also expect reductions in the carbon footprint of Western European clothing following payment of the living wage to BRIC workers to be small. Moreover, just as there is an employment multiplier effect in our model, there is also a carbon multiplier effect. This carbon multiplier cancelled out the reductions in carbon emissions coming directly from decreases in affluent country consumption. Negligible decreases in total carbon emissions suggests that the net environmental benefits of paying increased wages for developing country workers are limited if they are not adopted as part of a suite of sustainability policies. Therefore, payment of supply chain living wages is a useful but not sufficient step toward sustainability.

Acknowledgements

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Appendix A. Supplementary Data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ecolecon.2019.01.007.

Appendix B. Moving Between Classification Systems and Price Concepts

The World Input-Output Database (WIOD) uses a modified form of the NACE (Statistical Classification of Economic Activities in the European Community) industrial classification system to describe economic transactions. Conversely, household consumption is usually recorded in the COICOP (Classification of Individual Consumption According to Purpose) classification system. Moreover, WIOD data is valued at basic prices, while consumer expenditure is valued at purchaser's prices. We examine household consumption of clothing goods, as defined by COICOP, and integrate an input-output model with various demand elasticities based on COICOP expenditures at purchaser's prices. Therefore, we require coherent translation between the two classification systems and price concepts.

B.1. Converting Between Classification Systems

To convert between classification systems we follow Druckman and Jackson (2009) and Mongelli et al. (2010) in using bridge matrices. We do not convert directly between NACE and COICOP but instead use an intermediary classification (Classification of Products by Activity (CPA)), when going from NACE to COICOP and vice versa (because we will use CPA to convert between price concepts). We need a bridge matrix for each transition.

The mechanics for estimating each bridge matrix all follow the basic process used to transform Supply-Use Tables (SUTs) to symmetric input-output tables (Dietzenbacher et al., 2013; Miller and Blair, 2009). For example, to move from CPA to NACE we use the World SUTs from WIOD. The world supply table is best visualised as partitioned matrix with a NACE (industry) classification for the rows and a CPA (product) classification for the columns. Where the partitions on the diagonal show the domestic (within country) supply of products from each industry, and the off-diagonal partitions (which would represent import/exports) are zero:

$$\mathbf{V} = \begin{matrix} \mathbf{V}_a & \mathbf{0} \\ \mathbf{0} & \mathbf{V}_b \end{matrix} \tag{A-1}$$

where superscript letters are countries.

We then post multiply this by a partitioned vector, $= \begin{matrix} \mathbf{t}_a \\ \mathbf{t}_b \end{matrix}$, in which each partition shows the total use of the domestically produced products (i.e. total use in CPA):

$$\mathbf{B} = \mathbf{V}\hat{\mathbf{t}}^{-1} \tag{A-2}$$

where, **B** is a NACE by CPA matrix where each element of the partitions on the diagonal indicates the share of domestic output of given product that is produced by a given industry. This is well established as the fixed product sales structure transformation method (see Miller and Blair (2009) and Dietzenbacher et al. (2013) for more).

The other bridge matrices all follow similar processes, taking a matrix showing flows from one classification to another and post-multiplying by the inverse of output in the relevant classification system.

The only exception is that to estimate CPA to COICOP (**C**) and vice versa (**R**) we use the CPA/COICOP conversion table from the United Kingdom Office for National Statistics (UK ONS, 2016). As this table is much more detailed than either the WIOD database or our elasticity parameters we aggregate from 104 products to 59 and from 36 COCIOP categories to 9. As this type matrix is rarely released by national statistical offices (Mongelli et al., 2010) we assume that every country has the same conversion from CPA to COICOP as the UK. To estimate CPA to NACE (**B**) and vice versa (**D**) we use data from the WIOD world SUTs.

The difficulty of the move from COICOP to CPA is that the single COICOP category of clothing becomes several CPA categories and then several NACE categories. As the living wage price shock effects some CPA/NACE categories more than others, the relative shares in the respective bridge matrices are changed. As a result, we also estimate price adjusted bridge matrices for COICOP to CPA ($\mathbf{R}_*$) and CPA to NACE ($\mathbf{B}_*$).

B.2. Converting Between Price Concepts

While the bridge matrices translate between classification systems, we also need to convert between price concepts. In the modelling framework, NACE data is always in basic prices and COICOP data is always in purchaser5s prices. However, the CPA classification functions as an intermediary between the two price concepts. CPA is used as an intermediary because in the world use tables WIOD provide an estimate of household demand for each country[4] in CPA at both basic and purchaser's prices. From this information we derive a matrix, **M**, in which each element in a given column is the ratio of basic to purchaser's prices for household demand from that CPA category. To convert household demand from basic prices to purchaser's prices we take the entrywise (elementwise) product of the demand matrix (in CPA) and **M**. To convert from purchaser's prices to basic prices we do entrywise division of the demand matrix by **M**.

Appendix C. Derivation of the Price Adjusted Input-output Model

The price adjusted input output model is estimated by updating the transactions table and gross output vector from the World Input-Output Table so that it's elements reflect a change in price, in our case the 'new' price of labour under the living labour compensation counterfactual. This updated table can then be used to estimate an input-output model in the usual way. This process follows Choi et al. (2010), who estimate the impacts of a carbon tax in the United States Economy.

To update the transactions table (**Z**) so that it reflects the living labour compensation rate we multiply it by the price index estimated in the main paper in Eq. (3),

$$\mathbf{Z}^* = \widehat{\mathbf{p}}^*\mathbf{Z} \tag{B-1}$$

Likewise, to estimate how the living labour compensation rate would have been reflected in gross output we multiply it by our price index,

$$\mathbf{x}^* = \widehat{\mathbf{p}}^*\mathbf{x} \tag{B-2}$$

We then estimate the price adjusted Leontief inverse,

$$\mathbf{L}^* = (\mathbf{I} - \mathbf{Z}^*\widehat{\mathbf{x}^*}^{-1})^{-1} \tag{B-3}$$

and the price adjusted impact vector,

$$\mathbf{u}^* = \mathbf{f}\widehat{\mathbf{x}^*}^{-1} \tag{B-4}$$

From which we can derive $\mathbf{Q}^*$, the matrix of impacts per unit of final demand,

$$\mathbf{Q}^* = \widehat{\mathbf{u}}^*\mathbf{L}^* \tag{F-4}$$

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