Anatomy of China's carbon dioxide emission: the role of induced and autonomous consumptions

Abstract

Anthropogenic greenhouse gas (GHG) emissions have been increasing globally since the pre-industrial era, driven largely by economic growth. Modeling consumption change under the background of economic growth is central to GHG projection models. With respect to income, consumption is either induced or autonomous. The former is influenced by income level, while the latter is independent of disposable income. Because the induced consumption is more elastic on income and more sensitive on policies, it is important to differentiate these two types of consumption in analytical and projection models for CO_2 mitigation. Here, we decompose the driving factors of China's CO_2 emission by considering the two consumptions in a comprehensive multi-sectoral model. Our projection model based on the decomposition analysis shows that (1) Baseline scenario that estimated induced consumption conservatively will over-estimate China's CO_2 emission; (2) Policy arrangement focusing on induced consumption can mitigate GHG emission efficiently.

key words: CO_2 **emission mitigation; induced consumption; autonomous consumption; scenario analysis; environmental input-output model**

1 Introduction

The spread of consumption is one of the large drivers of environmental degradation (IPCC, 2014). Although many studies considered the relation between emission and consumption in GHG projection models (Lenzen et al., 2004; Weber and Matthews, 2008; Peters and Hertwich, 2008; Davis and Caldeira, 2010), they did not distinguish between income disparities from those by non-income factors. At low income levels, consumption is used to satisfy basic human needs, while with rising income, people change choices and seek meaning, contentment, and acceptance in consumption (IPCC, 2014). Further, non-income factors such as geography, energy systems, waste management, household size, and lifestyle also influence the consumption pattern (Tukker et al., 2010; Corsten et al., 2013). According to Keynes' consumption theory, consumption can be classified into induced and autonomous consumption. The former is influenced by income level and the latter is independent of disposable income (Keynes, 1936). Induced consumption, which is determined by income level, is more elastic and autonomous consumption, which is roughly stable, exerts a long-run effect on growth (Serrano, 1995; Girardi and Pariboni, 2016). Moreover, the relation between income and consumption varies with commodities because their income elasticities of demand are different. The productions of different commodities have different carbon intensities. Therefore, a multi-sectoral model considering both induced and autonomous consumptions could help us to investigate the exact relation between growth and GHG emission. This eventually contributes to GHG projection and evaluates GHG mitigation policies.

China has achieved notable success in its economic development characterized by a high growth rate of income per capita. However, a byproduct of the growth miracle is the environmental disaster. China has become the largest CO_2 emitter in the world since 2006 (Peters et al., 2012; Guan et al., 2012). The Chinese government has pledged to reach a peak in its carbon emissions by 2030 (Liu et al., 2015), while the income per capita is expected to be thrice the current level (World Bank, 2013). It has long been assumed that economic growth increased emissions per capita (Steinberger et al., 2012). Environmental Kuznets Curve (EKC) hypothesis states an inverted U relationship between environmental impact and per capita income, however, most previous findings show a positive relationship between emissions and income (Roca and Serrano, 2007; Girod and De Haan, 2010; Golley and Meng, 2012). In this paper, income effect on emission will be evaluated by induced consumption. As induced consumption is more elastic, CO_2 from induced consumption is easier to adjust by individuals and institutions to achieve emission reduction.

Moreover, after Serrano (1995) proposes the Sraffian Supermultiplier model in which autonomous demand is viewed as the important driver of growth and as a stabilizing force that tames Harrodian instability, many studies have focused on the role of the autonomous demand in economic growth. Girardi and Pariboni (2016) tests empirically the major implications of Sraffian Supermultiplier model and finds that autonomous consumption exerts a long-run effect on growth. Unlike multi-sectoral analysis from Serrano, Serrano Sraffian Supermultiplier model is simplified as one-sector model and uses aggregate analysis. To the best of our knowledge, few researchers have studied the impact of autonomous demand on emission based on the multi-sectoral model. As induced and autonomous consumptions have different features, to achieve the mitigation target, it is necessary to optimize consumption from the perspective of induced and autonomous consumptions.

Structural decomposition analysis (SDA) based on IOA is a useful tool for studying economic structural changes (Dietzenbacher and Los, 1997, 1998). Many studies investigate structural changes with regard to environmental problems by using SDA (Peters et al., 2007; Guan et al., 2008). As we focus on income and autonomous impact on CO_2 emission instead of the progress that household income disparity generated, an extended SDA method based on regression analysis is more concise and effective than computable general equilibrium (CGE) model. Especially, SDA can estimate the induced and autonomous effect on consumption and then decompose the emission due to the induced and autonomous consumption from the total emission.

To differentiate induced and autonomous consumptions, we use regression analysis to evaluate the partial marginal effect of income growth on induced consumption. Then, a structure decomposition analysis (SDA) of input-output analysis (IOA) based on the regression is conducted to identify the contribution of induced and autonomous consumptions on global warming. Finally, based on our approach, we calibrate the forecast of China's CO_2 emissions in 2030. The remainder of this paper is organized as follows. Section 2 introduces the method and data employed in this study, Section 3 provides the results and discussion, and Section 4 concludes.

2 Method and data

This paper evaluates the impact of induced and autonomous effect on environmental emissions by using a structure decomposition analysis (SDA). To measure the effect of rising income on consumption, we use a regression analysis to differentiate induced and autonomous consumptions. Then, an SDA based on the regression is conducted to measure the contributions of the factors, especially induced and autonomous consumptions, towards global warming. Finally, a simulation analysis is introduced to show the CO_2 emission in different scenarios of China in 2030.

2.1 Income effect on consumption

Based on Keynes' consumption theory, the regression is employed to disaggregate consumption into induced and autonomous consumptions, which can be expressed as follows:

$$Y_{it} = \alpha_i + \beta_i X_t, \tag{1}$$

where $i = 1, 2, 3, ..., n$ stands for the categories of consumption that correspond to the economic sectors; $t = 1, 2, 3, ..., T$ stands for time; $\mathbf{Y}$ is a vector of consumption, whose ith entry y_{it} is consumption volume of sector i at time t, and $\mathbf{X}$ is resident income. Least squares regression is used to evaluate the marginal propensity of consumption (MPC), β. From the regression, consumption volume of each sector can be separated into the induced consumption, $\beta_i X_{it}$, and the autonomous consumption, α_i $(Y_{it} - \beta_i X_{it})$. Data of sectoral consumption used for regression is from China national input-output Tables (NIOTs) in world input-output database (WIOD) (Timmer et al., 2015). Data of income from 1995 to 2011 used for regression is from National Bureau of Statistics (2014).

Income elasticity of demand (ε) measures the responsiveness of demand quantity to a change in income. Sectoral income elasticities for 2011 are calculated by the regression. Sectoral income elasticities for 2030 are based on the calculation and adjustment of the elasticity 2011 and elasticity during the period 1995-2011 and on the estimating in Huang and Rozelle (1998) and Huang and Chen (1999). Meanwhile, sectoral income elasticities of demand for 2030 are evaluated to calculate sectoral consumptions in 2030, which can be expressed as follows:

$$COM(2030) = (1 + \epsilon \times \frac{INC(2030) - INC(2012)}{INC(2012)}) \times COM(2012), \quad (2)$$

where COM represents consumption expenditure, INC represents income level, and ε is income elasticity. The regression results and income elasticities are shown in Appendix.

2.2 Structural decomposition analysis

Employing an extension of the average of two polar decompositions (Dietzenbacher and Los, 1997, 1998), we disaggregate production-related sectoral CO_2 emission changes and obtain income effect on sectoral CO_2 emission changes. The production-related CO_2 emission can be expressed as follows[1]:

$$q_i = c(I-A)^{-1}y = cLy = cLMS, \tag{3}$$

where c is CO_2 emission intensity. $(I-A)^{-1}$ equals to L and records the Leontief inverse matrix. y is a vector representing final demand, which can be decomposed into $M \times S$. Further, M is a $n \times k$ matrix recording final demand structure and S is a 4×1 vector representing the aggregate final demand quantity of each part. CO_2 emission changes decomposition can be written as:

[1]Final demand can also be decomposed into induced consumption, autonomous consumption, and the other final demand, respectively.

$$\Delta Q_i = \widehat{c}_1 L_1 y_1 - \widehat{c}_0 L_0 y_0 = \widehat{c}_1 L_1 M_1 S_1 - \widehat{c}_0 L_0 M_0 S_0$$
$$= \underbrace{(\widehat{\Delta c} L_1 y_1 + \widehat{\Delta c} L_0 y_0)/2}_{\mathbf{E}_c} + \underbrace{(\widehat{c}_0 \Delta L y_1 + \widehat{c}_1 \Delta L y_0)/2}_{E_L} \tag{4}$$
$$+ \underbrace{(\widehat{c}_0 L_0 \Delta M S_1 + \widehat{c}_1 L_1 \Delta M S_0)/2}_{E_M} + \underbrace{(\widehat{c}_0 L_0 M_0 \Delta S + \widehat{c}_1 L_1 M_1 \Delta S)/2}_{E_S}$$

where E_c denotes CO_2 emission changes caused by CO_2 emission intensity, E_L records CO_2 emission changes caused by Leontief matrix or economic structure, and E_M and E_S are matrices recording changes in sectoral CO_2 emissions caused by final demand structure and final demand aggregate, respectively. Δ denotes the changes in variables between periods 1 and 0. The data of the decomposition uses the previously obtained coefficient, the Chinese IOTs for 1992 and 2012 together with the CO_2 emission intensity data sourced from the **?**National Bureau of Statistics (2014) and the Intergovernmental Panel on Climate Change (2006).

2.3 Scenario analysis

To illustrate potential CO_2 emission in 2030, different scenarios (baseline scenario, US pattern scenario, and ecological scenario) are constructed. To construct scenarios, we provide following conditions.

(1) Economic growth

From 1992 to 2014, gross domestic product (GDP) of China experiences a 10.09% average annual growth rate and the growth rate for 2015 is 6.9% (National Bureau of Statistics, 2015). The slowdown of Chinese economic growth is becoming the "new normal". According to the prediction from International Monetary Fun (IMF) and World Bank (2013), these scenarios assume that during the period 2015 - 2020, GDP growth rate is 6% and from 2020 to 2030 the economic growth rate slows to 4.5%. Per capita income growth rate is consistent with economic growth rate.

(2)Technical and structural change

To evaluate input-output coefficients matrix for 2030, biproportional scaling method (RAS) (Stone and Brown, 1962) is employed. We adopt 2012 as the base year, whose coefficient matrix is A_t (t=2012) and the predicted year is 2030, whose matrix is A_p (p=2030). Existence matrices R and S satisfy the equation: $A_p = RA_tS$. Under an objective function, we can estimate matrices R and S, and obtain the coefficient matrix for 2030. The objective function can be expressed as:

$$min\, G = \sum_{j=1}^{n}[\frac{\sum_{i=1}^{n} r_i a_{tij} s_j X_{pj} + Z_{pj} - X_{pj}}{X_{pj}}]^2 + \sum_{i=1}^{n}[\frac{\sum_{j=1}^{n} r_i a_{tij} s_j X_{pj} + Y_{pi} - IM_{pi} - X_{pi}}{X_{pi}}]^2, \quad (5)$$

where r_i is the cell of matrix R and s_j is the cell of matrix S, respectively. a_{tij} is the input-output coefficient at time t. X_{pj} is total output and Z_{pj} is value-added of sector i at time p. Y_{pi} is final demand and IM_{pi} is import of sector i at time p. All of them keep a steady growth.

(3)Consumption pattern

Consumption pattern for baseline scenario is calculated by equation (2) using sectoral income elasticities for 2030, sectoral consumption aggregate of 2012, and income growth rate from 2012 to 2030. Induced consumption is calculated by regression coefficients times income level, while autonomous consumption is equal to total consumption (determined by income elasticity) subtracts induced consumption. Consumption patterns for US pattern scenario uses the US induced consumption pattern in 2011 to adjust induced consumption pattern and autonomous consumption is the same with the baseline model. Consumption pattern for the ecological civilization scenario is based on the baseline scenario, the US pattern scenario, and eco-indicators defined by the government to promote the consumption for service and public transport and cut down the consumption for appliances and private transport.

(4)Energy demand and structure

The annual rate of energy demand is about 6.08% from 1992 to 2014 (National Bureau of Statistics, 2015). Based on a regression and GDP growth rate, the relationship between GDP growth rate and energy demand growth rate can be calculated. Considering an average GDP growth rate is 6% and 4.5% respectively, the average growth rate for energy demand will be 3% and 2.3% per year for the two periods. This assumption is consistent with energy growth rate during 1992 -2012. For energy structure changes, we adopt the assumption as World energy outlook (International Energy Agency, 2015) and BP energy outlook (BP, 2016).

It should be noted that in the baseline scenario conditions and assumptions about the economic growth rate, Leontief technical coefficients matrix, energy demand, and energy structure are based on development rules and induced consumption in this scenario is calculated by past regression coefficients, which is the conservative case for emission prediction. In the US pattern scenario, we estimate the induced consumption pattern for 2030 based on the US induced consumption pattern of 2011, and in the ecological civilization scenario, we consider mitigation actions on induced consumption and CO_2 intensity.

3 Results and discussion

3.1 Income effect on consumption

With income growth and lifestyle improvement, both consumption aggregate and structure changed significantly. From 1992 to 2012, China's consumption increased by 11.97 times. With regard to the structure, demand on manufacture products, such as household appliances, rose significantly during this period, which is consistent with the S-shaped relationship between income and appliance, as demands on household appliances increased with rising income during this period (Auffhammer and Wolfram, 2014).

Induced and autonomous consumptions can be estimated by using a regression model. Our results show that the structural change of induced consumption differed from that of the autonomous consumption. For induced consumption, the share of services expanded, while the shares of food and clothing reduced from 1992 to 2012. Autonomous consumption showed phase characteristics and remained roughly stable for about 10 years, which is consistent with Chinese stages of development and lifestyle. Sectoral consumptions for 2030 are estimated by income elasticity of demand and estimated income level, while induced consumptions for 2030 are calculated by regression coefficients (partial marginal effect of income growth on induced consumption). From 2012 to 2030, consumption shares for agriculture, food, and transport decrease, while the ratios of service consumption and electric power rise for both consumption and induced consumption.

3.2 SDA results from 1992 to 2012

We employ an SDA of IOA to decompose the contribution of various factors on the growth of CO_2 emission in China, especially the effect of induced and autonomous consumptions. The factors in question are CO_2 emission intensity, production technology changes, induced consumption, autonomous consumption, and the other final demand. Each type is further divided into structure and aggregate. The former refers to the proportion across commodities, while the latter refers to the aggregated quantity. Fig.1 shows the contribution of each driving force for different sectors.

From 1992 to 2012, production-related CO_2 emission increased by 7,731 million tonnes (Mt), growing by 268.08%. Thanks to the technology progress

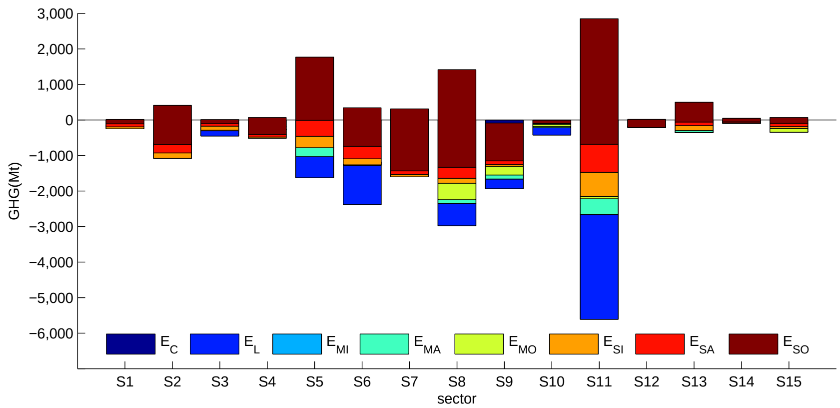

Figure 1: The drivers of CO_2 emission changes for different sectors from 1992 to 2012. E_C: CO_2 changes due to the CO_2 emission intensity changes; E_L: CO_2 changes due to the technology changes; E_{MI}: CO_2 changes due to the induced consumption pattern changes; E_{MA}: CO_2 changes due to the autonomous consumption pattern changes; E_{MO}: CO_2 changes due to the other final demand pattern changes; E_{SI}: CO_2 changes due to the induced consumption volume changes; E_{SA}: CO_2 changes due to the autonomous consumption volume changes; E_{SO}: CO_2 changes due to the other final demand volume changes. Sector names are shown in Appendix corresponding to sector numbers.

and pollution control, the contribution of CO_2 intensity on CO_2 growth was -237.94%. In other words, it offset 237.94% of CO_2 emission. Production technology change and final demand were responsible for 70.89% and 267.05% of the CO_2 growth, respectively. By decomposing final demand into consumption, fixed capital investment, net export, and others, we obtained that consumption caused 6,048 Mt of CO_2 increase (78.23%), fixed capital investment contributed 14,293 Mt (184.87%), and net export and other factors led to 323 Mt of CO_2 increase (4.18%) and -18 Mt of CO_2 reduction (-0.23%), respectively. Electric production, petroleum processing, and metal products were the main sources of CO_2 emission during this period, as these sectors relied heavily on fossil fuels such as coal and oil. Currently, cutting coal use is an effective way to achieve national mitigation goals in China.

Consumption changes contributed to 78.23% of emission growth. Among these, 25.96% was attributed to induced consumption and 52.27% to autonomous consumption. With regard to induced consumption changes, structure changes led to only 0.08% of CO_2 emission growth. With income growth, the share of food products in induced consumption decreased, while the share of services in the same increased, and both were produced by sectors with low CO_2 intensity. Meanwhile, the shares of consumption of sectors with high CO_2 intensity, such as manufacture sectors, obviously did not change. Therefore, the effect of change in induced consumption pattern on CO_2 growth was relatively small. Chinese GDP per capita is expected to exceed 10 thousand US dollars in the next few years. Consumption demand on some high CO_2 emission sectors, especially electric power demand, would increase significantly in this period. Importantly, in China, the share of the population living above the poverty line is an important determinant of electricity demand (Auffhammer and Wolfram, 2014). To achieve the CO_2 mitigation target proposed by the Chinese government, it is important to reduce the CO_2 intensity of these key sectors with high expected growth rate of induced consumption in the near future. The effective policy is to use tax and subsidy tools to adjust energy structure, especially replace coal with cleaner energy.

3.3 Scenario results

Based on our decomposition, we forecast the CO_2 emission of China. Three different scenarios are constructed: baseline scenario, US pattern scenario, and ecological civilization scenario. In the baseline scenario, the growth rate of induced consumption is assumed to be business-as-usual. In the US pattern scenario, the change of induced consumption pattern is the same with that of the US. We use this scenario to see the effects of the hypothetical situation in which China becomes another USA in induced consumption pattern. In the ecological civilization scenario, we introduce a hypothetical induced-consumption-concentrated policy to control CO_2 emission.

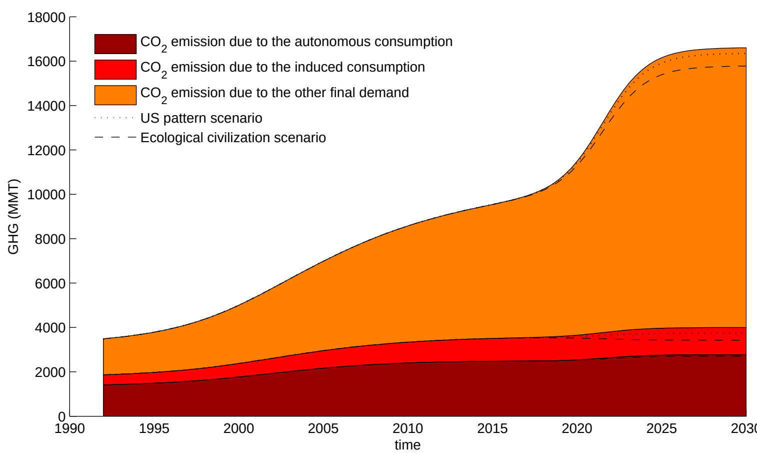

Figure 2: The contribution of final demand categories to CO_2 emission.

Potential production-related CO_2 emission for the baseline scenario in 2030 is 16,615 Mt, which is an increase by 5,999 Mt (56.52%) since 2012. Total CO_2 emission and the contribution of various driving forces from 1992

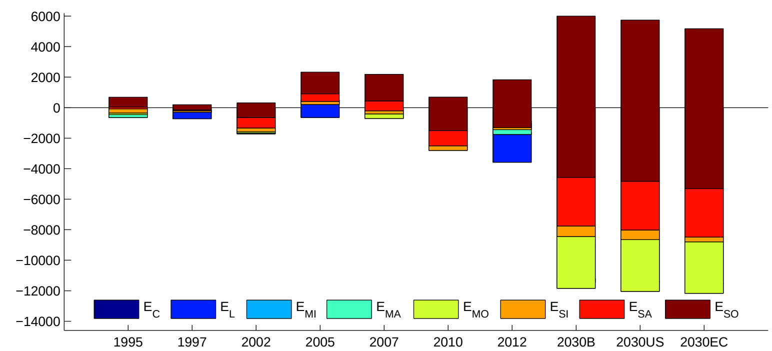

Figure 3: The contribution of CO_2 emission changes for two scenarios from 1992 to 2030. E_C, E_L, E_{MI}, E_{MA}, E_{MO}, E_{SI}, E_{SA}, and E_{SO} are historical CO_2 emission changes caused by CO_2 emission intensity changes, technology changes, induced consumption pattern changes, autonomous consumption pattern changes, the other final demand pattern changes, induced consumption volume changes, autonomous consumption volume changes, and the other final demand volume changes, respectively; $2030R$, $2030US$, and $2030EC$ are reference scenario, US consumption pattern scenario, and ecology civilization scenario, respectively.

to 2030 are shown in Fig 2. During 2012-2030, CO_2 emissions caused by induced consumption increase from 1,152 Mt to 1,227 Mt, while the proportions decreased from 10.86% to 7.39% mainly because of consumption structure changes. CO_2 emission caused by autonomous consumption is relatively stable. It implies that the non-income factors did not change the consumption significantly. Investment and infrastructure construction played important roles in CO_2 emission growth. The results for SDA of different periods are shown in Fig 3. From 2012 to 2030, the change of induced consumption pattern contributes to 4.18% to CO_2 emission increase. In this scenario, food, cloth, appliances, and electric power consumption are still important, while consumptions for services, which will rise obviously with income growth, do not increase remarkably. The baseline scenario can be viewed as a conservative estimate for induced consumption. Increasing induced consumption for electric power is one of the driving forces that pull emission. At present, over 70% of China's electricity supply comes from coal-fired stations, and thus, approaches that reduce electricity use and improve power generation are effective to control anthropogenic CO_2 emission.

To realize the emission reduction target, optimization of the induced consumption pattern is important and induced consumption determined by income is more flexible than autonomous consumption. The US pattern scenario is designed to estimate induced consumption by US consumption pattern because with rising income, the induced consumption pattern would be similar to that of developed countries. Therefore, we use the scenario analysis to determine the situation in which China becomes another USA. The consumption proportion of China in this US pattern scenario is set to be the same as that of the US in 2011, all other factors remaining unchanged. Compared with the baseline model, people consume more services, such as wholesales, retails, restaurants, hotels and other services, and less products from food, clothing, power-use, and household appliances in the US pattern. Under this scenario, CO_2 emission in 2030 would be 16,356 Mt, which is 1.56% less than that of the baseline scenario. Emission caused by induced consumption is 968 Mt, which is 21.07% less than that of the baseline scenario. The consumption structure of USA, especially induced consumption structure, is better than that of China. Increasing consumption of service sectors and reducing consumption from manufacture sectors have remarkable effects on CO_2 emission reduction. This result is consistent with Guan et al. (2008) and Peters et al. (2012), which show that the US consumption structure would be "cleaner" since US residents consume relatively more services and less manufacturing products and China surpassed the USA in consumption-based emissions in 2009. Compared with the baseline scenario, using regression coefficients from past data to forecast induced consumption would over-estimate emission, as evaluation on past coefficients is relatively lagging, while using the consumption pattern of high-level areas could predict future trends more clearly and obtain more accurate results.

Multiple efforts have been made by the Chinese government regarding sustainable development and the emission reduction targets. A series of initiatives to reduce energy consumption and individual consumption have been proposed, including China's Air Pollution Prevention and Control Action plan published in 2013 and Air Pollution Prevention and Control Law revised in 2015. These initiatives are expected to reduce CO_2 intensity and improve consumption structure. In this scenario, on the one hand, we reduce CO_2 intensity, which is affected by the change of energy intensity. On the other hand, we improve induced consumption structure by promoting the consumption for service and public transport and cutting down the consumption for appliances and private transport by various eco-indicators defined by the Chinese government (Yong, 2011). Under this scenario, CO_2 emission for 2030 is 15,787 Mt, dropping by 4.98% compared with the baseline scenario. This scenario is the "best case" for our simulation analysis. The contribution of CO_2 intensity reduction to CO_2 reduction is 176.23%, which is greater than those in the previous two scenarios. Because of the improvement of the induced consumption structure, CO_2 emission resulting from induced consumption drops from 7.39% in the baseline scenario to 4.53% and 0.95% CO_2 emission reduction is due to induced consumption structure changes.

4 Conclusion

Our results indicate that (1) projection models in baseline scenario which estimated CO_2 emission conservatively over-estimate China's CO_2 emission. If we adopt the US-induced consumption pattern, emission would reduce by 1.56%. (2) Furthermore, a mitigation policy arrangement focusing on induced consumption could mitigate GHG emission efficiently and if we consider mitigation measures, emission would reduce by 4.98%.

The results have a number of implications. Fist, with rising income, guiding rational and sustainable consumption is important, which includes control consumption aggregate and adjust structure. On the one hand, transforming induced consumption from high intensity sectors to low intensity sectors is an effective way to control emission. On the other hand, reducing induced consumption on electricity and private transport has effect on cutting emission. Second, policies should inform economical and environmental harmonious element in emission mitigation. Mitigation policies, including carbon tax mechanism and a cap-and-trade system (Tollefson, 2015), can impel transformations to cleaner production, however, government should resolve the conflict between emission reduction and economic growth and reduce subsidizes for industries that generate excessive emissions (Miao, 2015). That is, for industrial policymaking, both economic effect and environmental impact should be taken into account. Third, improve coal-leading energy structure and boost renewable energies and hydro power can help to build a low-carbon economy (Liu, 2013). Nowadays energy-intensive goods produced in China have relatively high embodied emissions. Transforming energy mix to "green power" can reduce emission to a large degree. With effective policy, inefficient coal-driven industry should be eliminated to satisfy emission-mitigation indicators.

Appendix

Table 1 shows the regression results and income elasticities which are used to decompose induced consumption and evaluate consumption for 2030.

Table 1: Regression results and income elasticity

Num	sector names	Coef	IE2011	IE2030
S1	Agriculture, forestry, animal husbandry & fishery	0.0358	1.2386	0.3600
S2	Mining	-0.0002	1.4202	1.1000
S3	Manufacture of foods, beverage & Tobacco	0.0901	1.0943	1.1000
S4	Manufacture of textile, wearing apparel & leather products	0.0158	1.1540	1.1000
S5	Coking gas and processing of petroleum	0.0012	1.3192	1.1000
S6	Chemical industry	0.0022	0.5466	1.1000
S7	Manufacture of nonmetallic mineral products	0.0013	1.2490	1.1000
S8	Manufacture and processing of metals and metal products	0.0001	1.3030	1.1000
S9	Manufacture of machinery and equipment	0.0002	1.4444	1.1000
S10	Other manufacture	0.0001	1.1000	1.1000
S11	Production and supply of electric power, heat power, and water	0.0068	1.5008	1.1000
S12	Construction	0.0067	1.6035	1.1000
S13	Transport, storage, post, information transmission, computer services & software	0.0318	1.5272	1.2000
S14	Wholesales, retail trades, hotels and catering service	0.0322	1.4889	1.2000
S15	Other services	0.0369	1.1770	1.0000

Sector names are from National Bureau of Statistics (2015).

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