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Higher Labor Income Can Help China Meet Macroeconomic, Social and Ecological Challenges: Consumption, Labor Income and Emissions in China's Provinces, 1995-2017

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Abstract: In recent years, China has been a major force driving the global economic growth. However, China's economic growth in the future faces macroeconomic, social, and ecological challenges. This paper studies the sustainability of China's development by evaluating the empirical relationship between household consumption, labor income share, and carbon dioxide emissions using provincial-level data from 1995 to 2017. We find that labor income share has positive and significant impact on household consumption share. Both household consumption share and labor income share have negative and significant impact on emission intensity of GDP. Household consumption share and labor income share influence emission intensity through their impact on the industrial structure. These findings suggest that higher labor income share may help China to simultaneously address macroeconomic, social, and ecological challenges.

China is now the world's second largest economy measured by market exchange rate. In 2019, China's gross domestic product (GDP) measured by current US dollars reached 14.3 trillion dollars, accounting for 16 percent of the gross world product. Measured by purchasing power parity, China has already overtaken the US and become the world's largest economy. In 2019, China's GDP measured by constant 2017 international dollars reached 22.5 trillion dollars, accounting for 17 percent of the gross world product. In recent years, China has become a major force driving the global economic growth. During 2009-2019, China accounted for 34 percent of the cumulative global economic growth measured by market exchange rate or 31 percent of the cumulative global economic growth measured by purchasing power parity (data are from World Bank 2021).

However, China's economic growth in the future faces macroeconomic, social, and ecological challenges. Without effective management of these challenges, China's economic progress could be derailed by economic, social, or ecological crisis.

Despite years of effort by the Chinese government, China has not yet succeeded in correcting its structural macroeconomic imbalances. Household consumption has stayed below 40 percent of China's GDP. As a result, the Chinese economy continues to depend on excessively high level of investment that has reduced investment efficiency and led to surging nonfinancial sector debt.

China's low levels of household consumption are partly caused by relatively low labor income as a share of economic output. China's economic model depends on the exploitation of a large cheap labor force. Relatively low labor income allows for high business profit which in turn contributes to high investment levels. However, persistently low labor income share not only prevents China's macroeconomic rebalancing but also contributes to high levels of income inequality that threatens to increase social instability.

Moreover, China's economic growth has been made possible by massive consumption of fossil fuels. China is the world's largest consumer of coal, second largest consumer of oil, and third large consumer of natural gas. As a result, China is now the world's largest carbon dioxide emitter (according to data from BP 2020). Without a fundamental change in the energy consumption pattern, China's future economic growth will not be compatible with requirements of global ecological sustainability. Recently, China's President Xi Jinping promised that China would work towards "carbon neutrality" (meaning China's net carbon dioxide emissions will fall to zero) by 2060 (Myers 2020). Therefore, China's future economic growth will need to take place under the constraint of rapid and substantial emissions reduction.

How can China meet the future macroeconomic, social, and ecological challenges simultaneously? This paper attempts to address a part of this question by evaluating the empirical relationship between household consumption, labor income share, and carbon dioxide emissions in China's provinces during the period 1995-2017.

The next section provides a general discussion of China's macroeconomic, social, and ecological challenges. The third section conducts a panel data analysis with fixed effects of the various factors that help to determine household consumption share using the provincial-level data. We find that labor income share has significant and positive impact on the household consumption share. The fourth section conducts a panel data analysis with fixed effects of the various factors that help to determine carbon dioxide emissions at the provincial

level. We find that both the household consumption share and the labor income share have significant and negative impact on emission intensity of GDP. These findings suggest that, in the Chinese context, higher labor income share may help to raise household consumption and reduce carbon dioxide emissions and thereby helping to address China's macroeconomic, social, and ecological challenges simultaneously. The last section concludes the paper.

China's Economic Development: Macroeconomic, Social, and Ecological Challenges

For years, China's macroeconomic structure has been characterized by its unusually low share of household consumption and unusually high share of investment (gross capital formation). Figure 1 compares China's household consumption share (household consumption as % of GDP) with that of the high-income countries, upper middle-income countries (the income group to which China now belongs), East Asian and Pacific countries, and the world average from 2000 to 2019.

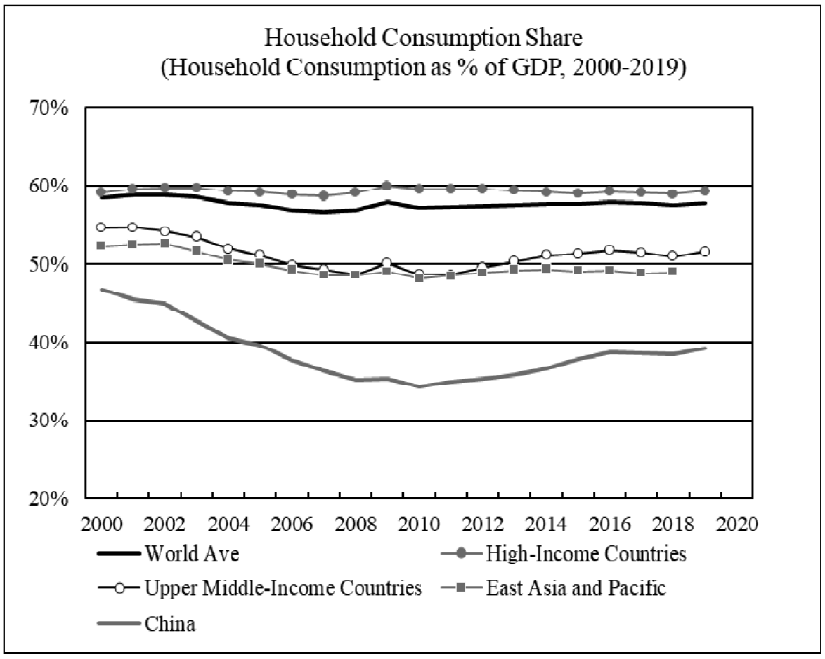

Figure 1: Household Consumption Share (Household Consumption as % of GDP, 2000-2019)

Source: World Bank (2021).

In recent years, the household consumption share in the high-income countries has averaged about 59 percent. The household consumption share of upper middle-income countries and East Asian countries has been in the range of 49-52 percent. By comparison, China's household consumption share has stayed consistently below 40 percent, lower than the East Asian average by about 10 percentage points and lower than the high-income countries' average by about 20 percentage points.

China's unusually low share of household consumption implies high domestic saving rates. China's gross domestic saving as percent of GDP peaked at 51 percent in 2010. Since then, the saving rate has slowly declined. By 2019, gross domestic saving as percent of GDP fell to 44 percent. Before 2010, a significant portion of the domestic saving was absorbed by net exports. Net exports peaked at near 9 percent of GDP in 2007. Since the global economic crisis in 2008-2009, the developed capitalist economies have stagnated and China's export expansion has slowed down. Before the Covid crisis, China's net exports shrank to about 1 percent of GDP.

Because much of the decline of domestic saving rate from 2010 to 2019 was offset by the decline of net exports as share of GDP, domestic investment has stayed at elevated levels. China's gross capital formation as share of GDP reached 47 percent in 2010 and stayed at 43 percent in 2019. Excessively high level of investment may have contributed to misallocation of capital and led to rapid decline of the average rate of return on China's business sector capital stock (Li, 2020a: 83-39).

Moreover, much of China's investment has been financed by business and household debt. Persistently high investment has been associated with rising and potentially unsustainable debt levels. China's "total social financing" (a proxy for domestic non-financial sector debt) surged from 121 percent of GDP in 2008 to 255 percent of GDP in 2019 (data are from NBS 2020: Table 18-4). By comparison, the US domestic non-financial sector debt reached 253 percent of GDP in 2019 (ERP 2021: 504, Table B-40). In other words, China's domestic debt had reached levels comparable to that in the United States before the Covid crisis.

In 2018, Martin Wolf, the famous *Financial Times* columnist, considered four possible scenarios regarding how China's debt surge could come to an end. Wolf argued that a crisis followed by a substantial reduction of long-term growth would be the most likely outcome (Wolf 2018). Also in 2018, Michael Pettis, a professor at Peking University, argued that China would have to make

an urgent adjustment towards a consumption-oriented growth model in order to avoid debt crisis (Pettis 2018). In 2019, a report by OECD warned that China's unsustainable debt levels may trigger large-scale corporate defaults (OECD 2019: 28-38).

A variety of factors may have contributed to China's low household consumption share. China's underdeveloped social safety net and uncertainties associated with market reform may have forced households to keep the saving rates high and therefore depressed consumption (Aziz and Cui 2007; Yang 2012). But an important factor has to do with China's relatively low share of labor income. It is well recognized that labor income is likely to have a higher consumption propensity than capital income. Classical political economists such as Karl Marx assumed that the working-class families tended to spend all of their incomes on essential consumption (Marx, 1967[1867]: 709-710, 725-734). Economists from the Post-Keynesian or Kaleckian tradition often assume that a higher share of labor income will have expansionary effect on the economy through its positive impact on consumption demand (Steindl 1952; Kalecki 1971: 93-104; Stockhammer and Onaran 2012).

Figure 2 compares China's labor income share (labor income as % of GDP) with that of the United States, European Union (the average of 27 European Union countries), Japan, and South Korea. For the European Union, data are from 2000 to 2020; for China, data are from 2000 to 2019; for the US and Japan, data are from 2000 to 2018; for South Korea, data are from 2010 to 2017.

In recent years, labor income share in the US and the European Union has stayed around 60 percent. Japan's labor income share was 54 percent in 2018 and South Korea's labor income share was 52 percent in 2017. China's labor income share fell to 41 percent in 2011. By 2019, China's labor income share recovered to 47 percent, which is still about 13 percentage points lower than that in the US or Europe or 5-7 percentage points lower than that in other East Asian economies.

Lower labor income share is likely to have contributed to China's unusually low share of household consumption. Besides, low labor income share may have been responsible for China's relatively high level of income inequality. Empirically, inequality in labor income distribution is much smaller than inequality in capital ownership distribution (Piketty 2014: 304-376). Therefore, lower labor income share is likely to be associated with higher level of inequality.

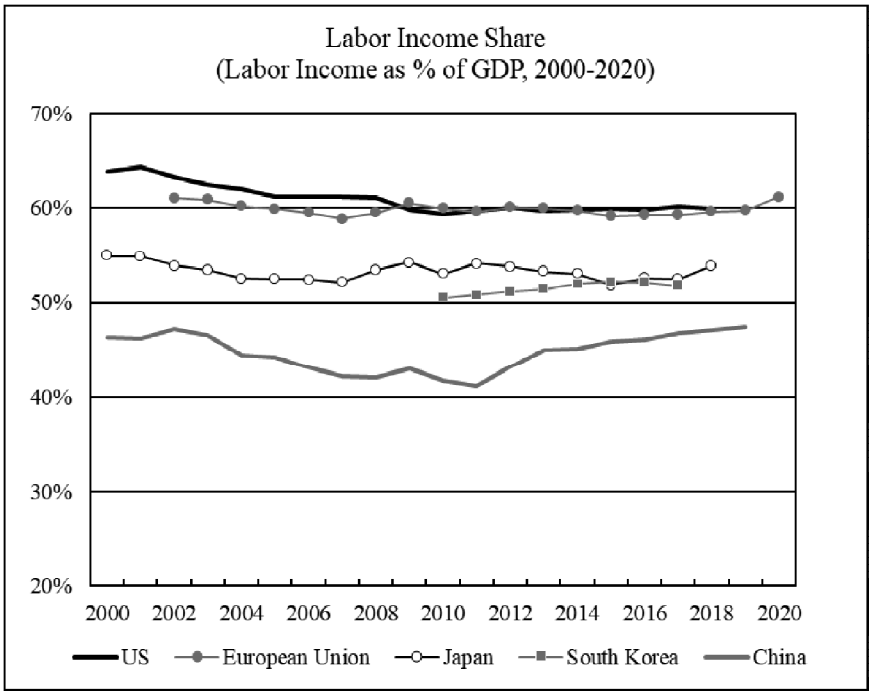

Figure 2: Labor Income Share (Labor Income as % of GDP, 2000-2020)

Sources: Labor income share for US, European Union (average of 27 European Union countries), Japan, and South Korea are calculated using data from OECD (2021). Labor income for OECD countries is defined as compensation of employees plus two-thirds of the mixed income (following the Johnson adjustment, see Johnson 1954). China's labor income share is calculated using data from China's Flow of Funds Account (NBS 2021a). China's Flow of Funds Account treats all self-employed income as labor income (Zhang 2012). In the Flow of Funds Account, self-employed income is considered to be labor income paid by the household sector to itself. To make the Chinese labor income comparable with the OECD labor income, we calculate China's total labor income as the sum of labor income paid by the business and government sector and two-thirds of the labor income paid by the household sector.

Gini index is the commonly used index to measure inequality in family income distribution. According to the World Bank estimate, in 2016 (the latest year for which World Bank estimate of China's Gini index is available), China's Gini index was 0.385 (World Bank 2021). However, according to China's current official data, in 2017-2019, China's Gini index is in the range of 0.465-0.468 (CEIC 2021). Using the World Bank estimate, the CIA'S *World Factbook* ranks China number 74 among 174 countries for which Gini index is reported (CIA 2021). However, using China's official Gini index, China would have ranked

number 22 in CIA's list of countries ranked by Gini index, making China more unequal than 152 countries.

Although there is not a fixed and certain relationship between inequality and social instability, social and political observers generally agree that higher inequality is likely to increase the risk of social unrest. Oxfam International (2014) warned that extreme economic inequality could lead to social instability and undermine political democracy. World Economic Forum's *Global Risks Report 2015* cited the trend of rising inequality and related social instability as major risks to global businesses (World Economic Forum 2015). Rising inequality may have contributed to the surge of far left or far right populism in North America and Western Europe in recent years (Goodhart and Pradhan 2020: 101-116). In China, growing frequency of strikes and other social incidents has increased the pressure on the Chinese government to address social inequality (Equal Times Newsdesk 2013; Huang 2012).

In addition to macroeconomic and social imbalances, China's economic growth has involved heavy environmental costs. China has some of the world's most polluted cities. About one million Chinese people die every year prematurely due to air pollution, accounting for 40 percent of the world's premature death caused by air pollution (Wong 2013). China's existing water resources are heavily polluted. About two-fifths of China's rivers and three-quarters of the lakes are considered to be unsuitable for drinking or fishing (China Water Risk 2010). Soil erosion and pollution have degraded more than 40 percent of China' arable land (Patton 2014).

In term of impact on the global environment, the single most important impact results from China's carbon dioxide emissions. Figure 3 compares China's and the OECD carbon dioxide emissions as share of world emissions from 2000 to 2019.

The OECD countries' total emissions as share of world emissions declined from 55 percent in 2000 to 35 percent in 2019. During the same period, China's share of world total emissions rose from 14 percent to 29 percent. China's emissions now roughly equal the sum of emissions by the United States, the European Union, and the Russian Federation. Without China's firm commitment to reduce emissions rapidly and substantially, it is virtually impossible for the world to meet the objective of limiting global warming to not more than two degrees Celsius compared to the pre-industrial time (Li 2020b).

Therefore, despite the rapid economic growth that China has accomplished over the past several decades, in the future, China will have to confront major

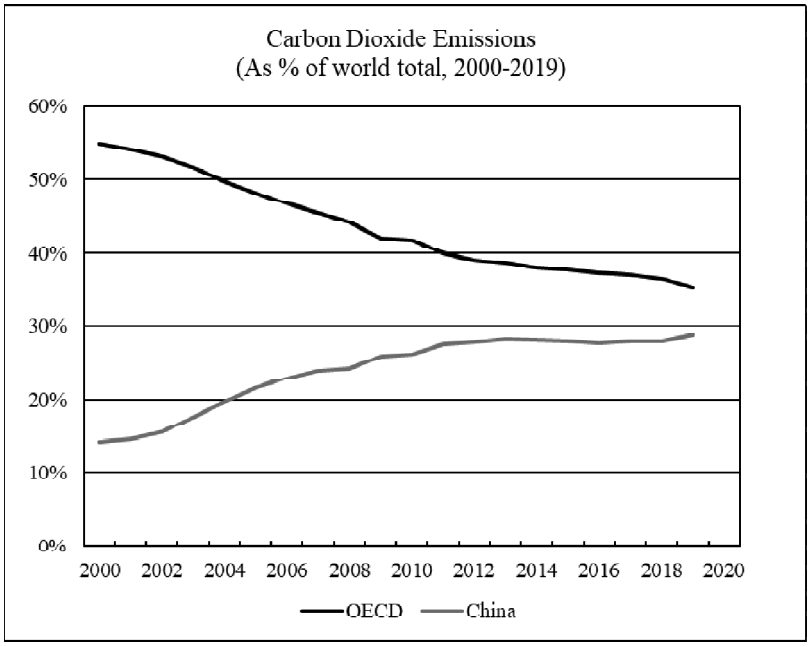

Figure 3: Carbon Dioxide Emissions (As % of world total, 2000-2019)

Source: BP (2020).

macroeconomic, social, and ecological challenges. In particular, China faces the task of raising household consumption share and labor income share while simultaneously reducing carbon dioxide emissions. The rest of this paper evaluates the empirical relationship between household consumption share, labor income share, and carbon dioxide emissions in the Chinese context.

Household Consumption and Labor Income

Household consumption depends on household disposable income and the household sector's consumption propensity. Household disposable income mainly depends on labor income. According to China's household survey, in 2017, wage income and "net entrepreneurial income" (self-employed income) together accounted for 74 percent of the household sector disposable income. If two-thirds of the self-employed income is considered to be labor income, then labor income accounted for 68 percent of the household sector disposable income (NBS 2018: Table 6-1).

According to Post-Keynesian, Kaleckian, or Marxian perspective, income distribution is a major factor that helps to determine the consumption propensity.

Because labor income is likely to have a smaller saving rate than the capital income, a higher labor income share can translate into a higher consumption propensity for the total economy.

Several other factors may have impact on the consumption propensity. According to the life cycle hypothesis, children and retirees usually consume more than what they produce. Therefore, higher child dependency ratio and old-age dependency ratio should be associated with higher household consumption (Modigliani and Brumberg 1954). According to neoclassical microeconomic theory, household consumption results from consumer's intertemporal optimization decision. Since real interest rate is the opportunity cost of current consumption, there should be a negative relationship between real interest rate and current consumption if higher real interest rate encourages consumers to substitute future consumption for present consumption. Alternatively, higher real interest rate may encourage households to spend more on consumption if the income effect dominates the substitution effect (Mishkin 2011: 76-77, 456-460).

In the Chinese context, housing price may be another important factor influencing household consumption. Higher housing price may have positive impact on household consumption through the wealth effect. On the other hand, higher housing price may discourage consumption through the substitution effect (by encouraging households to substitute saving or future consumption for present consumption). In an earlier study, Hui, Dong, and Jia (2018) find positive and significant relationship between housing price and consumption of house-owning families. Peng, Qiu, Song, and Huang (2019) find positive relationship between housing wealth appreciation and household consumption.

In this section, we use panel data of 30 provincial-level units from 1995 to 2017 to evaluate the impact of labor income share on household consumption share, controlling for the real interest rate, dependency ratios, and ratio of housing price to per capita GDP. The 30 provincial-level units include all provinces, autonomous regions, and directly administered municipalities in mainland China except the Autonomous Region of Xizang (Tibet). Tibet is excluded from this research due to absence or incompleteness of data. Year 2017 is the last year included because China's National Bureau of Statistics has not published provincial-level income approach of GDP and labor income for years after 2017.

The estimation equation for this section is defined as follows:

$$\text{Consumption Share}_{i,t} = \beta_0 + \beta_1 \text{ Labor Share}_{i,t} + \beta_2 \text{ Real Interest Rate}_{i,t} + \beta_3 \text{ Child Dependency}_{i,t} + \beta_4 \text{ Old Age Dependency}_{i,t} + \beta_5 \text{ Housing Price}_{i,t} + \varepsilon_{i,t} \quad (1)$$

Where "Consumption Share" is the share of household consumption in provincial GDP, "β_0" is the estimate value for constant, "Labor Share" is the share of labor income in provincial GDP, "Real Interest Rate" is calculated as one-year deposit interest rate deflated by provincial-level consumer price index, "Child Dependency" is the child dependency ratio defined as number of people aged between 0 and 14 years old divided by the working age population (the number of people aged between 15 and 64 years old), "Old Age Dependency" is the old-age dependency ratio defined as the number of people aged 65 year old or older divided by the working age population, "Housing Price" is the housing price to per capita GDP ratio calculated as the average housing price per square meter divided by the provincial per capita GDP, ε is the error term, and "i" and "t" denote individual provincial-level units and years.

All variables used in the regression except the deposit interest rate are calculated using data from NBS (2021b). The deposit interest rate from 1995 to 2017 is from NBS (2018: Table 18-5) and earlier volumes of *China Statistical Yearbook*.

In order to avoid the problem of spurious results which are commonly seen in time-series data regressions, we performed the Levin-Lin-Chu (LLC) test for unit root (Levin, Lin, and Chu 2002). Both the Consumption Share and the Labor Share series generate results that cannot reject the null hypothesis (that the panel contains a unit root) at the level of *I* (0). However, both series become stationary in LLC test at the level of *I* (1). But taking differenced value of the series may lead to the loss of information about long-run patterns. We performed the Pedroni panel-data cointegration test to find out whether there are long-run equilibria among the data series in the panel (Pedroni 1999). The p-values of the modified Phillips-Perron t-statistic indicate rejection of the null hypothesis (no cointegration) at a significance level of 1 percent in the panel. It is thus legitimate to assume that the relationship of long-run equilibrium exists within the panel and regression can be directly performed using the original data series.

To control for the province-specific effects, we considered using fixed effect regression model or random effect regression model. We performed Hausman test (Hausman 1978). The results suggest that the fixed effect model is superior to the random effect model. Therefore, we applied fixed effects to the panel data regression.

Table 1 reports descriptive statistics of the variables used in the regression described by estimation equation (1) and Table 2 reports the regression results.

Table 1: Household Consumption and Labor Income, Descriptive Statistics

Variable	*Number of Observations*	*Mean*	*Standard Deviation*	*Min*	*Max*
Consumption Share	690	0.403	0.073	0.229	0.732
Labor Share	690	0.496	0.064	0.333	0.692
Real Interest Rate	690	0.005	0.025	-0.086	0.083
Child Dependency	690	0.333	1.437	0.096	0.379
Old Age Dependency	690	0.119	0.028	0.053	0.219
Housing Price	690	0.834	1.052	0.099	6.540

Table 2: Household Consumption and Labor Income, Regression Results

	Dependent Variable: Consumption Share
Independent Variables:	
Constant	0.191**
	(0.025)
Labor Share	0.566***
	(0.040)
Real Interest Rate	0.139**
	(0.064)
Child Dependency	0.000
	(0.001)
Old Age Dependency	-0.676***
	(0.089)
Housing Price	0.013***
	(0.004)
R-square (within)	0.402

Standard errors are in parentheses.

** Statistically significant at 5 percent level.

*** Statistically significant at 1 percent level.

We find that labor income has positive and significant impact on household consumption share. An increase in labor income share by one percentage point is associated with an increase in household consumption share by 0.57 percentage points. This finding suggests that higher labor income share can help China to address its macroeconomic imbalances.

There are some other interesting findings. Real interest rate has positive and significant impact on the consumption share. This result suggests that, in the Chinese context, the income effect of higher real interest rate (higher real interest rate provides the household sector with higher disposable income that helps to raise consumption) may be stronger than the substitution effect. Old-age dependency ratio has negative and significant impact on consumption share. This result is in conflict with the life cycle hypothesis and suggests that as the Chinese population ages, consumption share may decline further in the future. Housing price to per capita GDP ratio has positive and significant impact on consumption share. This result is consistent with some of the earlier findings that housing price has positive impact on consumption through the wealth effect.

Emissions, Industrial Structure, and Labor Income

Higher labor income share not only can help China address macroeconomic imbalances, it may also help China to lower carbon dioxide emissions and achieve future economic growth on ecologically more sustainable grounds.

A country's or a province's carbon dioxide emissions equal real GDP times the ratio of emissions to real GDP. The ratio of emissions to real GDP is also know as emission intensity of GDP. Emission intensity of GDP can be further decomposed into emission intensity of energy (ratio of emissions to energy consumption) and energy intensity of GDP (ratio of energy consumption to real GDP). These mathematical relationships are known as the "Kaya Identity" in the literature on climate change (Yamaji, Matsuhashi, Nagata, and Kaya 1993).

Thus, a country's or a province's carbon dioxide emissions are positively related to both real GDP and emission intensity of GDP. If a country or a province enjoys positive economic growth, then the country's or the province's emissions will fall only if the emission intensity of GDP declines rapidly enough and more than offsets the growth of real GDP.

The emission intensity of GDP partly depends on energy technology (which helps to determine the efficiency of energy use and the share of decarbonized energy sources in the overall energy consumption). But it also depends on the industrial structure. It is well known that, as a country industrializes, the growth of the secondary industry (mining, manufacturing, utilities, and construction) tends to raise the overall emission intensity as the second industry is usually more energy-intensive and emissions-intensive than the rest of the economy.

On the other hand, as the share of the tertiary sector (the services) in the total economy rises, economic output shifts from the more energy- and emissions-intensive secondary industry towards the less energy- and emissions-intensive services, a process helping to reduce the overall emission intensity in the economy (Rosenblum, Horvath, and Hendrickson 2000; Suh 2006; Okamoto 2013).

We use panel data of 30 provincial-level units from 1995 to 2017 to evaluate the impact of industrial structure on China's emission intensity of energy, energy intensity of GDP, and emission intensity of GDP, controlling for per capita real GDP. Per capita real GDP is included as a proxy for level of technological development.

The estimation equations used to evaluate the impact of industrial structure on emissions includes the following:

$$\text{Emission Intensity of Energy}_{i,t} = \beta_0 + \beta_1 \text{Industry Share}_{i,t} + \beta_2 \text{Service Share}_{i,t} + \beta_3 \ln(y)_{i,t} + \varepsilon_{i,t} \quad (2)$$

$$\text{Energy Intensity of GDP}_{i,t} = \beta_0 + \beta_1 \text{ Industry Share}_{i,t} + \beta_2 \text{ Service Share}_{i,t} + \beta_3 \ln(y)_{i,t} + \varepsilon_{i,t} \quad (3)$$

$$\text{Emission Intensity of GDP}_{i,t} = \beta_0 + \beta_1 \text{ Industry Share}_{i,t} + \beta_2 \text{ Service Share}_{i,t} + \beta_3 \ln(y)_{i,t} + \varepsilon_{i,t} \quad (4)$$

Where "Emission Intensity of Energy" is the logarithmic value of the ratio of carbon dioxide emissions to energy consumption, "Energy Intensity of GDP" is the logarithmic value of the ratio of energy consumption to real GDP, "Emission Intensity of GDP" is the logarithmic value of the ratio of carbon dioxide emissions to real GDP, "Industry Share" is the share of second industry in GDP, "Serve Share" is the share of tertiary industry in GDP, "ln(y)" is the logarithmic value of per capita real GDP.

Data for real GDP, per capita real GDP, energy consumption, value added of second industry, and value added of tertiary industry are from NBS (2021b). NBS (2021b) also provides coal consumption, petroleum consumption, and natural gas consumption by province from 1995 to 2017. Carbon dioxide emissions by province are then calculated using the following approximate conversion factors: one ton of oil equivalent of coal consumption emits 3.96 tons of carbon dioxide, one ton of oil equivalent of petroleum consumption emits 3.07 tons of carbon dioxide, and one ton of oil equivalent of natural gas consumption emits 2.35 tons of carbon dioxide (BP 2019).

We performed the LLC test for unit root. The Emission Intensity of Energy, Energy Intensity of GDP, and Service Share series generate results that cannot reject the null hypothesis at the level of *I* (0). However, all three series become stationary in the LLC test at the level of *I* (1). We performed the Pedroni panel-data cointegration test and concluded that it is legitimate to assume that the relationship of long-run equilibrium exists within the panels and regression can be directly performed using the original data series. Because the Hausman test results suggest that the fixed effect model is superior to the random effect model, we applied fixed effects to the panel data regressions.

Table 3 reports descriptive statistics of the variables used in the regression described by estimation equation (2), (3), and (4) and Table 4 reports the regression results.

Table 3: Emissions and Industrial Structure, Descriptive Statistics

Variable	*Number of Observations*	*Mean*	*Standard Deviation*	*Min*	*Max*
Emission Intensity of Energy	690	8.999	0.074	8.606	9.096
Energy Intensity of GDP	690	-7.708	0.638	-8.992	-5.754
Emission Intensity of GDP	690	1.291	0.679	-0.373	3.338
Industry Share	690	0.431	0.079	0.169	0.619
Service Share	690	0.426	0.086	0.233	0.827
ln(y)	690	9.441	0.791	7.510	11.383

Table 4: Emissions and Industrial Structure, Regression Results

	Dependent Variable: Emission Intensity of Energy	*Dependent Variable: Energy Intensity of GDP*	*Dependent Variable: Emission Intensity of GDP*
Independent Variables:			
Constant	9.621***	-5.391***	4.231***
	(0.019)	(0.117)	(0.123)
Industry Share	0.444***	0.658**	1.103***
	(0.045)	(0.274)	(0.289)
Service Share	0.052	-1.679***	-1.627***
	(0.056)	(0.342)	(0.361)
ln(y)	-0.089***	-0.200***	-0.288***
	(0.004)	(0.023)	(0.024)
R-square (within)	0.809	0.603	0.688

Standard errors are in parentheses.

** Statistically significant at 5 percent level.

*** Statistically significant at 1 percent level.

We find that industrial structure has significant impact on China's carbon dioxide emissions. While Industry Share has significant and positive impact on emission intensity of energy, energy intensity of GDP, and emission intensity of GDP, Service Share has significant and negative impact on energy intensity of GDP and emission intensity of GDP. An increase in Industry Share by one percentage point tends to raise the emission intensity of energy by 0.44 percent, raise the energy intensity of GDP by 0.57 percent, and raise the emission intensity of GDP by 1.1 percent. On the other hand, an increase in Service Share by one percentage point tends to reduce energy intensity of GDP by 1.68 percent and reduce emission intensity of GDP by 1.63 percent.

We also find that per capita real GDP has significant and negative impact on emission intensity of energy, energy intensity of GDP, and emission intensity of GDP. This is consistent with the expectation that, as technology advances, rising energy efficiency and substitution of decarbonized energy sources (such nuclear and renewable energies) for fossil fuels will tend to reduce emissions.

A country's industrial structure is influenced by the structure of macroeconomic expenditures. According to China's input-output table in 2015, about 51 percent of household consumption expenditures were spent on the output of service sectors and 42 percent was spent on the output of industry (including mining, manufacturing, and utilities) and construction. By comparison, 88 percent of gross fixed capital formation was spent on the output of industry and construction and 11 percent of gross fixed capital formation was spent on the output of service sectors (NBS 2018: Table 3-23). Thus, higher consumption share can help to lower the carbon dioxide emissions by directing productive resources away from energy- and emission-intensive industry and construction and towards service sectors.

We use the following estimate equations to evaluate the impact of household consumption share on industrial structure:

$$\text{Industry Share}_{i,t} = \beta_0 + \beta_1 \text{Consumption Share}_{i,t} + \beta_2 \ln(y)_{i,t} + \varepsilon_{i,t} \quad (5)$$

$$\text{Service Share}_{i,t} = \beta_0 + \beta_1 \text{Consumption Share}_{i,t} + \beta_2 \ln(y)_{i,t} + \varepsilon_{i,t} \quad (6)$$

We performed both the LLC test and the Pedroni panel-data cointegration test. The result of the Pedroni test suggests that it is legitimate to assume the existence of long-run equilibrium relationship and regression can be directly performed using the original data series.

We conducted panel data regression with fixed effects. Table 5 reports the regression results.

Table 5: Household Consumption and Industrial Structure, Regression Results

	Dependent Variable: Industry Share	*Dependent Variable: Service Share*
Independent Variables:		
Constant	0.868***	-0.387***
	(0.030)	(0.028)
Consumption Share	-0.652***	0.369***
	(0.029)	(0.027)
ln(y)	-0.018***	0.070***
	(0.002)	(0.002)
R-square (within)	0.453	0.615

Standard errors are in parentheses.
*** Statistically significant at 1 percent level.

We find that household consumption share has negative and significant impact on Industry Share but positive and significant impact on Service Share. An increase in household consumption share by one percentage point is associated with an increase in Service Share by 0.37 percentage points and a decrease of Industry Share by 0.65 percentage points.

Because higher household consumption can help to lower carbon dioxide emissions through its impact on industrial structure, one would expect that higher household consumption share is likely to be associated with lower emission intensity. Moreover, to the extent that higher labor income share helps to raise household consumption share, higher labor income share may also help to lower emission intensity. Estimate equation (7) and (8) evaluates the relationship between emission intensity of GDP, household consumption share, and labor income share:

$$\text{Emission Intensity of GDP}_{i,t} = \beta_0 + \beta_1 \text{Consumption Share}_{i,t} + \beta_2 \ln(y)_{i,t} + \varepsilon_{i,t} \quad (7)$$

$$\text{Emission Intensity of GDP}_{i,t} = \beta_0 + \beta_1 \text{Labor Share}_{i,t} + \beta_2 \ln(y)_{i,t} + \varepsilon_{i,t} \quad (8)$$

We performed both the LLC test and the Pedroni panel-data cointegration test. The result of the Pedroni test suggests that it is legitimate to assume the existence of long-run equilibrium relationship and regression can be directly performed using the original data series.

We conducted panel data regression with fixed effects. Table 6 reports the regression results.

Table 6: Emissions, Consumption and Labor Income, Regression Results

	Dependent Variable: Emission Intensity of GDP	*Dependent Variable: Emission Intensity of GDP*
Independent Variables:		
Constant	5.673***	5.442***
	(0.177)	(0.172)
Consumption Share	-1.140***	
	(0.170)	
Labor Share		-1.016***
		(0.191)
ln(y)	-0.415***	-0.386***
	(0.014)	(0.012)
R-square (within)	0.610	0.600

Standard errors are in parentheses.

*** Statistically significant at 1 percent level.

The results confirm that both household consumption share and labor income share have negative and significant impact on emission intensity of GDP. An increase in household consumption share by one percentage point is associated with a decrease of emission intensity of GDP by 1.1 percent and an increase in labor income share by one percentage point is associated with a decrease of emission intensity of GDP by 1.0 percent.

We have also conducted regression of levels of carbon dioxide emissions with respect to household consumption share and labor income share, controlling for levels of real GDP. The results are similar to those reported in Table 6.

Conclusion

In the coming years, China will face some major macroeconomic, social, and ecological challenges. China's unusually low household consumption share forces China to rely upon investment to drive economic growth. The imbalance in China's macroeconomic structure has reduced efficiency of capital allocation and leads to increasingly unsustainable debt levels. China's relatively low labor income share has contributed to high inequality in income distribution that

threatens to undermine China's social stability in the future. As China becomes the world's largest carbon dioxide emitter, China is under growing international pressure to rapidly and substantially reduce carbon dioxide emissions at a pace consistent with its global climate obligations.

In this paper, we use panel data of 30 provincial-level units from 1995 to 2017 to study the empirical relationship between household consumption, labor income, and carbon dioxide emissions in the Chinese context. Figure 4 helps to illustrate the relationship between our various findings.

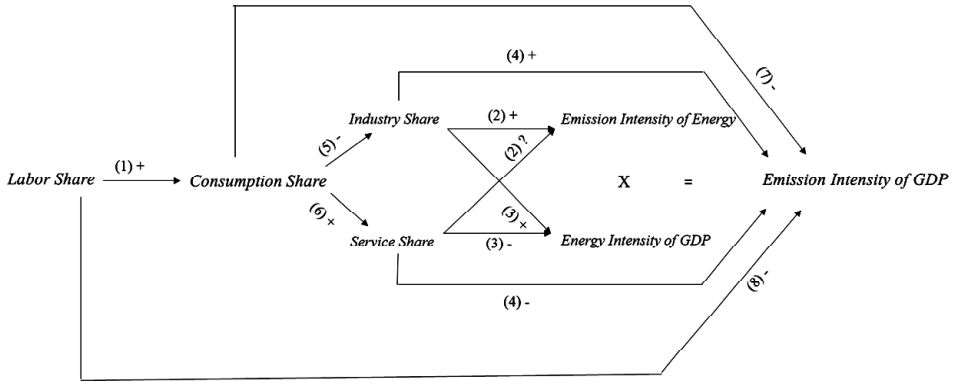

Figure 4: Relationship between Household Consumption, Labor Income, and Emissions

In Figure 4, the numbers represent the estimate equations, the arrows indicate the direction of impact from the independent variables to the dependent variables, the plus and minus signs indicate positive or negative impacts, and question mark means the impact is statistically insignificant.

Using panel data regression with fixed effects, we find that labor income share has positive and significant impact on household consumption share. Higher household consumption share is associated with a smaller secondary industry share of GDP but a larger tertiary industry share of GDP. We find that industrial structure has significant impact on emission intensity of GDP. Finally, we confirm that both household consumption share and labor income share have negative and significant impact on emission intensity of GDP.

In particular, an increase in labor income share by one percentage point is associated with an increase in household consumption share by 0.57 percentage points and a decrease of emission intensity of GDP by 1.0 percent. Thus, if

China could manage to raise the labor income share by 5 percentage points (making China's labor income share roughly comparable to South Korea's), household consumption share can rise by about 3 percentage points and carbon dioxide emissions can fall by 5 percent for a given level of real GDP.

These findings suggest that, by raising the labor income share, China may be able to simultaneously address the challenges of macroeconomic imbalances, income inequality, and emissions reduction obligated by China's global climate commitments.

It is beyond the purpose of this paper to discuss in detail policy proposals on how to raise labor income share in China. However, Qi (2014) argued that since the beginning the market-oriented reform, China's labor income share had declined and the decline was caused by the loss of workers' bargaining power resulting from privatization of state owned enterprises and a large flow of surplus labor force from the rural areas to the urban areas. Some non-governmental organizations have pointed out that the Chinese workers do not have rights of collective bargaining and the existing labor laws are not effectively enforced (Bozic 2018). Wang and Bai (2014) argued that the business sector's monopoly power had contributed to China's decline of labor income share. If China's labor income share decline had been caused by workers' lack of bargaining power, privatization, and business monopoly, economic and social policies designed to provide the worker with more space for collective action, more effective enforcement of China's existing labor laws, regulation of big business to check monopoly power, and a reconsideration of privatization aiming at a more reasonable balance between the state owned sector and the private sector should help China's labor income share to improve in the future.

We understand that the Chinese leadership has recognized that low incomes for large sections of the working population constitutes a serious economic and social problem. At the 18th Congress of the Chinese Communist Party, General Secretary Hu Jintao cited "raising the share of labor compensation in primary distribution" as one of the policy objectives (Hu 2012). At the 19th Congress of the Chinese Communist Party, General Secretary Xi Jinping did not explicitly mention labor income share. However, Xi pledged that the Party leadership would help to raise income for low-income social groups, expand the middle-income population, and ensure growth of labor compensation in proportion with labor productivity (Xi 2017). Given that China's labor income share has declined since the beginning of the market-oriented reform and continues to stay substantially below that in many countries, growth of labor

compensation "in proportion" with productivity may require restoring China's labor income share to a level consistent with the international norm. If the Chinese leadership succeeds in this effort, China's future development may become economically, socially, as well as ecologically more sustainable.

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