Will Carbon Tax Yield Employment Double Dividend for China?

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ABSTRACT

Carbon tax is an important economic means to reduce carbon emission. This paper establishes a Computable General Equilibrium (CGE) model to reflect China's resource environment where economic growth and employment play a role by analyzing impacts of carbon tax on employment. The CGE model measures short and long-term impacts of carbon tax on employment, and examines whether the employment "double dividend" would be possible. The analysis shows that the demand for employment tends to decrease as a whole, but different groups of employees would be affected in various ways. "Double dividend" will be possible if appropriate carbon tax cycle is in place.

Keywords: Carbon Tax; Employment; Double Dividend

1. Introduction

Climate change has been a popular topic requiring policy instruments around the world, and carbon tax has become one of such important instruments in many European countries for controlling the total amount of carbon emission. Our counterparts in other countries have done lots of academic researches to measure impacts of carbon tax on employment. If we introduce carbon tax while reducing income tax, we will probably achieve "double dividend" since that combining policies will not only reduce carbon emission but also increase job opportunities. As people become more concerned with environmental protection and continuing high unemployment rate in Europe, there have been intense debates on the "double dividend" hypothesis. Will carbon tax create "double dividend"? What conditions and mechanisms must be in place for such dividend? Will it be possible to improve environment without hindering economic growth?

If we analyze all impacts of carbon taxation, we will find it relatively difficult to measure its impacts on employment. Because such analysis centers on a key issue: possible double dividend of environment protection and employment stability. We have to take into account tax neutrality and means of imposing and refunding carbon tax. Some researchers applied simulation to measure how tax reforms would lead to double dividend. Carraro and other scholars simulated the impacts of carbon tax in Europe based on a Computable General Equilibrium (CGE) model in 1996 and concluded that carbon tax would yield short-term employment "double

dividend". Marx(2000)and Bosquet(2000) found that green policies would have "neutral" or "favorable" impacts on employment. Thkeda(2007) applied dynamic CGE model to prove that Japan would be able to achieve "double dividend" to certain extent through carbon tax. However, some pre-conditions are necessary to increase total demand for employment through carbon tax. Chinese scholars Wang Can, Chen Jining and Zou Ji(2005) used a recursive dynamic CGE model to demonstrate that carbon emission policies in China would increase energy efficiency but exert adverse impacts on employment and economic growth.

China has to take its own economic growth and patterns into account before predicting potential impacts of carbon tax on employment and other losses. Because most of such simulations were done by sampling developed countries rather than developing countries. Due to the significant differences in economic structures and comparative advantages between developed and developing countries, our research should be more targeted. For example, we need to analyze to which extent carbon tax will affect employment, and whether such policy will yield "double dividend" for China.

2. Impacts of Carbon Tax on Employment

Assume there is involuntary unemployment in the open economy and corporations invest in two production factors: labor (L) and energy (fossil fuel) (E); tax on earned income is t_w, and tax on energy is t_e. Capital is not considered because it is not taxed in this scenario, so the production function is $F = f(L, E)$. As figure 1 shows, the horizontal axis is for energy input, the vertical axis for labor input; if there is no tax, wage is w, and price of energy is p, the isocost line will be represented by R. At the initial stage, only earned income is taxed and energy is not, so the isocost line, which is expressed as $L_1E_1 = (1+t_w)wL + pE$, is tangential to the Equivolume U at point A. Here point A represents the initial equilibrium point where L_A is for labor input and E_A for energy input. Now we draw a dotted line $R^{`}$ parallel to line R to show locus of production factors' combination under different tax systems (mix of salary income tax and energy tax). Namely, if tax revenue is the same as that of point A, and the factors' prices are the same as those when no tax is imposed, there will be the line *R* which intersects with the Equivolume U at point B. Obviously, income tax rate $t^{`}_w$ and carbon tax rate $t_e$ push the equilibrium point move from A to B, so that output, tax-exclusive prices of production factors and output cost per unit remain the same while cost is minimized. Under this circumstance, the isocost line is $L_2E_2 = (1+t^{`}_w)wL + (1+t_e)pE$, where L_B is for labor and E_B for energy input. It's clear that at the

new equilibrium point B, more labor ($L_B > L_A$) and less energy ($E_B < E_A$) are required compared with point A.

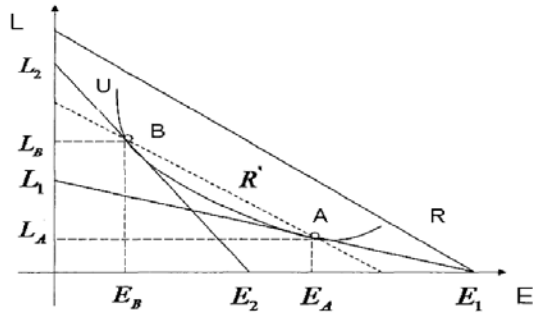

Figure 1. Model of carbon tax

In conclusion, adjusting income tax rate t_w and carbon tax rate t_e would result in a new equilibrium where output, the tax-exclusive prices of the production factors, output cost per unit and government revenue remain the same as those at the initial equilibrium point, but more labor and less energy would be required. In other word, it's very likely to save energy and increase jobs by reducing salary income tax while imposing carbon tax or increasing carbon tax rate properly.

In terms of the pre-conditions of the "second dividend", some scholars proposed two effects of carbon tax in offsetting distorts created by other taxes: creation of subsidy and interactions among taxes. There may be subsidy if we impose carbon tax while reducing earned income tax, because such policy will stimulate labor supply and increase employment; but carbon tax on fossil fuel may also result in price increase of such products, reducing the effective salary income of representative families and discouraging labor supply. If the subsidy surpasses the interactions among taxes, there will be more jobs and better environment, so "double dividend" emerges; otherwise, there will be less jobs and no "double dividend". One of the conditions for acquiring such dividend is to reform tax system by, in particular, shifting tax burden from labor to the polluters. Impacts on employment depend on the size of tax burden on workers and the extent to which labor cost is reduced. Carbon tax will affect capital and natural resources, requiring more qualified labor force.

Table 1 Factors affecting impacts of environment policies on employment

1	Level and consistency of environmental expenditures
2	Economic environment
3	Unemployment rate and types
4	Human resource
5	Environmental policy orientations
6	Nature of the policies
7	Types of expenditures
8	Types of investment and technology
9	Financing channels and their impacts on debit & credit and tax
10	Degree of import leakage
11	Scope affected by the environmental policies
12	Competitiveness of the industry

Data source: Copenhagen. Sprenger R.1997. Policy Background Paper on Environment and Employment. IFO Institute for Economic Research: Munich.

3. Modeling and Analyzing Impacts of Carbon Tax on Employment

It's not easy to analyze the impacts of carbon tax on employment. Some scholars tried modeling of "double dividend" from environment and employment to measure how carbon tax revenue could reduce the original distortions caused by other taxes in the economy. From China's perspective, we need models that are able to reflect specific conditions of China so as to understand which distortive tax rate(s) should be reduced and how should we tax. Many researches on employment were focused on aggregation level without stratifying various labor groups. Household registration system which is unique to China and other complicated issues, like gap between rural and urban areas, have lead to distinct groups of labor force in China. A CGE model for macro economy rarely takes into account differences among various labor groups when measuring impacts of policy changes on employment, and environment-related issues have been studied less by CGE model. Due to all the reasons above, the author introduces an expanded CGE model for resource and environment to reflect China's economy and employment structure as well as impacts that different labor groups would be subject to. That's why this model is suitable to simulate and analyze impacts of carbon tax on employment in China.

In this paper, the model is scaled up through dynamic recursion to cover several periods and general features of multiple economic agents, sectors and goods, so that it could center on resource environment and employment in China. Data used in this model is collected from the Social Accounting Matrix of China in 2007; other basic data is from Input-Output Tables of 42 Sectors of China in 2007 and relevant statistic yearbooks in order to reflect recent structure of the economy. Meanwhile, for employment research purpose, the factor of labor is stratified into four groups in this CGE model according to the general features of China's labor market: agricultural labor, rural migrant workers in cities, urban workers and technicians; each of them is then related to urban and rural

residents separately. Endowment differences also count in the model. Dynamic mechanism is one of the keys when designing such model so as to reflect both short and long-term effects of policies. This model could reflect changes in resource endowment of each labor group, population structure formulated during urbanization and also changes in income.

Carbon tax reflects "polluter pays" principle and regulates pollutants, so the aim of such tax is to reduce carbon emission. Assuming that in order to minimize negative impacts of carbon tax, all the revenue collected from this tax would be used to compensate residents and companies for their losses, so that this reform would be neutral. Carbon tax aimed at saving energy and reducing emission other than raising revenue, and its impacts on economic and social development should be minimized. Carbon tax would be able to support revenue cycle by subsidizing or reimbursing other distortive taxes. Based on above the mentioned assumptions, two scenarios are analyzed in this paper: one is that all of the carbon tax revenue is used to subsidize the residents, the other is all such revenue is used to reduce corporate income tax rate. If we want to reduce carbon emission by 10%, we need to apply relevant simulation mechanisms to achieve endogenous optimization of carbon tax rate. In scenario one where the carbon tax revenue is used to subsidize residents by increasing their disposable income through transfer payment, the portion of transfer payment available would be decided based on the ratio of the base period. A baseline scenario starts from China's economic conditions and covers future trends of major macro indicators like population, urbanization, endowment of labor force and technological development, etc. The baseline scenario is a basis with which we compare simulated results. If we set government revenue fixed as the resulting value of the baseline scenario (namely, the government revenue remains unchanged and corporate income tax rate is endogenous), it will be possible to reduce the corporate income tax rate when government raises additional revenue from carbon tax. Scenarios are illustrated in table 2:

Table 2 Scenario where carbon tax is imposed and carbon dioxide emission needs to be reduced by 10%

Scenario	Hypothesis
CTAX1	To impose a specific tax and all revenue raised will be used to subsidize residents
CTAX2	To impose a specific tax while reducing corporate income tax rate

According to the table 2, we find that when the baseline scenario is to reduce carbon dioxide emission by 10%, the model simulates changes in impacts of different tax cycles on employment, namely, short-term impacts reflected by a static model and long-term impacts reflected by a dynamic model. Carbon tax tends to have negative impacts on employment as a whole despite of the tax cycles, because demand for employment would decrease and different groups of employees will be subject to different impacts. Agriculture would still play a role as "reservoir", so employees in this sector remain almost intact; technicians would not be subject to substantial changes; the workers engaging in production, particularly the migrant workers would suffer from huge losses.

Table 3 Short-term changes in impacts imposed by tax policies under different carbon tax designs

Impacts on employment	CTAX1	CTAX2
Changes compared to real data of 2007(%)		
Employment in total	-0.73	-0.49
including: agricultural workers	0.24	-0.12
migrant workers	-1.78	-0.95
urban workers	-0.72	-0.23
technicians	-0.21	0.05

Note: Calculated based on CGE model. The short-term changes are measured by comparing results of the baseline scenario with those reflected by the model when there is no dynamic mechanism applied.

Table 4 Long-term changes in impacts imposed by tax policies under different carbon tax designs

Impacts on employment	CTAX1	CTAX2
Changes compared with real data of 2020 (%)		
Employment in total	-0.71	-0.38
including: agricultural workers	0.23	-0.11
migrant workers	-2.01	-1.02
urban workers	-0.86	-0.34
technicians	-0.23	0.04

Note: Calculated based on CGE model. The long-term changes are measured by comparing results of the baseline scenario with those reflected by the model after multiple periods.

It shows that two ways of tax cycle have different impacts on employment; by comparing the results of different cycles of one tax, we know that if we introduce carbon tax while reducing corporate income tax, there will be less substantial impacts on employment. The results of simulation also indicate how important it is to choose an appropriate tax cycle. If we choose the cycle where carbon tax is supported by reducing corporate income tax, there will be "double dividend". Besides, short-term and long-term trends of impacts imposed by carbon tax seem to be similar, that means such impacts would be relatively stable. Introduction of carbon tax will lead to increase in both resource prices and cost of emission, related economic entities who expect stable future development will adjust their activities accordingly to minimize their cost. Such responses will be a good indicator reflecting scarcity of resources and environment. Eventually, high emission and high energy consumption could be controlled and reduced to a proper level.

4. Insights

Low-carbon economy should not be at the expense of employment. Low-carbon technology and economy requires huge funds and many professional technicians. If the labor force is not that qualified and professional, industrial restructuring would inevitably result in structural unemployment. However, this problem can be

avoided when we learn to understand low-carbon economy, train the labor force and gradually establish polices supporting such economy.

Compared with the adverse impacts of strict environmental policies on economic growth and employment, carbon tax would be more pragmatic for China to deal with the climate issue. It will be necessary to introduce carbon tax in China for environment purpose if we want shift from the traditional economic model to a low-carbon one. Under new international and domestic circumstances today, China needs to continue its policies encouraging efficient energy consumption and minimizing additional energy consumption per unit to improve quality of economic growth. While maintaining economic growth and stable employment, China should introduce carbon tax when appropriate and take full advantage of such tax in regulating prices of resources and environment. These measures will not only reflect scarcity and value of resources and environment, but also guide corporations to reconsider their inputs and emissions, which will in turn be necessary to optimize the industrial structure.

China needs to consider environmental protection, economic growth and employment before introducing carbon tax, since such tax would have impacts on various aspects particularly on politically sensitive issues like employment. That's why we must be cautious in designing and implementing carbon tax; for example, we need to set a low carbon tax rate at the beginning and gradually increase it based on actual conditions. For neutrality purpose, it's also important to reform other taxes to coordinate with the new carbon tax so as to avoid conflicts or overlapping among related taxes.

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