Analysis

How responsible is a region for its carbon emissions? An empirical general equilibrium analysis

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ABSTRACT

CO_2 reduction targets tend to be set in terms of the amount of pollution emitted within a given region. However, there is increasing public and policy interest in the notion of a carbon footprint, or CO_2 generated globally to serve final consumption demand within a region. This raises an issue in that, despite the local economic benefits, the latter involves effectively absolving the region of responsibility for CO_2 generated in the production of exports. Using a CGE model of Wales, we illustrate by simulating an increase in export demand for the output of an industry (metal production) that is both carbon and export intensive and generally produces to meet intermediate rather than final demands. The key result is economic growth accompanied by a widening gap between regional CO_2 generation and the carbon footprint, raising questions as to the identification of precisely 'whose' carbon footprint these additional emissions should be allocated to.

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1. Introduction

The 2009 Copenhagen Climate Change conference focused attention on the methods and underlying principles that inform climate change targets. Climate change targets following the Kyoto Protocol are broadly based on a production accounting principle (PAP), or emissions produced within given geographical boundaries of the economy in question. An alternative approach is a consumption accounting principle (CAP), where the focus is on emissions produced globally to meet consumption demand within the national (or regional) economy (Munksgaard and Pedersen, 2001). Increasingly popular environmental footprint measures, including ecological and carbon footprints, attempt to measure environmental impacts based on CAP methods. The perception that human consumption decisions lie at the heart of the climate change problem is the impetus driving pressure on policymakers for a more widespread use of CAP measures.

Globally the emissions accounted for under the production and consumption accounting principles would be equal. However, at regional or national level emissions embodied in trade lead to differences under the two principles. Specifically, under a PAP measure, the generation of emissions in producing goods and services to meet export demand is charged to the producing region or nation's emissions account. Under a CAP measure, these emissions would be charged to the region or nation where the final consumption demand charged with ultimately driving this activity may be located. That is, under CAP, emissions embodied (directly or indirectly) in a region or nation's imports replace emissions embodied in export production, alongside domestic emissions to support domestic final consumption (which is common to both measures).

However, as public and policy enthusiasm for CAP measures grows (see Wiedmann, 2009, for a review), this paper raises the question as to whether it is appropriate entirely to attribute responsibility for emissions resulting from production decisions throughout (often quite complex) supply chains to final consumers, particularly where these consumers may be located in other regions, nations and jurisdictions.

To illustrate our argument we first produce base year results for regional carbon emissions calculated on PAP and CAP principles to

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reveal the differences in, and perspectives offered by, the two approaches. We then take the example of a decision to increase production in a regional industry where production is both carbon intensive and export intensive and examine the differential impacts on the alternative measures. We also examine the economic impacts of this increased activity on the regional economy. The economic benefit derived by local consumers raises questions as to whether it is appropriate to absolve them of all responsibility for emissions embodied in export production. We believe that this provides a first step in the process of understanding the concept of shared responsibility for pollution generation based on key economic indicators such as GDP/value-added (see Lenzen et al., 2007). Moreover, the case study focuses on an industry where the output produced tends to be used as an intermediate input to other production sectors (be they domestic or external) rather than directly serving final demands. This complicates matters in terms of identifying the location of the final consumers to whom emissions embodied in export production should be allocated.

The analysis involves two empirical techniques. The first is input–output accounting. Application of regional and interregional input–output accounting techniques to attribute pollution generation to different production and consumption activities has become commonplace particularly in the ecological economics literature (see Munksgaard and Pedersen, 2001, and Turner et al., 2007, for methods; and Wiedmann, 2009, for a review). A CGE framework (which integrates the input–output accounts as its core database) is then employed to model the economy-wide impacts of a change in activity, and the results are used to derive 'post-shock' input–output accounts that may be employed to examine impacts on pollution generation under both PAP and CAP measures. The key advantage offered by the CGE analysis is a more flexible and theory-consistent approach to modelling changes in both production and consumption activity levels than is possible using a conventional demand-driven input–output model, particularly in tracing factor market adjustments and resulting price and income induced effects in different time periods.

The empirical example in this paper focuses on a current policy issue in the case of Wales, a region of the UK with devolved responsibility for sustainable development. We provide a brief overview of the policy context of the Welsh case study in the next section. However, while some of the issues raised may be of specific interest to Wales, we contend that similar types of problems are faced by both regional and national policymakers around the world. In the third section we use the input–output accounting framework to consider base year carbon measures for Wales under CAP and PAP. This is followed in the fourth section with an overview of the CGE model and discussion of the results of simulating an increase in export demand to Welsh metal manufacturing in the fifth. Discussion and conclusions follow in the final section.

2. Policy Context — Carbon Generation and Attribution in the Welsh Economy

In this section of the paper we provide some context for carbon accounting in the Welsh economy, together with some background on the regional Metal Manufacturing sector which provides our case study.

Compared to other parts of the UK, industrial production in Wales is intensive in carbon dioxide emissions. For example in 2008 CO_2 (equivalent[1]) emissions per capita for Wales were 14 tonnes per capita, compared to an England and Scotland averages of just over 8 tonnes per capita (Welsh Assembly Government, 2010). This reflects an economy with a relatively high level of manufacturing compared to most other parts of the UK, and speaks to specific types of pollution intensive manufacturing activity (see below).

The reporting of carbon dioxide emissions for Wales are on production accounting principles (PAP) reflecting direct emissions from specific 'pollution points'. However, we suggest that this type of reporting on a production accounting perspective might provide misleading intelligence for the policy community. For example, achieving emissions targets following Kyoto and Copenhagen could result from a 'do-nothing' scenario in Wales as in the period to 2020 older polluting industries with ageing capital move offshore, and with Welsh annual PAP emissions sensitive to output in just a few plants (metal manufacturing among them – indeed in 2007, the top four pollution points in Wales contributed almost 50% of reported carbon dioxide emissions – NAfW, 2009). A concern is that structural change could lead to the achievement of regional pollution 'targets' but because the region merely imports goods connected with high levels of pollution.

For these reasons there is value in policymakers considering a consumption as well as a production perspective for emissions accounting. Indeed the espoused sustainable development objectives of the Welsh Assembly Government speak to more global responsibilities grounded in how regional consumption (as well as production) creates externalities from Welsh economy activity. For example, the ecological footprint has been embraced in Wales as one headline regional indicator of sustainable development (Munday and Roberts, 2006).

Expected differences in Welsh resource or pollution footprints relative to the production accounting perspective are grounded in the importance of trade to a small open economy. For example, energy generation, metal manufacturing, oil refining and chemicals are among the largest producers of CO_2 emissions in Wales and are large exporters. In 2010, of total Welsh exports of close to £9 bn, around 63% originated in these four sectors.

In summary the carbon intensity of Wales' most important industries, coupled with their pivotal role in supporting regional exports, leads to an a priori expectation of a consumption accounting of carbon giving very different results from that derived from a production accounting perspective. Put simply we believe that appropriate policy choices in regions need to be informed by both production and consumption accounting perspectives. However, the use of a consumption accounting approach provides different insights into regional responsibility for CO_2 emissions. Notwithstanding, there are still problems with its uncritical use. Moving from a production to consumption accounting approach for emissions serves to lessen the penalty Wales faces from having high location quotients in industries with high CO_2 intensities and levels. However, it is difficult to escape the fact that these same pollution intensive sectors support high levels of employment and incomes in the regional economy.

The metal manufacturing sector in Wales therefore provides a valuable lens through which to explore the ramifications of different emissions accounting processes and to show how the region benefits from expansion in a relatively pollution intensive sector.

The metal manufacturing sector is never far away from headlines in Wales. Following extensive restructuring during the 1980s and 1990s, the turn of the new Millennium still saw metals production in Wales employing an estimated 12,350 people. Steel making in particular (either as coil, slab, special or coated products) is a critical input for a number of Welsh (and UK/overseas) industries, and at the heart of regional production are the operations of Corus (since 2007 owned by the Tata corporation of India).[2] Much of the steel industry output goes as an input to other manufacturing facilities (including in the Welsh case to other parts of the Corus (Tata) group but also directly to industries such as automotive, construction and packaging in other parts of the UK and overseas).

Steel manufacturing operations are centred on the Port Talbot mill with a capacity of around 5 Mtonnes of steel output, but with a series of ancillary operations in Wales to process and finish steel. While

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