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Analysis

Does offshoring contribute to reducing domestic air emissions? Evidence from Belgian manufacturing

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ABSTRACT

Since the mid-90s, production-related air emissions in Belgian manufacturing have fallen substantially and it can be shown that the pace of the fall has been fastest for domestic intermediates. It is widely debated whether offshoring has played a role in this fall by replacing domestic intermediates by imported intermediates. This paper develops a decomposition analysis to measure the contribution of offshoring – the share of imported intermediates in total intermediates – to the fall in air emissions for domestic intermediates. Based on the results from this decomposition analysis, it was possible to calculate that 17% of the fall in greenhouse gas emissions, 6% of the fall in acidifying emissions and 7% of the fall in tropospheric precursor emissions in Belgian manufacturing between 1995 and 2007 can be attributed to offshoring.

1. Introduction

Production-related air emissions by the manufacturing sector in Belgium have fallen substantially since the mid-90s. Figures from the Belgian Air Emission Accounts (AEA, Janssen and Vandille, 2011) show that the fall amounts to 14% for greenhouse gas (GHG) emissions, 35% for acidifying (ACID) emissions and 33% for tropospheric precursor (TOFP) emissions between 1995 and 2007.[1] Air pollution from manufacturing is emitted not only for producing final goods and exports but also for producing intermediate goods, i.e. goods that are used in the production process of downstream industries. The level of air emissions for the production of goods for domestic intermediate use – in short: emissions for domestic intermediates – can be estimated by combining the AEA with supply-and-use tables (SUT) and making the assumption that air pollution emitted in the production of a good does not depend on its use, i.e. is the same whether it is delivered for domestic intermediate use, domestic final use or exports. For Belgium, it turns out that between 1995 and 2007, air emissions by the manufacturing sector for the production of goods for domestic intermediate use have fallen at a faster pace than overall manufacturing air emissions: 28% for GHG, 45% for ACID and 42% for TOFP.[2] As a corollary, this implies that air emissions for the production of domestically consumed final goods and exports have fallen at a below average rate.

The strong decrease in emissions for domestic intermediates in manufacturing deserves some further investigation. This may be to some extent user-driven. As pointed out in Wiedmann et al. (2010, p.20), there is “increasing emphasis on the idea that companies take some responsibility for production-related impacts of the goods they sell or use”. Hence, for a company, it matters to reduce emissions not only for the goods it produces and sells, but also for the goods it uses in its production process.[3] The focus in this paper is on the latter, i.e. goods that are being used as intermediates. Among the user-related factors that contribute to reducing emissions for domestic intermediates, three are particularly worth mentioning. The first is technology, which may be at the origin of the reduction as cleaner production processes become implemented. This may be driven by demand for cleaner intermediates by downstream industries pushing producers into adopting cleaner technologies. Second, a compositional effect may play a role. In order to reduce the production-related emissions of the goods they use, companies may switch to less emission-intensive intermediates, i.e. modify the intermediate input composition of their production. Third, trade may also be a means for lowering emissions for domestic intermediates. Instead of switching from dirty to clean intermediates, companies may leave their intermediate input composition unchanged, but switch from domestic to foreign suppliers. Replacing intermediates

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[1] In 2007, air emissions from manufacturing represented respectively 35%, 30% and 36% of total emissions of GHG, ACID and TOFP in Belgium (industries and households). For GHG, the fall in manufacturing emissions in Belgium is in line with the European Union (EU) average. According to data published by the Statistical Office of the EU (Eurostat), manufacturing GHG emissions has decreased in the EU by 12% during the period 1995–2007.

[2] Emissions for domestic intermediates account for respectively 19%, 17% and 20% of total emissions of GHG, ACID and TOFP in Belgian manufacturing.

[3] This is closely linked to the concept of sustainable supply chain management (Cadarso et al., 2012).

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sourced from domestic suppliers by imported intermediates directly implies a reduction in air emissions for domestic intermediates. It must be emphasized that this does not contribute to reducing global emissions as importing of intermediates only implies a displacement of emissions to other countries (Cadarso et al., 2012; Peters and Hertwich, 2008).[4]

The aim of this paper is to take a closer look at air emissions for domestic intermediates by the manufacturing sector and to measure whether and to what extent the above-mentioned factors contribute to reducing these emissions. The focus is on the role played by imports of intermediates. For this purpose, a decomposition of the change in emissions for domestic intermediates is developed. It is applied using data from the AEA for the three air emission indicators GHG, ACID and TOFP and a time-series of SUT for Belgium over the period 1995–2007.

By paying specific attention to the influence of imports of intermediates on domestic air emissions, this paper addresses an issue that appears as particularly relevant given the changing nature of international trade. As a consequence of the rise of global value chains and the growing international fragmentation of production processes in recent decades, trade in intermediates has become increasingly important.[5] The share of imported intermediates in total intermediates is on the rise in manufacturing. This is generally referred to as offshoring in the literature.[6] There are several potential motivations for offshoring, among which labour cost savings, the quality and variety of foreign sourced intermediates or economies of scale in the production of intermediates. The perspective of avoiding polluting air emissions and pollution abatement costs may also play a role in offshoring decisions (pollution haven hypothesis). In this paper total offshoring is considered rather than only offshoring that serves to reduce air emissions. The purpose of the decomposition analysis is to measure to what extent replacing domestic intermediates by imported intermediates – i.e., offshoring whatever its underlying cause – contributes to reducing emissions in manufacturing.

The specific focus on offshoring in the decomposition developed in this paper is novel compared to previous work on the impact of trade on air emissions. On the one hand, there is a vast literature on carbon leakage and the balance of emissions embodied in trade (Peters and Hertwich, 2008; Wiedmann et al., 2007). Compared to this literature, the decomposition analysis here highlights how much of the fall in domestic emissions *over time* can be attributed to replacing domestic intermediates by foreign intermediates. On the other hand, several previous studies have applied structural or index decomposition analysis to determine whether total trade lowers domestic emissions over time (Kander and Lindmark, 2006; Levinson, 2009). Compared to these studies, the decomposition developed here puts the emphasis on how offshoring, i.e. imports of intermediates, rather than total trade contributes to the fall in domestic emissions. Finally, as it comprises three composite indicators (GHG, ACID and TOFP), the data on emissions used here is richer than what is usual in the literature.

This paper is organised as follows. The next section reviews the literature on the effect of trade on emissions and Section 3 provides more detail on the data. Section 4 presents trends in air emissions, while Section 5 develops the decomposition. Results are reported in Section 6 and conclusions are drawn in Section 7.

2. Review of the Relevant Literature on the Impact of Trade on Air Emissions

Trade flows separate consumption and production in geographical terms and displace production-related emissions from one country to another. Hence, they raise production-related emissions in exporting countries and lower them in importing countries without changing global emissions. This is an issue in particular for pollutants such as CO_2, which is a harmful gas with global effects. For CO_2 emissions, this displacement is generally referred to as carbon leakage. According to the 'strong' definition of carbon leakage, only displaced emissions originating from shifts in production prompted by differences in climate change mitigation policies may be taken into account (Peters and Hertwich, 2008). These shifts in production and the resulting trade flows from countries with strict climate change mitigation policies to countries with lax climate change mitigation policies correspond to the pollution haven hypothesis (Dietzenbacher and Mukhopadhyay, 2007). However, it is common in the literature to determine carbon leakage for a country based on its balance of emissions embodied in trade (BEET). This approach actually corresponds to the 'weak' definition of carbon leakage (Peters and Hertwich, 2008) as it considers emissions embodied in all trade flows regardless of the underlying motivation for trade, i.e., compared to the strong definition, it is not restricted to trade flows under the pollution haven hypothesis.

For any country, the BEET is equal to the difference between its production-related and consumption-related emissions. Hence, in particular for a global pollutant like CO_2, it allows to compare emission responsibility according to the production principle and the consumption principle. Emissions embodied in trade are generally calculated based on input–output data and models to take into account both direct emissions and indirect emissions through intermediate inputs.[7] Regarding results from empirical applications, Peters and Hertwich (2008) calculate BEET for 87 countries in 2001 finding that "globally there are over 5.3 Gt of CO_2 embodied in trade" (p.1401). According to Ahmad and Wyckoff (2003), the CO_2 trade balance is negative for OECD countries, which implies that the emissions embodied in their imports exceed the emissions embodied in their exports. However, the change over time in BEET does not necessarily reflect expectations. It may be on the rise for both *developed economies* (Nakano et al., 2009) and *developing economies*, e.g., India (Dietzenbacher and Mukhopadhyay, 2007). In their exercise for Spain, Serrano and Dietzenbacher (2010) consider a wider set of air emissions (nine different gases) and find that – apart from one exception – the country has a negative BEET for all types of emissions. Finally, Steen-Olsen et al. (2012) have extended this type of analysis to land and freshwater use, showing that for EU countries land and freshwater use embodied in consumption was largely above the world average, i.e. the EU exports these two types of environmental pressure.

While the studies reviewed above look at how trade influences the cross-country distribution of production-related emissions, other studies have in parallel attempted to measure to what extent trade contributes to the change in emissions over time. They are part of the wider literature that applies decomposition analysis to assess the effect of various factors on emissions and other economically-induced physical flows. In this context, two types of decomposition have been primarily used: structural decomposition analysis (SDA), which relies on input–output data and models (Hoekstra and van der Bergh, 2002), and index decomposition analysis (IDA), which uses aggregate industry-level data (Ang and Zhang, 2000).[8]

Traditionally, IDA splits the total change in emissions or in the emission intensity into three effects: the *scale* effect, which measures the contribution of output growth, the *composition* effect, which measures the contribution of changes in the industry structure of output, and the *technique* effect, which measures the contribution of changes in industry-level emission intensities. In this framework, the standard approach is to consider that trade affects emissions through the *scale* effect

[4] This reasoning does not take into account the differences in technology and emissions for the transport of traded goods.

[5] Early discussions of this trend underpinned with data can be found in Yeats (2001) and Hummels et al. (2001). More recently, Johnson and Noguera (2012) provide a long term perspective of the international fragmentation of production processes and the composition of international trade since the 1970s.

[6] This is documented for OECD countries over 1995–2005 in De Backer and Yamano (2012) and for Belgium over 1995–2007 in Hertveldt and Michel (2012).

[7] For an overview of the models used in the literature (single-region and multi-region), see Wiedmann et al. (2007) and Peters (2008).

[8] For a comparison of these decomposition methods, see Hoekstra and van der Bergh (2003).