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A Quantification of the Diversification of European Coal Supplies

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Revision:

A Quantification of the Diversification of the European Coal Supplies

Chair of Energy Economics and Public Sector Management, Dresden University of Technology (TUD)

In preparation of Deliverables 5.3.2 (analysis of vertical integration in the coal sector) and 5.3.4 (model of the international coal trade), we carried out the subsequent quantification of supply portfolio diversification. While this deliverable (5.3.3) was originally scheduled to be carried out later in the project, it turned out that this analysis was a necessary pre-requisite to the further research for Deliverables 5.3.2 and 5.3.4. Hence, we would like to share it with the SECURE project community and the European Commission already at this stage of the project.

Introduction

Security of supplies depends on a number of factors. While in the long run, the security of each supplier and adequate investments in infrastructures along the value added chain of production are important, it is critical in the short run to be able to substitute failing supplies due to a supply disruption. Failing supplies can be substituted from other external sources or domestic resources. However, existing (flexible) supply relations with alternative external sources or domestic production capacities are necessary prerequisites to successfully compensate for failing supplies. In the following, we present a set of indicators that take into account these three dimensions: existing supply relations with alternative external suppliers, political security of the suppliers, and domestic production. We apply these indicators to the steam coal markets of Europe and other major coal consuming countries. We do not consider coking coal because this is a very specific market with specific demand sectors (metallurgical industry) and concentrated supplies. Steam coal (a hard coal type, as opposed to lignite) is used as an input fuel to electricity generation which corresponds to the energy focus of the SECURE project.

Measures of Supply Diversification

We use diversity indices derived from the Shannon-Wiener index in the following analysis. Stirling (1999) has shown that the Shannon-Wiener diversity index is the most

attractive indicator, reflecting both variety and balance in an even way. The basic country-based indicator for the portfolio of import sources is given by:

$$SW = - \Sigma_i (x_i * \ln x_i) \quad \forall i$$

Where x_i is the share of imports from a particular country i into the country considered. Because the natural logarithm of a fraction is always negative, the minus sign at the beginning of the equation ensures that the index is always positive. For example, if we assume 16 potential (foreign) regions of origin with equal shares in the supply portfolio, the corresponding maximum value would be approximately 2.77 [-ln (1/n); N=16]. The minimum value (for being completely dependent on a single importer) is zero. The index increases as the number of different supply sources increases. Thus, a lower value of the SWI suggests a worse situation than a higher value.

In addition to a "simple" accounting of supply source, political stability of the exporting countries can be an important determinant of supply security. We therefore suggest to augment the traditional Shannon-Wiener index with an indicator of political stability in exporting countries to the so-called Shannon-Wiener-Neumann1 index, or SWN1 (Neumann, 2004). A parameter b_i, derived from an index of political stability of the producing country, is included in the definition of the diversity index.

$$SWN1 = - \Sigma_i (b_i * x_i * \ln x_i) \quad \forall i$$

The parameter b_i ranges from 0 to 1 where a high index indicates high political stability. Thus the SWN1 index is lower than the corresponding SW index if the supply portfolio includes imports from unstable regions.

This index is further extended to include domestic production as well, to the so-called Shannon-Wiener-Neumann2 (SWN2) index (Neumann, 2004). In fact, a shortcoming of the SWN1 index is that it does not take account of domestic production within a country. Imagine a country that only imports 5% of its coal consumption from one single country: it would have a SWN1 of 0, although its supply security is very high. Therefore, a parameter g_i as the share of domestic production in the total consumption of coal is included. Countries with a high level of own production face less risk from supply disruptions, which is reflected by the SWN2.

$$SWN2 = - \Sigma_i (b_i * x_i * \ln x_i)*(1+ g_i) \quad \forall i$$

European Diversification of Coal Supplies Today

Figures 1 and 2 show the different indices presented above for major European and non-European importers and the OECD Europe for the most recent years with available data, 2006 and 2007. The data is from IEA (2008) for the import volumes and from PERC[1] for the index of political stability.

In 2007, OECD Europe obtained virtually all of its imports from six sources, with South Africa and Russia making up for more than 60% of the total imports. About 60% of the total steam coal consumption in Europe are imported. In contrast, US consumption was covered by more than 99% domestic production. The Chinese case is similar, with a very large domestic production making the country a net exporter. Japan has no production and receives more than half of its imports from Australia.
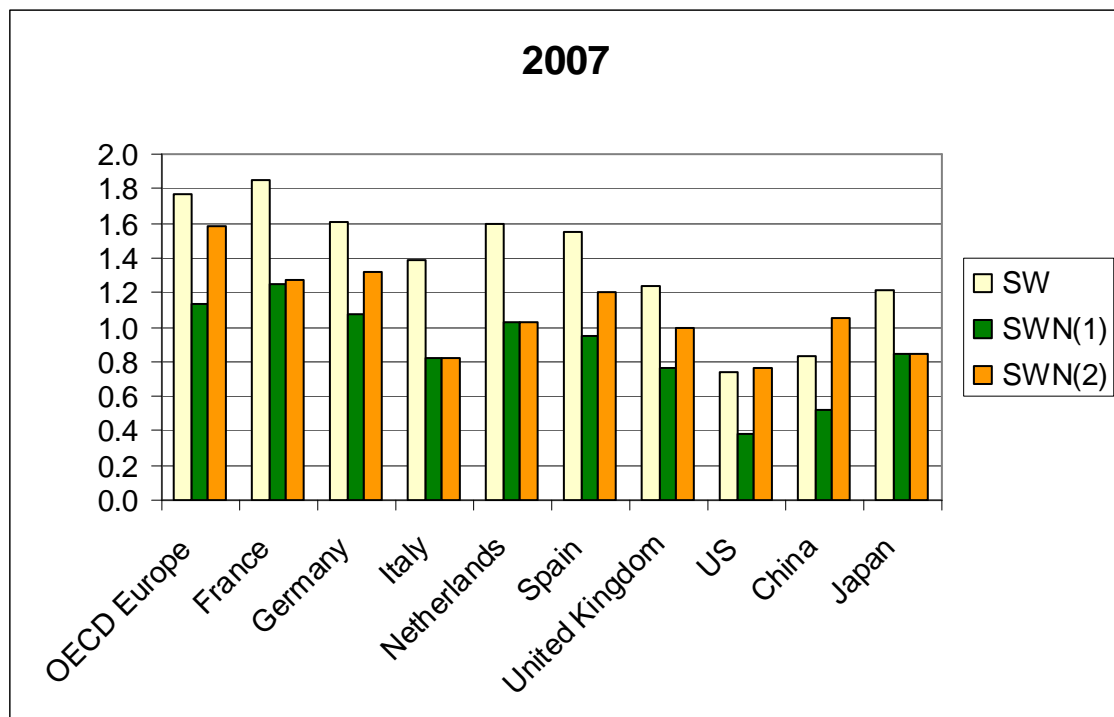

Figure 1: Diversification indices (SW, SWN1, SWN2) for major European and non-European importers in 2007

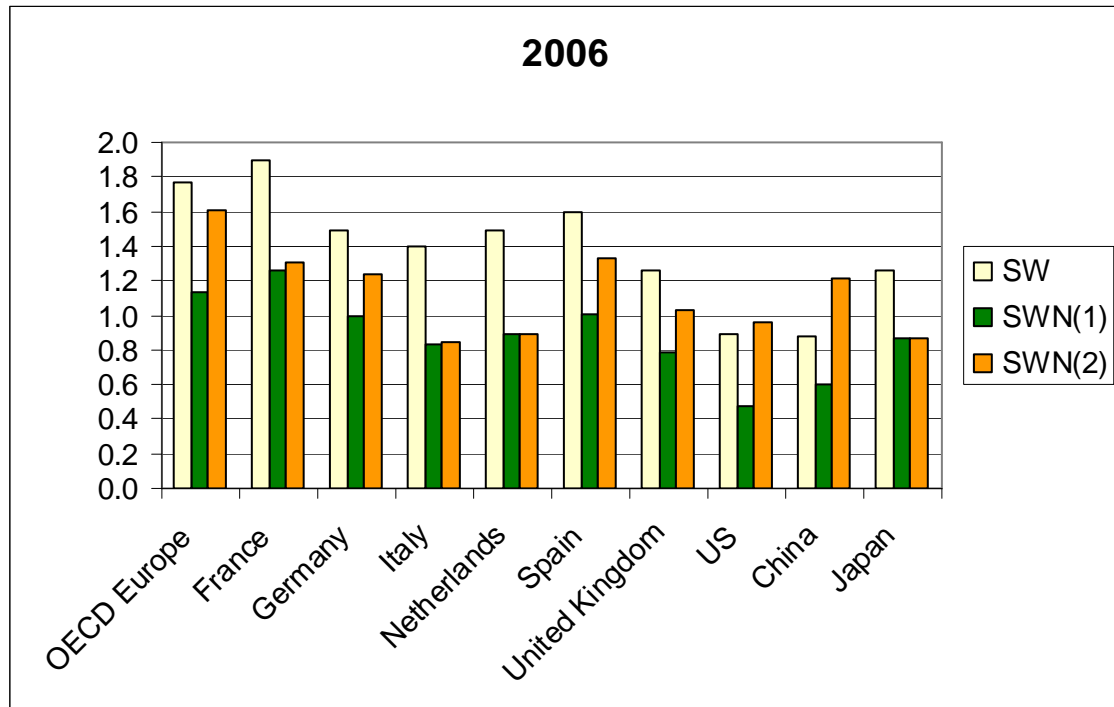
[1] Political and Economic Risk Consultancy Ltd.

Figure 2: Diversification indices (SW, SWN1, SWN2) for major European and non-European importers in 2006

In Figures 1 and 2, we observe that the augmented Shannon-Wiener-Neumann indices are generally lower than the traditional Shannon-Wiener index, as can be expected from their definition. Incorporating political stability (in SWN1) has a great effect on the index, especially given that the most important suppliers to Europe are South Africa and Russia with a relatively low political stability index in the PERC database. However, these coal suppliers have proven to be reliable in the last decades and in the Russian case coal is not as sensitive a fuel as natural gas.

The SWN2 index shows the importance of domestic supplies. However, domestic production is not very relevant for most Western European countries. The only European country with significant domestic production of steam coal is Poland which explains the high value of the SWN2 index for total OECD Europe.

The US and China with their small share of undiversified imports have low SW and SWN1 indices, but considerably higher SNW2 indices reflecting their large domestic production. This leads to the unusual result that the SWN2 index is even higher than the standard SW index. Japan's relatively low level of diversification is shown by its SW-

index lower than the average for OECD Europe. Japan has no domestic production and therefore the SWN1 and SWN2 indices have the same value.

Development of Coal Supply Security Over Time

In the last years, the amount of internationally traded coal expanded considerably, at an annual rate of about 50 million tonnes (Mt) per year (Ritschel and Schiffer, 2007). In 2007, more than 600 Mt were traded in the seaborne market, which is about 13% of the total world consumption of steam coal (IEA, 2008).

Figures 3 and 4 show the development of the augmented Shannon-Wiener-Neumann indices between 2004 and 2007. One observes a fluctuation of the indices between the years, but overall they stay in the same range for each importing country. The variations between the years follow the same pattern for almost all importers. This confirms the increasing globalization of the steam coal market. In 2006 and 2007, freight rates and commodity prices increased steadily and had a negative effect on diversification in most importing countries. This shows that the variation of the indices is not the result of political decisions but is market-driven.
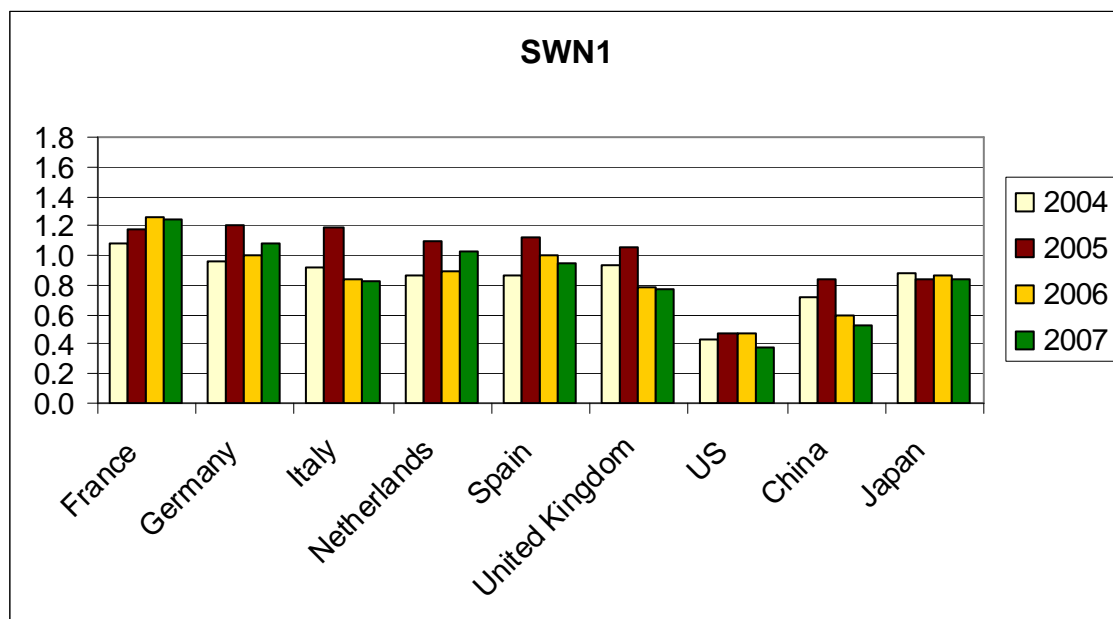

Figure 3: Historical development of the SWN1 diversification index including suppliers' political stability for major European and non-European coal importers (2004 – 2007)
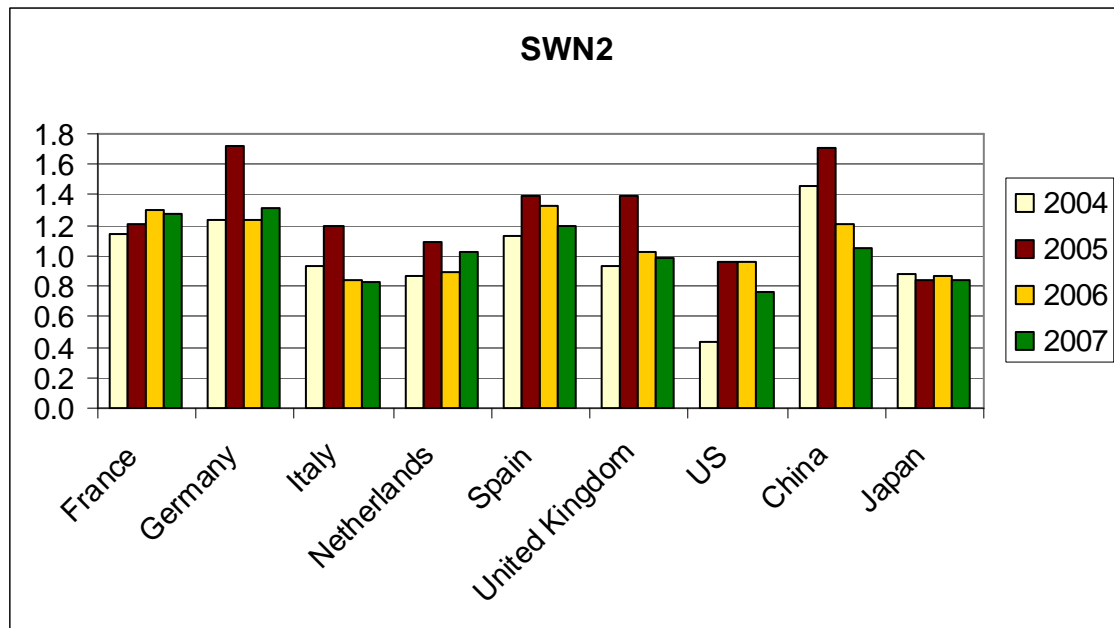
Figure 4: Historical development of the SWN2 diversification index including suppliers' political stability and domestic production for major European and non-European coal importers (2004 – 2007)

In conclusion, the three diversity indices used in this report show that Europe enjoys a relatively high level of security of its coal supplies compared to the other major coal consumers U.S.A, China and India. It seems as if coal is a secure and abundant energy resource on the world market. The "only" remaining internal risk, therefore, is technological: will Europe be willing and able to adopt CCS technology? This question will be examined in further research in this Work Package (Deliverable 5.3.5).

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