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Offshoring, employment, labour market reform and inequality: Modelling the German experience

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Abstract

A usual interpretation of the high performance of the German economy since 2006 is that the Hartz labour market reforms have boosted German competitiveness, resulting in higher exports, higher production and lower unemployment. We start from the diagnosis that this explanation is at odds with the sequence of observed facts. We propose and model an alternative scenario in which offshoring explains the gains in competitiveness but increases unemployment and inequality, and the subsequent labour market reforms lower unemployment by lessening the reservation wage and expanding the non-tradable sector, amplifying the rise in inequality. The model outcomes are consistent with all the developments of the German economy since 1995: 1) The model explains why Germany offshored earlier and more intensively than other Eurozone countries; 2) The increase in competitiveness and in the exports/production ratio occurs before the setting of the labour market reform, and this comes with both higher inequality and higher unemployment; 3) The setting of the labour market reform reduces unemployment and increases production, and this comes with a decrease in the exports/production ratio and an increase in inequality. We finally discuss (i) the possible extension of this 'strategy' to other Eurozone countries, and (ii) alternative policies that act through similar mechanisms, but without increasing inequality.

Keywords: Germany, inequality, labour market reform, offshoring, unemployment.

JEL Classification: H55, J31, J65.

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1. Introduction

Since the mid-2000s, Germany has exhibited better economic results than most European countries. Growth has been higher, unemployment has continuously diminished, budget deficits and public debt have decreased and are now significantly lower than the European average levels. Above all, the German performance on external markets has been particularly beneficial since Germany has accumulated substantial trade surpluses and maintained its international market share, in contrast with all advanced economies whose market shares have narrowed because of the increasing weight of emerging countries.

The turning point occurred in the mid-2000s. In the late 1990s-early 2000s, Germany was considered as 'the sick man' in Europe (e.g., Economist, 2004), with low growth, high and increasing unemployment, budget deficits and public debt. Most German economic indicators began to improve and to perform better than the European average in 2006, i.e., one year after the final setting of the Hartz reforms. Implemented from 2003 up to 2005, the four stages of the Hartz reform aimed at lowering unemployment and increasing German competitiveness by making labour more flexible and inciting unemployed workers to participate in the labour market.

The coincidence of the German recovery with the implementation of Hartz laws has led most observers to explain the German success by the following sequence. The combination of Hartz-related labour flexibility with lower wages has boosted German competitiveness, resulting in both higher exports and higher production, and finally lower unemployment. A virtuous circle has then emerged in which higher exports, production and employment have lessened public deficit and debt, which prevented Germany from setting the highly restrictive fiscal policy followed by most European countries, which has in turn resulted in higher growth compared to the rest of Europe. [1]

Unfortunately, this sequence is at odds with observed facts. The very core of the explanation is the impact of Hartz reforms and on wage moderation, competitiveness and exports, which would have boosted production and employment. However, the increase in competitiveness and exports occurred over the period 1993-2005, i.e., before the setting of Hartz laws.

After 2005, German exports in percent of GDP as well as the exports/imports ratio have decreased, in contradiction with the aforementioned explanation. Moreover, the most striking result of the Hartz reforms is the huge increase in atypical employment.

This paper provides an alternative explanation that combines offshoring and labour market reforms to explain the German experience. The scenario is as follows. Facing higher labour cost than other European (and advanced) countries, German firms have relocated the (low skilled) labour-intensive stages of production to low-wage countries, particularly Central European countries. This has (i) increased the competitiveness of German products in foreign markets, raising thereby German exports, (ii) increased the unemployment of unskilled workers in Germany, and (ii) increased inequality by driving down the wages of the unskilled. The impact upon growth was rather ambiguous and probably negative in a first stage because the increase in export was to a large extent based on offshoring, i.e., composed of imported parts. Confronted with the offshoring-related increase in unemployment, the German government introduced the Hartz reforms whose key implication was the promotion of low paid jobs in non-tradable services. This policy has reduced unemployment, but this has come with the increase in non-standard employment and with growing inequality and in-work poverty. Finally, the increasing demand for German goods due to higher competitiveness has

[1] Arguments along these lines can, e.g., be found in Kirkegaard (2014) and Rinne & Zimmermann (2013).

subsequently boosted production in the segments located in Germany, implying a further increase in employment.

We develop a general equilibrium framework that replicates the aforementioned scenario and provides a modelling of the German experience (outsourcing + labour market reform). The GE model does not aim at capturing all the dimensions of the German macroeconomic experience since the mid-nineties. Its goal is to analyse the impact on the German economy of the combination of, and interplay between, offshoring and the labour market reform, and to verify that these mechanisms provide a reliable picture of the major characteristics of the German economy over this period. The model comprises three sectors and three countries. The three countries are Germany, the rest of Eurozone (labelled 'Eurother') and the 'South'. The South displays a comparative advantage in low skill intensive productions. There is one skill-intensive sector which comprises two goods differentiated according to their country of origin ('Harmington's hypothesis'), Germany and Eurother, and produced from two segments, one utilising skilled labour and the other unskilled labour. The 'unskilled' segment can be offshored, but offshoring has a cost which decreases with time (globalisation). Another sector is unskilled-intensive and its production is fully located in the South. Finally, a non-tradable unskilled-intensive good is produced in each country. We start from an initial situation in which the offshoring cost is large enough to maintain the whole production of the skill-intensive sectors in Germany and Eurother. The subsequent continuous decrease in this cost results in offshoring (partial, then total) to the South of the unskilled-intensive segment of the German skill-intensive good. We analyse the impact of offshoring by assuming a reservation wage in Germany, and then a decrease in this reservation wage due to a labour market reform.

In contrast with the usual explanation based on the impact of wage limitation upon German competitiveness on external markets, the results of our model reproduces the main characteristics of the German experience since the mid-nineties. The fact that Germany outsources before other countries is an endogenous finding of the model. In addition, the model replicates the sequence of observed facts. In particular, it explains the increase in the exports/GDP ratio before the Hartz reforms and its decrease afterwards, as well as the fact that the rise in the skill premium and in the cost of unskilled labour began before the implementation of these reforms. Finally, by showing that the decline in unemployment is essentially based on the development of non-tradables, the model provides a useful starting point to discuss alternative pro-employment policies.

The stylised facts and the related literature are outlined in Section 2. Section 3 presents the general framework of the model, the analysed scenario and the modelling strategy. Section 4 derives the main results corresponding to each stage of our scenario, these results being subsequently discussed in Section 5. Section 6 contains a summary and a conclusion.

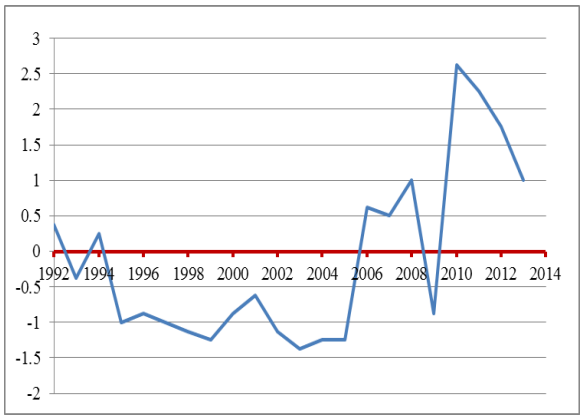
2. Facts and literature

2.1. Economic outcomes in Germany and Eurozone countries

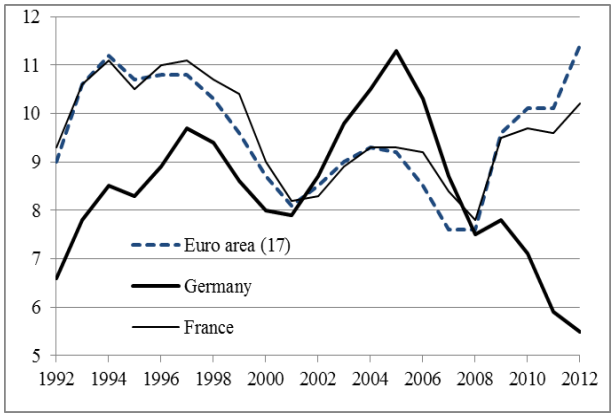
Comparing the German economy with that of other Eurozone countries since 1995 leads to a clear distinction between two phases (Figure 1). From 1995 to 2005, the German performances were below those of the rest of Eurozone: growth was lower and unemployment was higher. In contrast, from 2006 onwards, Germany has exhibited economic results incontestably better than those of its Eurozone partners. In particular, the recession that has followed the 2008 financial crisis has had far less damaging impact upon Germany than upon most advanced economies.

A noticeable specificity of Germany is its superior performance in terms of external trade (Figure 2). Germany is the only advanced country whose ratio of exports of goods on GDP has substantially increased in the last two decades, passing from 25% in 1996 up to 47% in 2008. In addition, the exports/imports ratio of goods has always been significantly higher than one, attaining 1.25 over the period 2001-2008. It must finally be highlighted that the German export performance measured by the Exports/GDP ratio has improved from 1995 up to 2005, i.e., before the Hartz reforms. In contrast, the implementation of these reforms has come with a decrease in this ratio.

Figure 1. GDP Growth and Unemployment in Germany and the Eurozone (1992-2012)



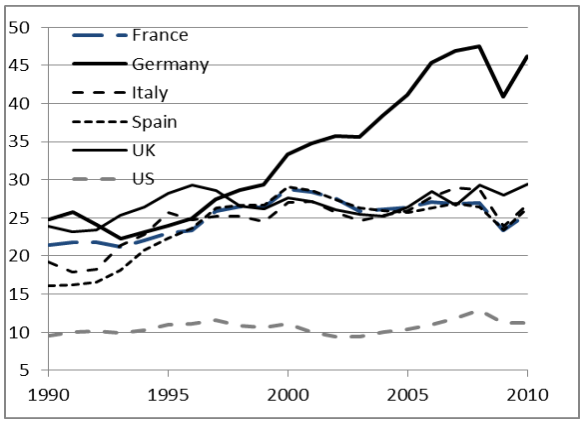
a) GDP Growth Gap: Germany – Eurother



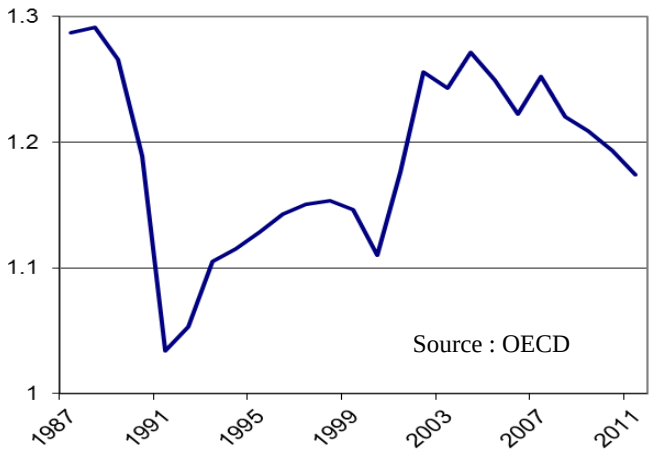
b) Rate of Unemployment

Source: Eurostat. *http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database*. *a)Difference between the German GDP growth rate (volume) and the GDP Growth rate of other Eurozone countries (13 countries minus Germany). Calculations by the authors.*

Figure 2: German foreign trade



a) Ratio Exports / GDP (%)



b) Germany: Ratio Exports/Imports, goods

Source: OECD. *http://www.oecd.org/statistics/*. *a) Exports (goods & services) in % of GDP. b) Exports/Imports ratio for goods only*.

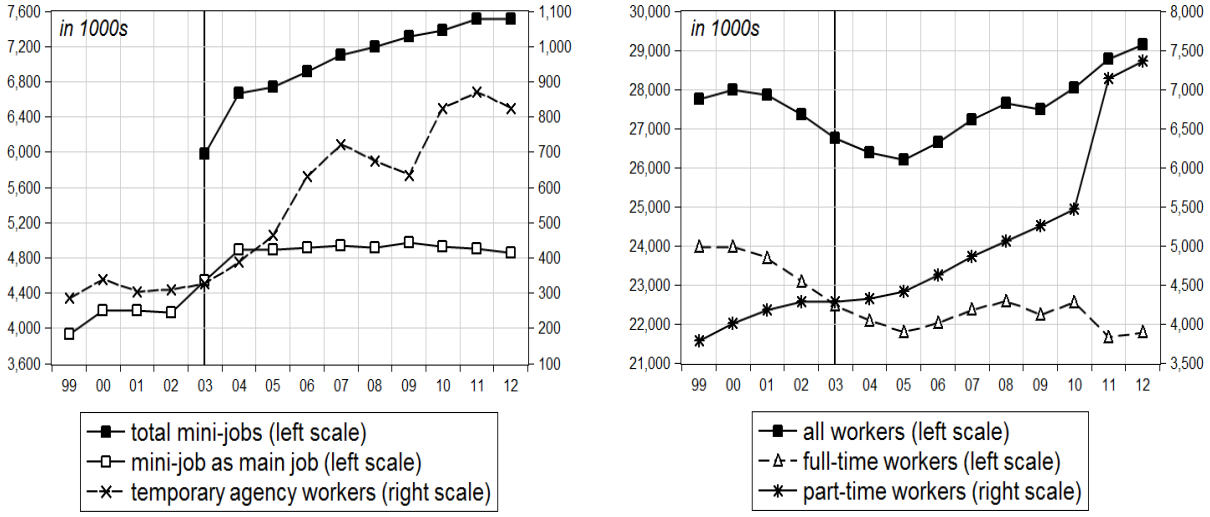
2.2. The Hartz Reforms

When unemployment started to rise again in 2000, especially among the unskilled, the German government decided a series of labour market reforms, known as the Hartz reforms and implemented in four stages from 2003 to 2005 (Jacobi & Kluve, 2007 and Alber & Heisig, 2011, for details). We focus here on the measures of the Hartz reforms that have significantly contributed to the increase in low-wage and non-standard employment: i)

deregulation of temporary agency employment (Hartz I in 2003), ii) reform and facilitation of marginal employment in the form of so-called mini jobs (Hartz II in 2003) and iii) reform of the unemployment compensation system (Hartz IV in 2005).

Hartz I led to an increase in temporary agency employment by about 150 percent, up to 822.000 temporary agency workers in 2012 (Figure 3a). Temporary agency workers accept considerably lower wages. Depending on the econometric model variant, Jahn & Pozzoli (2013) find pay gaps for the majority of temporary agency workers ranging from about 20 to 40 percent.

Figure 3: Standard and non-standard employment in Germany (1999 – 2012)



a) Mini-jobs and temporary agency workers b) Workers covered by social security

Source: Federal Employment Agency (BA). End-of-year values. a) Mini-jobs: Beschäftigungsstatistik: Geringfügig entlohnte Beschäftigte nach ausgewählten Merkmalen; temporary agency workers: Arbeitsmarkt in Zahlen – Arbeitnehmerüberlassung. Leiharbeitnehmer und Verleihbetriebe. b) Beschäftigungsstatistik: Sozialversicherungspflichtig Beschäftigte nach ausgewählten Merkmalen. The vertical line indicates the start of the Hartz reforms in 2003.

Before the Hartz II reform, incomes up to 325 Euro per month were exempt from employees' social security contributions if the weekly working time was less than 15 hours. The Hartz II reform raised this threshold to 400 Euros, eliminated the hour constraint and exempted from social security contributions and income tax the mini-jobs held as secondary jobs (fully taxable since 1999). As a consequence, the number of mini-jobs significantly increased. In 2012, about 7.5 million mini-jobs are reported, with about 4.9 million mini-jobs held as main job and about 2.6 mini-jobs held as secondary job (Figure 3a). According to Eichhorst et al. (2012), nearly one half of the workers with a mini job as main job earned less than 7,50 Euro per hour, and about 75 percent earned less than 10 Euro. According to RWI (2012), about one third of the firms employing mini-jobbers do not grant continued payment of remuneration in case of illness, holiday pay or maternity pay, though mini-jobbers would have an entitlement to these payments by law (as regular workers). Mini-jobbers are predominantly employed in services, especially in health and social work, hotels and restaurants, wholesale and retail trade and other services (RWI, 2012). There are also indications that regular workers have been substituted by mini-jobbers, especially in smaller firms (Hohendanner & Stegmaier, 2012).

The Hartz IV reform united the formerly separate (earnings-related) unemployment assistance and social assistance schemes into a new flat-rate unemployment assistance benefit, called unemployment benefit-II. For most people, unemployment benefit II is less generous

than the former earnings-related assistance benefit. There are indications that this has led to a reduction in reservation wages (Arent & Nagl, 2011). Moreover, the duration of earnings-related unemployment benefits-I has been reduced (Alber & Heisig, 2011, for details). Unemployment benefit-II can also be used to augment insufficient earnings from work (or insufficient earnings-related unemployment benefit-I). The number of workers receiving both wages and unemployment benefit II amounted to 1.2 million in 2012.[2]

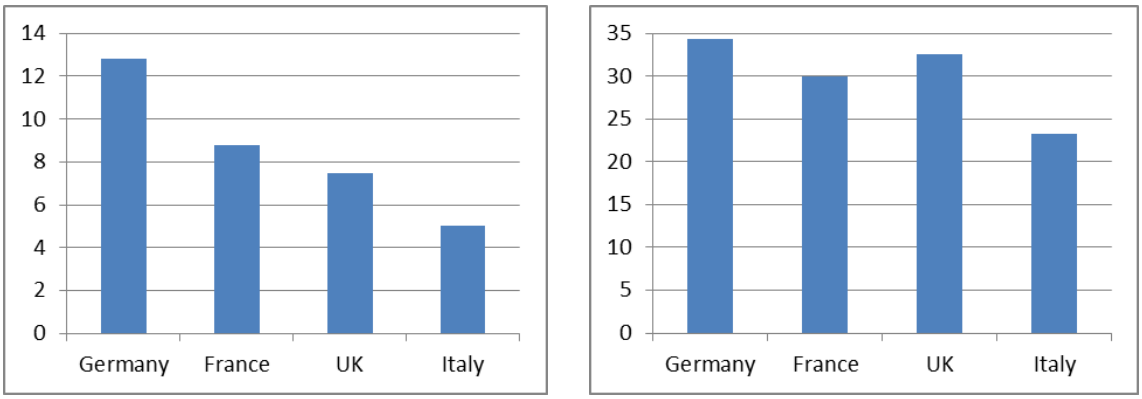
The rise in employment of workers covered by social security observed after the implementation of the Hartz reforms has only derived from the increase in part-time employment (Figure 3b). From 2003 to 2012 the number of part-time workers increased by 72 percent, amounting to 7.4 million part-time workers in 2012. In contrast, the number of full-time workers declined by 3 percent over the same period.

The evidence on whether the decline in German unemployment can be ascribed to the Hartz reforms remains inconclusive. Using calibrated macro models, Launov & Wälde (2013a) only find a negligible effect on unemployment, whereas Krebs & Scheffel (2013) and Krause & Uhlig (2012) diagnose a substantial reduction in equilibrium unemployment. Busl and Seymen (2013) only find weak effects of the Hartz reforms on wage restraint and no effects on the German current account surplus. In empirical studies, the evidence is mixed as well. Fertig et al. (2006) find no significant effects of the Hartz I-III reforms on unemployment in- and outflows. In contrast, several studies on the overall effectiveness of the Hartz reforms, particularly by estimating matching functions, find a positive impact on job creation (Fahr & Sunde, 2009; Klinger & Rothe, 2012; Hertweck & Sigrist, 2013).

All in all, the Hartz reforms are certainly one of the main driving forces of the increase in non-standard employment, especially in services. This can be regarded as an intended effect since the Hartz reforms main objective was the activation of the unemployed who were essentially low skilled workers. The reforms may also have contributed to the decline in aggregate unemployment and may have dampened wage demands. However, wage moderation and the increase in competitiveness started long before the Hartz reforms, as outlined below.

2.3. Offshoring, unemployment and wage inequality in Germany

Figure 4. Offshoring in manufacturing industries in the 4 largest EU economies



a) Increase in offshoring 1995-2008 b) Level of offshoring 2008

Source: Timmer et al. (2013). Offshoring is measured by the percentage of imports within intermediate inputs utilised in manufacturing industries. a) Variation in this percentage over the period 1995-2008. b) Level of this percentage in 2008.

[2] Data taken from: Bundesagentur für Arbeit (2013), Erwerbstätige Arbeitslosengeld II-Bezieher.

Since the mid-nineties, the Germany manufacturing industries have experienced a substantial rise in offshoring (Figure 4), particularly towards the Central European countries. This has resulted in a huge increase in the unemployment of low skilled workers.
The economic analysis of international offshoring has known a critical development since the early nineties. Theoretical and empirical works on the subject are many (reviews by Crino, 2009, Chang, 2012 and Chusseau & Dumont, 2013).

There is now a rather large literature dealing with the impact of offshoring upon wages and labour demand in Germany. The early work by Falk & Koebel (2002) showed no impact on the demand for unskilled workers, but this result is questionable from a methodological point of view (Geishecker & Görg, 2008) and, maybe more important, it concerns the period 1978-1990 in which offshoring to emerging countries was limited. More recent studies typically diagnose a non-negligible negative impact upon both the demand for unskilled workers and their pay (Geishecker, 2006; Becker et al., 2009; Geishecker & Görg, 2008; Braun & Scheffel, 2007).

Dustmann et al. (2014) and Bonin (2012) suggest that the decentralization of wage setting since the early 1990s and the introduction of 'opening clauses' in industry-level collective agreements may be attributed to the credible threat of offshoring to central and eastern European countries. Both works argue that the rising flexibility of the German industrial relations had led to wage moderation and to an increase in competitiveness long before the Hartz reforms. Dustman et al. (2014) also point out that the offshoring intensity in Germany increased far more than that in other European countries. For example, in 2000, imported inputs from Poland, Hungary, the Czech and the Slovak Republics amounted to about 8.5 percent of inputs in Germany, compared to only 2.5 percent in Italy and 1.9 percent in France. Higher German offshoring dynamics compared to other large European economies is confirmed by Timmer et al. (2013).

The growing offshoring of unskilled-intensive stages of production has come with wage moderation, rising flexibility and increasing earnings inequality. The German income distribution remained quite stable from the seventies up to the mid-1990s (Steiner & Wagner, 1998; Biewen, 2000; Prasad, 2004). Since then, Germany has experienced a critical increase in income inequality and poverty (Gernandt & Pfeiffer 2007, Dustmann et al, 2009; Fuchs-Schündeln et al. 2010, Antoncyck et al., 2010).

Gernandt & Pfeiffer (2007) find that the rise in wage inequality in West Germany from 1994 to 2005 is essentially attributable to the bottom side of the wage distribution. Dustmann et al. (2009) find that wage inequality in West Germany increased at the bottom half of the wage distribution from the 1990s onward, but also at the top half from the 1980s. For the period 1999-2006, Biewen & Juhasz (2012) find that about one half of the increase in income inequality is explained by labour incomes, the other half being equally shared by employment changes and changes in the tax system.

2.4. Observed facts and the modelled scenario

Taken together, the stylized facts and empirical literature exposed above show the plausibility of the scenario exposed in introduction:

1) The increase in competitiveness and exports started early in the mid-1990s and can be explained by the relocation of the labour-intensive stages of production to low-wage countries. This strategy of firms was implemented much more intensively in Germany than in other European countries and led to an increase in unemployment and to wage inequality.

2) Confronted with rising unemployment, the German government introduced the Hartz reforms, thereby promoting the creation of low-paid jobs, especially in non-tradable services.

In the remainder of the paper, we develop a theoretical framework based on these facts and we show that the so-generated mechanisms replicate the main traits of the German experience. From the mechanisms revealed in this scenario, we discuss the possibility and effectiveness for other Eurozone countries to imitate this strategy. Based on the diagnosis that the decrease in unemployment essentially derives from the job creation in non-tradable services, we finally discuss alternative pro-employment policies that could prevent the most controversial aspect of the German experience, i.e., the increase in inequality and poverty.

3. The model

We firstly present the general framework of the model and the offshoring decision. We subsequently describe the successive phases of the analysed scenario. We finally expose the modelling strategy.

3.1. General framework

There are 3 countries: two Eurozone countries, Germany and Eurother (the latter depicted by a tilde, ~), and the South, i.e., emerging countries (depicted by a star,*).

There are two factors, skilled labour (*H*) and unskilled labour (*L*). Factor endowments are given. The German endowment is $\left(\bar{H},\bar{L}\right)$ and Eurother's endowment $(\tilde{\bar{H}},\tilde{\bar{L}})$. We denote *H* and *L* ($\tilde{H}$ and $\tilde{L}$) the factor utilisation in Germany (Eurother) that can differ from the factor endowment when there is unemployment.

For the sake of simplicity, the South is assumed to be endowed with unskilled labour only.

There are three sectors:

- Sector *l* provides one homogenous unskilled intensive good (*l*) which is fully produced by the South and imported by both Germany and Eurother.
- Sector *nt* utilises unskilled labour only to produce one homogenous non-tradable service in each country.
- The third sector is skill-intensive and produces two tradable goods that are differentiated according to Armington's hypothesis, *h* being the German variety and $\tilde{h}$ Eurother's. Both varieties are produced by combining two segments, one using skilled labour only and the other unskilled labour only.

We suppose that the segments utilising unskilled labour may be relocated to the South depending on the cost of producing abroad relative to the cost of producing domestically. In contrast, the segment utilising skilled labour is always produced in the home country because it encompasses the specificities that differentiate the products according to Armington's hypothesis. We finally assume that labour is immobile, i.e., labour mobility costs are sufficiently high to prevent migration flows.

a) Production

In all countries, the non-tradable service (*nt*) utilises unskilled labour only with the same linear technology[3]:

$$Y_{nt} = \delta L_{nt}$$

[3] For the sake of simplicity, we only present the production function for Germany.

Assuming perfect competition in the market for goods and services, the zero-profit condition ($p_{nt}Y_{nt} = w_L L_{nt}$ and $\tilde{p}_{nt}\tilde{Y}_{nt} = \tilde{w}_L \tilde{L}_{nt}$) determines the prices of non-tradable services p_{nt} and $\tilde{p}_{nt}$:

$$p_{nt} = w_L / \delta \; ; \quad \tilde{p}_{nt} = \tilde{w}_L / \delta \tag{1}$$

where w_L ($\tilde{w}_L$) denotes the wage of unskilled labour in Germany (Eurother).

The two skill intensive goods (variety *h* for Germany and $\tilde{h}$ for Eurother) are produced by the same Cobb-Douglas combination of two segments:

$$Y_h = A S_L^{\alpha} S_H^{1-\alpha}; \qquad \tilde{Y}_{\tilde{h}} = A \tilde{S}_L^{\alpha} \tilde{S}_H^{1-\alpha}$$

Segments S_L and $\tilde{S}_L$ display the same technology which utilises unskilled labour only. Symmetrically, S_H and $\tilde{S}_H$ utilise skilled labour only with the same technology:

$$S_L = L_h \qquad \tilde{S}_L = \tilde{L}_{\tilde{h}} \tag{2}$$

$$S_H = H_h = H \qquad \tilde{S}_H = \tilde{H}_{\tilde{h}} = \tilde{H} \tag{3}$$

b) Demands for goods

In the three countries, households maximise the same utility function subject to the usual (instantaneous) income constraint:[4]

$$u = \gamma_l \log c_l + \gamma_h \log\left(a c_h^{\beta} + c_{\tilde{h}}^{\beta}\right)^{1/\beta} + \gamma_{nt} \log c_{nt}, \qquad \gamma_h + \gamma_l + \gamma_{nt} = 1$$

where c_i is the consumption of good i, $i = l, h, \tilde{h}, nt,$ and $0 < \beta < 1$.

Coefficients γ_l, γ_h and γ_{nt} are respectively the share of the demand for *l*, $h+\tilde{h}$ and *nt* in the households' income.

Coefficient *a* depicts the demand attractiveness of the German quality *h* compared to Eurother's quality $\tilde{h}$.

Good l. Good *l* is fully produced by the South. The imports of *l* by Eurozone countries are:

$$M_l = \gamma_l I; \qquad \tilde{M}_l = \gamma_l \tilde{I}$$

where *I* and $\tilde{I}$ denote total income in Germany and Eurother, respectively.

Good nt. The non-tradable good is produced by each Eurozone country for its own consumption. At the macro level, we have (because of the utility function):[5]

$$p_{nt}Y_{nt} = p_{nt}c_{nt} = \gamma_{nt} I \tag{4}$$

$$\tilde{p}_{nt}\tilde{Y}_{nt} = \tilde{p}_{nt}\tilde{c}_{nt} = \gamma_{nt} \tilde{I} \tag{5}$$

[4] We only present the German utility function. The utility functions for Eurother and the South are obtained by adding a tilde and a star to the variables.

[5] We do not provide this relation for the South because it is useless for what follows.

Goods h and $\tilde{h}$. Because of the utility function, the world total expense for the sum of goods *h* and $\tilde{h}$ is:

$$p_h Y_h + p_{\tilde{h}} Y_{\tilde{h}} = \gamma_h (I + \tilde{I} + I^*) = \gamma_h I_W ,$$

with *I** being the South's total income and $I_W = I + \tilde{I} + I^*$ that of the world.

Utility maximisation determines the world demands for goods *h* and $\tilde{h}$, $Y_{h,W}^d$ and $Y_{\tilde{h},W}^d$:

$$Y_{h,W}^d = \frac{a^\sigma \gamma_h I_W}{p_h{}^\sigma \left(a^\sigma p_h{}^{1-\sigma} + p_{\tilde{h}}{}^{1-\sigma} \right)} \Rightarrow p_h Y_{h,W}^d = \frac{a^\sigma \gamma_h I_W}{a^\sigma + (p_h / p_{\tilde{h}})^{\sigma-1}} \tag{6}$$

$$Y_{\tilde{h},W}^d = \frac{\gamma_h I_W}{p_{\tilde{h}}{}^\sigma \left(a^\sigma p_h{}^{1-\sigma} + p_{\tilde{h}}{}'^{1-\sigma} \right)} \Rightarrow p_{\tilde{h}} Y_{\tilde{h},W}^d = \frac{\gamma_h I_W}{a^\sigma (p_{\tilde{h}} / p_h)^{\sigma-1} + 1} \tag{7}$$

with $\sigma = (1-\beta)^{-1} > 1$ being the elasticity of substitution between goods *h* and $\tilde{h}$.

3.2. Offshoring

a) Offshoring costs

We assume that there are specific costs attached to offshoring. These comprise transportation costs (to move the parts from a production site to another), extra-costs linked to low quality public equipment and services in the South, organisational costs (to match segments produced in different countries), training cost (to adapt the unskilled manpower to the imported technology), political, social and 'criminal' costs linked to low property right enforcement and corruption in the host country. This also covers the fact that labour productivity is typically lower in the South than in advanced countries.

As Ranjan (2013), we further assume that globalization is characterised by decreasing offshoring costs. This decrease derives from two channels:

1) The decrease in transportation costs, the better enforcement of property rights, the improvement in public equipment and collective services linked to development, and the positive externalities due to better knowledge and insertion in the globalized economy generate a decrease in offshoring costs. This decrease occurs for all firms, whenever they already outsource their unskilled intensive segment or not.

2) Once a firm has begun to outsource its unskilled segment, then learning-by-doing, on-the-job training, improvement in internal organisation etc. make the cost of producing the unskilled segment in the South to decrease. This decrease is specific to the firms that outsource and, the longer the time since the firm has begun to outsource its unskilled segment, the higher the decrease in this cost.

In what follows, we focus on the offshoring cost for the German segment S_L, provided that the case of Eurother can be identically treated.

We denote ω the cost per unit of efficient (Eurozone-equivalent) unskilled labour in the production of segment S_L when this segment is offshored to the South. Hence, producing one unit of segment S_L in the South has a cost ω for German firms (Eq. 2).

The dynamics of the cost of producing offshore is then depicted by the functional form:

$$\omega = \omega(t, \tau), \qquad \tau = \tau(t, t_o) = \max\{0, t - t_o\}, \ \frac{\partial \omega}{\partial t} < 0, \ \frac{\partial^2 \omega}{\partial t^2} > 0, \ \frac{\partial \omega}{\partial \tau} < 0, \ \frac{\partial^2 \omega}{\partial \tau^2} > 0 \tag{8}$$

with *t* denoting time and t_o the time when German firms begin to outsource.

Eq. (8) signifies that the cost of producing S_L offshore is $\omega(t) = \omega(t,0)$ as long as the firm has not offshored this production yet and this cost decreases with time ($\partial\omega / \partial t < 0$). From the moment t_o when the firm begins to outsource, the second channel through which the cost ω declines begins to operate. Then, $\omega = \omega(t,\tau)$, $\tau = t - t_o > 0$, and the decrease in ω is reinforced ($\partial\omega / \partial\tau < 0$).

b) Offshoring decision

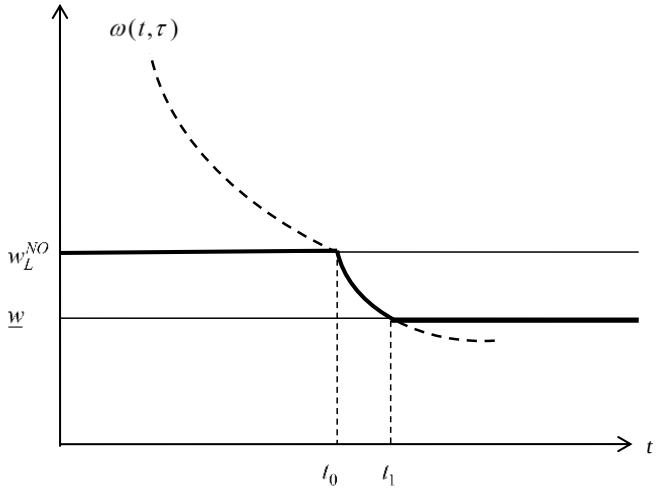


Figure 1. Unit costs in the offshored segment

We denote w_L^{NO} the German unskilled workers' wage when segment S_L is fully produced in Germany (*NO* for 'no-offshoring') and $\underline{w}$ the reservation wage in Germany, wjicj is supposed to be lower than w_L^{NO}: $\underline{w} < w_L^{NO}$.

Figure 1 depicts the variation of the German unskilled workers' wage over time depending on the cost of producing offshore, $\omega(t,\tau)$, and on the German reservation wage $\underline{w}$. This wage is depicted by the bold curve.

As long as $\omega > w_L^{NO}$, i.e. before t_0, the German firms producing good *h* have no incentive to outsource segment S_L; this segment is fully produced in Germany and the German unskilled workers' wage is w_L^{NO}.

When $\underline{w} < \omega < w_L^{NO}$, German firms (partly or fully) outsource the unskilled intensive segment S_L. As long as the cost of producing this segment in the South ω is higher than the reservation wage ($\omega > \underline{w}$), the German unskilled labour wage adjusts so that $w_L = \omega$,[6] which is the case between t_0 and t_1 in Fig.1.

When the cost ω becomes lower than the reservation wage, i.e. $\underline{w} < \omega$, the German unskilled workers' wage remains at the reservation value $\underline{w}$ and German firms fully outsource the unskilled intensive segment S_L. This creates unemployment if the production of the non-tradable service does not fully employ the available unskilled labour $\bar{L}$.

[6] except if this wage results in a demand for *L* by sector *nt* which exceeds the German unskilled labour supply $\bar{L}$.

Finally, we limit our analysis to the case in which offshoring concerns the sole German variety *h* and thus does not affect Eurother's production.

3.3. The scenario

From the above-described model, we develop the following scenario.

1) At the beginning, both Eurozone countries fully produce their own skill-intensive variety (*h* for Germany and $\tilde{h}$ for Eurother). Because of low unskilled labour cost, the whole of the production of *l* is located in the South. In contrast, because of the specific offshoring costs, producing the unskilled segments of goods *h* and $\tilde{h}$ remains more costly in the South than in both Eurozone countries. In this equilibrium without offshoring, the demand for each variety (depending on parameter *a*) and the countries' endowments of skilled and unskilled labour determine both the difference in the skill premia and the difference in wages between the two Eurozone countries. Given the countries' characteristics, we show that the skill premium is lower, and the wage of unskilled workers higher, in Germany than in Eurother.

2) We assume that globalization lessens the cost of outsourcing. From a certain time, this cost becomes sufficiently low to incite German firms to offshore the unskilled segment of their variety *h*. German firms outsource first because the wage of unskilled labour is higher there. This makes the wage of low skilled workers to decrease and the skill premium to increase in Germany. As long as the wage of low skilled workers decreases (because offshoring costs continue to fall), this causes a move in the German production pattern: the weight of the non-tradable sector increases (because its relative price decreases) and a growing share of segment S_L is offshored.

3) We assume that, in each Eurozone country, there is a reservation wage that is positively related to social protection (unemployment benefits, union bargaining power, redistribution, social allocations etc.). We also assume that the social system is initially more generous in Germany that in Eurother, which is in line with institutional differences between the two areas in the early 2000s. As the offshoring cost continues to decrease, there is a moment when the unit cost of producing S_L in the South becomes lower than the German reservation wage. From then, (i) the whole of the unskilled segment S_L is offshored to the South, and (ii) this creates unemployment of the unskilled in Germany.

4) Facing the increase in unemployment, the German government decides to implement labour market reforms that lessen the social net and the reservation wage. This lowers the unskilled labour wage and the price of non-tradables, increasing thereby the demand for and production of *nt*, which diminishes unemployment.

3.4. Modelling strategy

The core of the above scenario lies in the decrease in offshoring costs.

A first way to model this scenario is to build a complete framework with the three countries endowments in skilled and unskilled labour being given and to calculate the general equilibrium values related to each aforementioned stage. This modelling pattern is twice disputable. First, it assumes a given size of the South (given endowments $\bar{L}^*$ and $\bar{H}^*$) which is at odds with the fact that a growing number of developing countries have joined the globalized economy. Second, it comprises the calculations of all Southern values (production of each good, imports and exports, unskilled labour wage, etc.), implying thereby a complexity which is not necessary for our scenario which focuses on Germany and Eurother. Finally note that correcting the first shortcoming by assuming an increasing size of the South would reinforce the second critique.

In fact, there is a simpler way to model the same scenario. This consists in introducing the South through two elements, namely, the exogenously decreasing offshoring cost ω and the South balanced trade constraint. The latter permits to calculate the Southern total income as a linear function of both the German and Eurother total incomes. This modelling strategy significantly simplifies the calculations because it allows ignoring the South 'inside equilibrium', i.e., its unit wage, its equilibrium on the labour market, its production of non-tradables, and finally its size. As we focus on equilibria in Germany and Eurother, this is the strategy we select here. Then the different stages of our scenario can be modelled as follows.

We firstly calculate different equilibria with Germany being at full employment. In this case, the German unskilled labour wage w_L is equal to the offshoring-related production cost ω when there is offshoring with albeit segment S_L being not fully offshored (otherwise, there would be unemployment of German unskilled workers). We calculate three types of full employment equilibrium:

1) No outsourcing, which determines the skill premium in Germany w_{NO} and all the other variables in the model (relative wages and prices, production and trade of goods, etc.);

2) Full offshoring of segment S_L with the production cost of the offshored segment being equal to the German unskilled labour wage, which determines the German skill premium w_{FO} (*FO* for 'full offshoring') corresponding to the moment when ω reaches the value that make all German unskilled workers be employed in the production of non-tradables.

3) Partial offshoring of segment S_L, which corresponds to skill premia being between w_{NO} and w_{FO}. In fact, when $w_L = \omega$ decreases from no offshoring to full offshoring of segment S_L, the full employment German skill premium varies from w_{NO} and w_{FO}.

Having defined the above three equilibria, we can then introduce the German reservation wage $\underline{w}$ which becomes higher than the offshored production cost ω from a certain time. This results in full offshoring (because the offshoring production cost is lower that the German domestic production cost in segment S_L) with unemployment of unskilled workers.

We finally introduce labour market reforms by making the reservation wage $\underline{w}$ decrease.

It must be noted that the model developed here is limited by construction and cannot thereby embrace a large number of specificities of the German experience. In particular, the successive equilibria assume balanced trade for the three countries, which cannot account for the large surplus of Germany. The impact of the German reunification is ignored. Also, Germany and Eurother are the sole advanced countries considered in the theoretical model. As a consequence, the impacts of the variations in the exchange rate between the Eurozone and other advanced countries are disregarded. Finally, we shall suppose that Eurother remains at full employment throughout the scenario.

4. Equilibria

4.1. Full employment equilibrium

a) Equilibrium without offshoring in Germany

Both Eurozone countries are at full employment. We also suppose that the cost of producing the unskilled-intensive segments in the South is higher than the costs of producing them in their countries of origin. Consequently, there is no offshoring.

We add the following two assumptions which are consistent with the German economic structure:

1. The German relative endowment in skilled labour is higher than that of Eurother. In fact, the proportion of workers with a tertiary degree within the working population is slightly higher in Germany compared to the rest of Eurozone, but the share of workers with post-secondary non-tertiary degree is substantially higher. This last characteristic corresponds to a specificity of the German education system in which within-the-firm apprenticeship has a significant weight. All in all, this shows that the German relative endowment in skilled labour is higher than that of Eurother, i.e.:

$$\bar{H} / \bar{L} > \bar{\tilde{H}} / \bar{\tilde{L}} \tag{7}$$

2. We also assume that the following condition is met:

$$a > \left(\frac{\bar{L}}{\bar{\tilde{L}}} \right)^{1/\sigma} \left(\frac{\bar{\tilde{H}} / \bar{\tilde{L}}}{\bar{H} / \bar{L}} \right)^{\frac{(1-\alpha)(\sigma-1)}{\sigma}} \tag{8}$$

Condition (8) establishes a relationship between (i) the demand attractiveness of the German quality, *a*, (ii) the relative endowment in skilled labour in both Eurozone countries, $\frac{\bar{\tilde{H}} / \bar{\tilde{L}}}{\bar{H} / \bar{L}}$, and (iii) the size of Germany in relation to Eurother, $\bar{L} / \bar{\tilde{L}}$. In this relation, $a > \left(\bar{L} / \bar{\tilde{L}} \right)^{1/\sigma}$ corresponds to an attractiveness of German goods which is high compared to the size of Germany. The full significance of Condition (8) is explained further on.

The full employment general equilibrium without offshoring is built in Appendix A. This equilibrium is characterised by the following values of the skill premia and of the wage of unskilled workers in Germany in relation to Eurother:

$$w_{NO} = \frac{(1-\alpha)(1-\gamma_{nt})}{\alpha + (1-\alpha)\gamma_{nt}} \frac{\bar{L}}{\bar{H}} \tag{9}$$

$$\tilde{w}_{NO} = \frac{(1-\alpha)(1-\gamma_{nt})}{\alpha + (1-\alpha)\gamma_{nt}} \frac{\bar{\tilde{L}}}{\bar{\tilde{H}}} \tag{10}$$

$$\frac{w_{NO}}{\tilde{w}_{NO}} = \frac{\bar{L} / \bar{H}}{\bar{\tilde{L}} / \bar{\tilde{H}}} \tag{11}$$

$$\frac{w_L^{NO}}{\tilde{w}_L^{NO}} = a \left(\frac{\bar{\tilde{L}}}{\bar{L}} \right)^{1/\sigma} \left(\frac{\bar{H} / \bar{L}}{\bar{\tilde{H}} / \bar{\tilde{L}}} \right)^{\frac{(1-\alpha)(\sigma-1)}{\sigma}} \tag{12}$$

where $\tilde{w}_L^{NO}$ ($\tilde{w}_L^{NO}$) and w_{NO} ($\tilde{w}_{NO}$) are the unskilled labour wage and the skill premium in Germany (Eurother) in the 'no-outsourcing' stage of our scenario.

From the preceding values, we infer the following two propositions:

Proposition 1: *At the full employment equilibrium without offshoring, the skill premium is lower in Germany than in Eurother*.

Proof. From (7) and (11).

Proposition 2: *At the full employment equilibrium without offshoring, the wage of unskilled workers is higher in Germany than in Eurother*.

Proof. From (8) and (12).

The interpretation of Proposition 1 is straightforward: the skill premium is lower in Germany because of its higher relative skill endowment.

As regards Proposition 2, three mechanisms combine to raise the wage of unskilled workers in Germany in relation to Eurother:

1. A high coefficient *a* makes the German quality *h* to be highly demanded in relation to Eurother's quality $\tilde{h}$. This increases the demand for both skilled and unskilled labour in Germany, and thereby the German wage for both types of labour.

2. A higher relative size of Eurother ($\bar{\tilde{L}} / \bar{L}$) increases the supply of both skilled and unskilled workers in Eurother in relation to Germany, which increases the German wages for both types of labour in relation to Eurother for a given attractiveness coefficient *a*.

3. A higher German skill endowment $\bar{H} / \bar{L} > \bar{\tilde{H}} / \bar{\tilde{L}}$ signifies a lower relative supply of unskilled labour in Germany compared to Eurother. This entails a higher wage of unskilled labour in Germany compared to Eurother.

Mechanism 3 is obvious. Mechanisms 1 and 2 combine so as to determine the wage level in one country in relation to the other. If the quality produced by Germany is highly demanded (high coefficient *a*), then the size of Germany must be large enough to provide the world market with this good. If it is not the case, the price of this good increases which pushes up the German wages. This correspondence between the quality and the country size directly stems from Armington hypothesis that states country-specific qualities of goods.

Proposition 2 can thus be interpreted as follows. The difference in skill endowments ($\bar{H} / \bar{L} > \bar{\tilde{H}} / \bar{\tilde{L}}$) results in higher *relative* wage of unskilled labour in Germany (Proposition 1). Thus, to have a wage of unskilled workers higher in Germany than in Eurother, it is sufficient the attractiveness of the German quality, *a*, not to be too low (low attractiveness would reduce the relative price of the German quality and thus the wages of both skilled and unskilled workers in Germany compared to Eurother). Note that an attractiveness of the German quality higher than that of Eurother's (i.e., $a > 1$) is not required to reach such a result.

b) Full employment equilibrium with offshoring

We now suppose that (i) Germany remains at full employment and (ii) the cost ω of unskilled labour in the offshored segment S_L is lower than w_{NO}. As soon as the offshoring cost moves below w_{NO}, German firms begin to outsource segment S_L. So as to ensure full employment, the German wage w_L adjusts. As long as segment S_L is not fully offshored, the wage adjustment imposes equality $w_L = \omega$ to reach full employment. When ω attains the value for which the German unskilled labour $\bar{L}$ is fully employed in the sector of non-tradables, then the full employment German wage w_L cuts of from ω. In addition:

Proposition 3. *In the skill-intensive sector, German firms begin to outsource their unskilled segment before Eurother firms.*

Proof. As $w_L > \tilde{w}_L$, then the deceasing value $\omega(t,0)$ attains w_L before $\tilde{w}_L$. Hence, German firms begin to outsource before Eurother firms.

In what follows, we place ourselves in the situation in which Germany partially offshores its segment S_L whereas Eurother still fully produces its quality $\tilde{h}$. The buildings of the model with full and partial offshoring are exposed in Appendix B and C. The decrease in offshoring cost is introduced in the model through a decrease in the relative price $\omega / \tilde{w}_L$. The results of this modelling lead to the following proposition:

Proposition 4. *During the partial offshoring stage with full employment, the German skill premium increases from* $w_{NO} = \frac{(1-\alpha)(1-\gamma_{nt})}{\alpha+(1-\alpha)\gamma_{nt}} \frac{\bar{L}}{\bar{H}}$ *to* $w_{FO} = \frac{1-\gamma_{nt}}{\gamma_{nt}} \frac{\bar{L}}{\bar{H}} > w_{NO}$.

4.2. Reservation wage, unemployment and labour market reform

We now introduce a reservation wage $\underline{w}$ in Germany. This reservation wage is firstly assumed to be higher than the unskilled labour wage w_L^{FO} corresponding to the situation in which the only non-tradable sector generates full employment of the unskilled workers as this wage is equal to the offshore production cost ($w_L^{FO} = \omega$). Secondly, the decrease in the offshore production cost ω makes this cost to attain the reservation wage $\underline{w}$ at a certain time. From then, the production of segment S_L is fully offshored to the South, and unskilled labour is thus only employed by the non-tradable sector in Germany. Consequently, the feature $\underline{w} > w_L^{FO}$ generates unemployment of the unskilled workers in Germany.

We can then establish the following two Propositions:

Proposition 5. *Assume a reservation wage* $\underline{w} > \omega$ *in Germany such that and* $\underline{w} > w_L^{FO}$. *Then:*

1) *If* $\underline{w} > \omega$, *then the German skill premium with reservation wage* w_{RW} *is lower than the skill premium without and the German skill premium* w_{RW} *decreases with the reservation wage* $\underline{w}$.
2) *The decrease in the offshore production cost* ω *raises the German skill premium.*
3) *There is an upward jump in unemployment of the German unskilled workers as and when* ω *goes below the reservation wage* $\underline{w}$, *and unemployment increases with the reservation wage* $\underline{w}$ *and decreases with the decrease in* ω.

Proof. See Appendix D, results D1, D2 and D3.

Proposition 6. *Assume a reservation wage* $\underline{w}$ *such that* $\underline{w} > w_L^{FO}$. Then:

1) *There is an upward jump in the ratio of Exports on Production in Germany as and when* ω *goes below the reservation wage,*

In addition, for plausible values of the parameters:

2) *The subsequent decrease in* ω *lessens this ratio.*
3) *A decrease in* $\underline{w}$ *due to the labour market reform also lessens this ratio.*

Proof. Appendix D, result D4 and D5.

The explanation for Proposition 5 is as follows. When the cost ω goes below the reservation wage, the whole production of segment S_L is immediately relocated to the South. This generates a one-shot upward jump in unemployment in Germany. From then:

1. An increase in the reservation wage diminishes the skill premium because it increases the wage of unskilled workers. Hence, the German skill premium with reservation wage w_{RW} is lower than the skill premium without from the moment when ω goes below $\underline{w}$. It must however be noted that this does not mean that the presence of the reservation wage comes with a decrease in the skill premium. On the contrary, the skill premium increases because the offshore production cost continues to decrease (Proposition 5, Feature 2). However, this increase in slowed down by the reservation wage.

2. An increase in the reservation wage raises the price of and lessens the demand for and production of the non-tradable service, which lowers the employment of unskilled workers.

3. When the offshore production cost decreases, this lowers the price of good *h*, which increases the demand for this good and consequently the demand for German skilled workers and the skill premium.

In addition, Proposition 5 shows that the reservation wage generates an inequality-unemployment trade-off in Germany. Actually, an increase (decrease) in the reservation wage entails a decrease (increase) in the skill premium and an increase (decrease) in unemployment.

Finally, Proposition 4 shows that unemployment displays an inverted-v curve. It firstly jumps up as and when ω goes below $\underline{w}$, and it subsequently decreases because of the decrease in ω.

Combined with Proposition 5, Proposition 6 has several key consequences.

Firstly, at the moment when the offshoring cost goes below the reservation wage, Germany displays an upward jump in both its exports/production ratio and its unemployment. Subsequently, the decrease in ω reduces the exports/production ratio, lessens unemployment and augments the skill premium. Finally, the decrease in the reservation wage $\underline{w}$ due to the labour market reform reinforces the decrease in unemployment, the rise in the skill premium and the decrease in the exports/production ratio.

In other words, from the time when ω attains $\underline{w}$, unemployment and the exports on production ratio are moving in the same direction, firstly increasing when ω goes below $\underline{w}$ and subsequently decreasing with the reduction in ω and $\underline{w}$.

5. Discussion

We have developed a model in which the cost of offshoring decreases with time. From this model, we have shown that, if Germany is characterised by (i) a skill endowment slightly higher than other Eurozone countries and (ii) a quality of its differentiated good which is sufficiently high compared to its size in relation to other Eurozone countries (Eurother), then:

1. Germany displays a lower skill premium and a higher wage of unskilled workers than other Eurozone countries before offshoring.

2. Germany begins to offshore before Eurother.

3. As long as the cost of the offshore production is higher than the German reservation wage, offshoring decreases the wage of unskilled workers and increases inequality, but full employment is preserved.

4. From the moment when the cost of the offshore production becomes lower than the German reservation wage, segment S_L becomes fully offshored and there is an upward jump in unemployment and in the exports/production ratio.

5. As the offshore production cost continues to decrease, this lessens unemployment and the exports/production ratio, and it increases the skill premium. It must be noted that this rise in the skill premium is now fully driven by the increase in the skilled labour wage because the unskilled labour pay remains at the reservation wage.

6. The labour market reform that lowers the reservation wage entails a decrease in unemployment and an increase in inequality (the skill premium) in Germany.

7. Finally, the exports/product ratio increases with unemployment, and it decreases with the setting of the labour market reform.

We now firstly discuss the capacity of this model to appropriately picture the main traits of the German experience. Based on the fact that the key channel by which unemployment decreases is the rising production of non-tradables, we shall finally discuss (i) the possibility for other Eurozone countries to implement the same 'strategy', and (ii) the existence of alternative policies that could prevent the most controversial impact of the German experience, i.e., the increase in inequality and poverty.

5.1. The model results facing observed facts

The decreasing production cost ω in the offshored segment and the subsequent labour market reform that lessen the reservation wage define five successive stages:

1. As long as $\omega(t) < w_{NO}$, (i) both Germany and Eurother produce both segments of the skilled intensive sector and remain at full employment, (ii) the skill premium is lower in Germany than in Eurother, and (iii) the unskilled workers' wage is higher in Germany than in Eurother.

2. From time t_0 such that $\omega(t_0) = w_{NO}$ up to time $t_1 > t_0$ such that $\omega(t_1) = \underline{w}$, (i) the unskilled workers' wage declines in Germany compared to Eurother , (ii) a growing share of the unskilled-intensive segment S_L is offshored, (iii) the German skill premium increases both in absolute terms and relative to Eurother's skill premium, and (iv) full employment is preserved.

3. At time t_1 such that $\omega(t_1) = \underline{w}$, (i) segment S_H is fully offshored, (ii) there is an upward jump in the German unemployment, and (iv) an upward jump in the exports/production ratio in Germany.

4. Afterwards, i.e. after time t_1, (i) the skill premium remains at its reservation level $\underline{w}$, and (ii) the continuing of the decrease in ω lessens unemployment and increases the skill premium.

5. When the Hartz reform is implemented, the related decrease in the reservation wage $\underline{w}$ entails a decrease in unemployment. Higher inequality comes with lower unemployment and with a decrease in the exports/production ratio.

Finally, the model generates an inequality-unemployment trade-off related to institutional changes.[7]

This sequence is far more consistent with observed facts than the 'usual' explanation. In particular, this story adequately portrays the joined variation in unemployment and in the exports/production ratio exposed in Section 2.1: both unemployment and the export/GDP

[7] See Dumont (2013) and Hellier and Chusseau (2010) for analyses of the inequality-unemployment trade-off.

ratio firstly increase as and when the offshore production cost attains the reservation wage, and both simultaneously decrease afterwards.

Another key finding is that, once segment S_L has been fully outsourced, both decreases in ω and $\underline{w}$ lessen unemployment. This result has two major implications. First, it can explain the huge and fast decrease in German unemployment after the setting of the Hartz reforms. Actually, Germany has known a rather atypical profile compared to all advanced economies. Its unemployment has decreased much more rapidly and this decrease has not been reversed by the 2008-2009 recession. The fact that the Hartz reforms reinforce the decrease in ω so as to lessen unemployment provides an explanation for the German substantial job creation. Second, the model shows that unemployment would have decreased even without the Hartz reforms, provided that the offshore production cost had continued to decrease. In other words, the Hartz reform is not 'the' explanation for the reversal of unemployment. It is just one component of this reversal.

There are however several findings that do not perfectly fit with the facts highlighted in Section 2.1. We show now that these shortcomings are generated by certain simplifying assumptions and can thereby be easily corrected.

A first inadequacy comes from the results that (i) inequality increases and full employment is preserved in stage 2, and (ii) unemployment and the exports/production ratio display a one-shot upward jump in stage 3. In fact, inequality, unemployment and the exports/production ratio have concurrently risen from the mid-1990s up to the mid-2000s. This shortcoming obviously derives from two simplifying assumption, i.e., (i) the existence of one skill intensive sector only with thereby a single offshoring cost and (ii) the fact that all unskilled workers are identical. These assumptions generate a one-shot rise in unemployment and makes that rising inequality cannot come with rising unemployment. A simple way to smooth the increase in unemployment is to assume several *H*-utilising sectors with different offshoring costs. Then, the offshoring story would display both successive offshoring decisions and successive sectoral jumps to full offshoring, which would produce a gradual rise in unemployment once the (decreasing) unskilled workers' wage that clears the labour market has attained the reservation wage. Since the decrease in ω pushes up the German exports and the skilled labour wage, there is from this time a concomitant rise in inequality (the skill premium), in unemployment and in the exports on production ratio. Another way to get the same outcome is to assume heterogeneity between unskilled workers so that they do not share either the same reservation wage, or the same productivity. In both cases, an increasing number of unskilled workers fall in unemployment as the unskilled labour wage decreases with the offshoring cost.

Another limit is that the model tells nothing about the huge increase in part-time work experienced by Germany in the last two decades (Fig. 3b). If this increase can be explained by certain structural changes (such as the rising female employment rate), another factor linked to the Hartz reforms themselves must be accounted for. By lessening the cost of the mini- jobs compared to full time work because of lower social contributions, the Hartz laws have prompted firms to create part-time jobs, and this also magnifies the reduction in unemployment. Such mechanisms could easily be inserted into the model by assuming a conditional decrease in the cost of part-time jobs.

In summary, the model provides a rather convincing picture of the main mechanisms that compose the German experience since 1995, and the few shortcomings could be easily corrected by expanding the model with more realistic assumptions.

5.2. Policy implications

In the scenario modelled in this paper, (i) firms decide to offshore their unskilled-intensive stage of production when offshoring costs have sufficiently decreased, (ii) this generates inequality as long as the unskilled labour wage is downward flexible, and (iii) this creates unemployment from the time when the unit cost of producing abroad has attained the German reservation wage. Then, the setting of labour market reforms that lessen the reservation wage permits to reduce unemployment by creating jobs in the non-tradable sector.

One additional consequence of this strategy is that it generates inequality, which can make the least skilled to fall below the poverty line (the poverty rate has significantly increased in Germany since 1999, for both working and unemployed individuals). Low pay is the price for low unemployment, which may be considered as damaging.

This leads to the following two questions: a) Is this 'strategy' applicable to other Eurozone countries? b) Is it possible to generate the same mechanism, i.e., job creation in the non-tradable sector, without reducing the wage of the less skilled?

a) Extension to other Eurozone countries

One frequent critique brought to the Hartz reforms is that it is a 'beggar my neighbour' policy (e.g., Lagarde, 2010). If this is true, the implementation of similar reforms in other Eurozone countries could just set the record straight. However, this critique directly stems from the 'usual' diagnosis that wage moderation is the main driver of German competitiveness on foreign markets. In contrast, the 'beggar my neighbour' impact remains marginal if, according to our interpretation, the labour market reforms essentially act through the employment of low skilled workers in non-tradable services.

Our model makes it possible to analyse the effects of such reforms in Eurother. First, as drawn on Figure 1, the same scenario begins in Eurother from time t_1, i.e., when the cost of producing segment $\tilde{S}_L$ in the South attains the wage $\tilde{w}_L^{NO}$ corresponding to full employment without offshoring. From then on, the same story as displayed for Germany applies. As long as $\underline{\tilde{w}} < \omega(t, \tilde{\tau}) < \tilde{w}_L^{NO}$, unskilled workers' wage decreases and the skill premium increases in Eurother, which maintains full employment. Once ω has reached the reservation wage $\underline{\tilde{w}}$, the production of $\tilde{S}_L$ is fully offshored and unemployment appears. As in the German scenario, a reform that lowers the reservation wage allows reducing unemployment. It must however be noted that:

1) As for Germany, this policy increases inequality, and inequality will be all the higher that skill endowment is lower in Eurother than in Germany.

2) The catching up of the German competitiveness in the *H*-intensive sector could reveal to be long because German firms benefit from the cost advantage linked to the fact that they were the first to outsource to the South (see Section 3.2).

b) Alternative policies

In the short term, there is obviously a way to boost employment in the non-tradable sector without lessening wages. This consists in subsidising production in this sector and taxing the tradable goods to finance the subsidies. In addition, when the tax is set on the consumption of tradables, this does not lessen competitiveness in this sector. This strategy allows attaining the same goal without lessening the reservation wage and without increasing inequality. Of course, this typically raises the levies so as to transfer subsidies to the non-tradable sector. However, a number of countries have attempted to increase their international competitiveness by lowering the cost of unskilled labour through both a decrease in wages

and a decrease in the social contributions paid by firms on low wages. A more targeted strategy that concentrates subsidies or decreases in contributions in the non-tradable services with a high elasticity of unskilled labour demand could prove to be more appropriate.

In the longer term, it is clear that skill upgrading is an efficient means to prevent the offshoring-related rise in inequality. Ceteris paribus, a decrease in the relative supply of unskilled labour reduces the skill premium. This provides an additional reason to prefer the subsidy policy to the low wage strategy. In fact, as revealed by a numerous literature, growing inequality tends to reduce human capital accumulation when the credit market is imperfect and education is costly. By impoverishing the low-skilled part of the working population, a policy that fosters inequality could reveal to be counterproductive in the longer term.

In summary, short term subsidies to the unskilled-intensive no tradable sectors combined with an active pro-skill education and training policy could reveal to be an alternative strategy that avoids the inequality-unemployment trade-off that characterise the German Hartz reforms.

6. Conclusion

From a three-country North-South general equilibrium model in which (i) production is segmented in the skill-intensive sector, (ii) there is a decreasing offshoring cost and (iii) there is a non-tradable sector, we have built a scenario that aims at portraying the key characteristics and mechanisms of the German experience since the mid-nineties. The model indeed replicates the key observed facts and developments characterising the German economy since 1995. In particular:

1) The model explains why Germany started offshoring earlier and more intensively than other Eurozone countries.

2) The increase in competitiveness and in the exports/production ratio occurs before the setting of the labour market reform, and this comes with both higher inequality and higher unemployment.

3) The implementation of the labour market reform that lowers the reservation wage allows reducing unemployment and increasing production by creating new and cheaper jobs in the non-tradable sector, and this comes with a decrease in the exports/production ratio and an increase in inequality.

The same strategy can obviously be applied in other Eurozone countries once their firms have started to offshore their unskilled intensives stages of production. However, the catching up of the German external competitiveness could be difficult and slow. This is because the first country whose firms decide to offshore benefits from a lasting cost advantage.

In addition, the channel by which the labour market reform lessens unemployment and boosts production is the creation of jobs in non-tradable services. Based on this diagnosis, we have discussed the possibility to implement alternative policies that could act through this channel without increasing inequality.

The increase in the production of non-tradables can actually be attained by subsidising non-tradable services and taxing the tradable sectors. Such a policy could lessen unemployment without rising inequality. Combined with training and skill upgrading, this pictures a strategy that permits to escape from the inequality-unemployment trade-off, both in the short and the longer term. The sources of employment linked to such a policy are potentially substantial given the growing needs linked to the rising age of the population, the expansion of female activity and the prevention and control of pollution in most advanced economies.

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Appendix A. Equilibrium with No Offshoring & Full Employment

Both segments of *h* and $\tilde{h}$ are fully produced in the related Eurozone country, i.e., without international outsourcing.

Assuming perfect competition on the markets for goods and because of the Cobb-Douglas technology, we have $p_h = A^{-1}\left(\frac{w_H}{1-\alpha}\right)^{1-\alpha}\left(\frac{w_L}{\alpha}\right)^{\alpha}$, $p_{\tilde{h}} = A^{-1}\left(\frac{\tilde{w}_H}{1-\alpha}\right)^{1-\alpha}\left(\frac{\tilde{w}_L}{\alpha}\right)^{\alpha}$, and thus:

$$\frac{p_h}{\tilde{p}_{\tilde{h}}} = \frac{w_L}{\tilde{w}_L}\left(\frac{w}{\tilde{w}}\right)^{1-\alpha} \qquad \text{(A1)}$$

Labour demand

Demand is denoted by superscript *d*.

From the non-tradable sectors. Because of zero profit, $p_{nt}Y_{nt} = w_L L_{nt}^d$ and $\tilde{p}_{nt}\tilde{Y}_{nt} = \tilde{w}_L \tilde{L}_{nt}^d$. Hence:

$$L_{nt}^d = p_{nt}Y_{nt} / w_L = \gamma_{nt} I / w_L : \qquad \tilde{L}_{nt}^d = \gamma_{nt}\tilde{I} / \tilde{w}_L$$

From the skill-intensive sectors. Because of the Cobb-Douglas technology and relations (4) and (5) in the text:

$$L_h^d = \frac{\alpha p_h Y_h}{w_L} = \frac{\alpha a^{\sigma}\gamma_h I_W}{w_L p_h^{\sigma-1}\left(a^{\sigma} p_h^{1-\sigma} + p_{\tilde{h}}^{1-\sigma}\right)}; \quad \tilde{L}_{\tilde{h}}^d = \frac{\alpha p_{\tilde{h}} Y_{\tilde{h}}}{\tilde{w}_L} = \frac{\alpha\gamma_h I_W}{\tilde{w}_L p_{\tilde{h}}^{\sigma-1}\left(a^{\sigma} p_h^{1-\sigma} + p_{\tilde{h}}^{1-\sigma}\right)}$$

Demand for unskilled labour in each Eurozone country.

$$L^{-} = L_h + L_{nt} = \frac{\alpha a^{\sigma} \gamma_h I_W}{w_L p_h{}^{\sigma-1}\left(a^{\sigma} p_h{}^{1-\sigma} + p_{\tilde{h}}{}^{1-\sigma}\right)} + \gamma_{nt} \frac{I}{w_L} \tag{A2}$$

$$\tilde{L}^{d} = \tilde{L}^{d}_{\tilde{h}} + \tilde{L}^{d}_{nt} = \frac{\alpha \gamma_h I_W}{\tilde{w}_L p_{\tilde{h}}{}^{\sigma-1}\left(a^{\sigma} p_h{}^{1-\sigma} + p_{\tilde{h}}{}^{1-\sigma}\right)} + \gamma_{nt} \frac{\tilde{I}}{\tilde{w}_L} \tag{A3}$$

Balanced trade in the South

Balanced trade of the South allows defining *I** in terms of *I* and $\tilde{I}$.
Let M_i^* be the import of good *i* by the South and X_j^* the South's exports of good *j*. We have $M_h^* + M_{\tilde{h}}^* = \gamma_h I^*$ and $X_l^* = \gamma_l (I + \tilde{I})$. Balanced trade ($X_l^* = M_h^* + M_{\tilde{h}}^*$) implies:

$$I^* = \frac{\gamma_l}{\gamma_h}(I + \tilde{I}) \tag{A4}$$

Finally, inserting (A4) into (A2) and (A3) yields:

$$L^{d} = \frac{\alpha a^{\sigma}(1-\gamma_{nt})(I + \tilde{I})}{w_L\left(a^{\sigma} + (p_h / \tilde{p}_h)^{\sigma-1}\right)} + \gamma_{nt} \frac{I}{w_L} \tag{A5}$$

$$\tilde{L}^{d} = \frac{\alpha(1-\gamma_{nt})(I + \tilde{I})}{\tilde{w}_L\left(a^{\sigma}(p_{\tilde{h}} / p_h)^{\sigma-1} + 1\right)} + \gamma_{nt} \frac{\tilde{I}}{\tilde{w}_L} \tag{A6}$$

Balanced trade in Germany

We now introduce balanced trade for Germany. Note that, when trade is balanced in both the South and Germany, it is *ipso facto* balanced in the third country (Eurother).

$M_l = \gamma_l I$, $M_{\tilde{h}} = \dfrac{\gamma_h I}{a^{\sigma}(\tilde{p}_h / p_h)^{\sigma-1} + 1}$ and $X_h = \dfrac{a^{\sigma}\gamma_h(\tilde{I} + I^*)}{p_h{}^{\sigma-1}\left(a^{\sigma} p_h{}^{1-\sigma} + \tilde{p}_h{}^{1-\sigma}\right)}$, which can be written

$X_h = \dfrac{(\gamma_h + \gamma_l)\tilde{I} + \gamma_l I}{1 + a^{-\sigma}(p_h / \tilde{p}_h)^{\sigma-1}}$ because of (A4). Equilibrium $M_l + M_{\tilde{h}} = X_h$ entails:

$$(p_h / \tilde{p}_h)^{\sigma-1} I = a^{\sigma} \tilde{I} \tag{A7}$$

Equilibrium on labour markets

Because of zero profit:

$$I = w_L L + w_H H = w_L (L + wH) \tag{A8}$$

$$\tilde{I} = \tilde{w}_L \tilde{L} + \tilde{w}_H \tilde{H} = \tilde{w}_L (\tilde{L} + \tilde{w}\tilde{H}) \tag{A9}$$

By inserting (A7), (A8) and (A9) into (A5) and (A6), equalising supplies $\bar{L}$ and $\bar{\tilde{L}}$ and demands given by (A2) and (A3) and assuming full employment of skilled labour, this yields:

$$\bar{L} = \frac{\alpha + (1-\alpha)\gamma_{nt}}{(1-\alpha)(1-\gamma_{nt})} w_{NO} \bar{H} \Leftrightarrow w_{NO} = \frac{(1-\alpha)(1-\gamma_{nt})}{\alpha + (1-\alpha)\gamma_{nt}} \frac{\bar{L}}{\bar{H}} \tag{A10}$$

$$\bar{\tilde{L}} = \frac{\alpha + (1-\alpha)\gamma_{nt}}{(1-\alpha)(1-\gamma_{nt})} \tilde{w}_{NO} \bar{\tilde{H}} \Leftrightarrow \tilde{w}_{NO} = \frac{(1-\alpha)(1-\gamma_{nt})}{\alpha + (1-\alpha)\gamma_{nt}} \frac{\bar{\tilde{L}}}{\bar{\tilde{H}}} \tag{A11}$$

Hence:

$$\frac{w_{NO}}{\tilde{w}_{NO}} = \frac{\bar{L} / \bar{H}}{\bar{\tilde{L}} / \bar{\tilde{H}}} \tag{A12}$$

By inserting (A1), and (A8) to (A12) into (A7):

$$\frac{w_L^{NO}}{\tilde{w}_L^{NO}} = a \left(\frac{\tilde{L}}{L} \right)^{1/\sigma} \left(\frac{H / L}{\tilde{H} / \tilde{L}} \right)^{\frac{(1-\alpha)(\sigma-1)}{\sigma}} \tag{A13}$$

Appendix B. Full outsourcing and full employment in Germany with $w_L = \omega$

Germany fully outsources segment S_L. Hence, German unskilled workers are only employed by the sector of non-tradables. Let ω be the cost of unskilled labour in the South. Then, because of the Cobb-Douglas technology:

$$p_h = A^{-1} \left(\frac{w_H}{1-\alpha} \right)^{1-\alpha} \left(\frac{\omega}{\alpha} \right)^{\alpha}; \quad \tilde{p}_{\tilde{h}} = A^{-1} \left(\frac{\tilde{w}_H}{1-\alpha} \right)^{1-\alpha} \left(\frac{\tilde{w}_L}{\alpha} \right)^{\alpha}$$

Hence:

$$\frac{p_h}{\tilde{p}_{\tilde{h}}} = \left(\frac{w}{\tilde{w}} \right)^{1-\alpha} \frac{\omega}{\tilde{w}_L} \tag{B1}$$

We place ourselves in the situation where the offshored production cost is exactly equal to the unskilled labour wage that ensures the full employment of unskilled workers in the sector of non-tradables. We thus have $w_L = \omega$.

B.1. ***Demands for goods***

These are not changed by outsourcing. Consequently:

$$M_l = \gamma_l I; \qquad \tilde{M}_l = \gamma_l \tilde{I}$$

$$p_{nt} Y_{nt}^d = \gamma_{nt} I; \qquad \tilde{p}_{nt} \tilde{Y}_{nt}^d = \gamma_{nt} \tilde{I}$$

$$Y_h^d = \frac{a^\sigma \gamma_h I_W}{p_h{}^\sigma \left(a^\sigma p_h{}^{1-\sigma} + p_{\tilde{h}}{}^{1-\sigma} \right)} \tag{B2}$$

$$\tilde{Y}_{\tilde{h}}^d = \frac{\gamma_h I_W}{p_{\tilde{h}}{}^\sigma \left(a^\sigma p_h{}^{1-\sigma} + p_{\tilde{h}}{}^{1-\sigma} \right)} \tag{B3}$$

Unskilled Labour demands

From the sectors of non-tradables. Because of zero profit, and as the total of unskilled labour is employed in sector *nt* in Germany:

In Germany: $L_{nt}^d = p_{nt}Y_{nt} / w_L = \gamma_{nt} I / w_L \Rightarrow w_L = \omega = \gamma_{nt} I / L_{nt}$

In Eurother: $\tilde{L}_{nt}^d = \gamma_{nt} \tilde{I} / \tilde{w}_L$

From the sector of skill-intensive goods. Because of the Cobb-Douglas technology and relation (B3):

$$\tilde{L}_{\tilde{h}}^d = \frac{\alpha p_{\tilde{h}} \tilde{Y}_{\tilde{h}}}{\tilde{w}_L} = \frac{\alpha \gamma_h I_W}{\tilde{w}_L p_{\tilde{h}}^{\sigma-1} \left(a^\sigma p_h^{1-\sigma} + p_{\tilde{h}}^{1-\sigma} \right)}$$

Total demand for L in each Eurozone country

$$L^d = L_{nt}^d = \frac{\gamma_{nt} I}{w_L} \tag{B4}$$

$$\tilde{L}^d = \tilde{L}_{\tilde{h}}^d + \tilde{L}_{nt}^d = \frac{\alpha \gamma_h I_W}{\tilde{w}_L p_{\tilde{h}}^{\sigma-1} \left(a^\sigma p_h^{1-\sigma} + p_{\tilde{h}}^{1-\sigma} \right)} + \gamma_{nt} \frac{\tilde{I}}{\tilde{w}_L} \tag{B5}$$

Skill premium in Germany

$$p_{nt} Y_{nt} = w_L L = \gamma_{nt} I$$

$$w_L = \frac{\gamma_{nt} I}{L} = \frac{\gamma_{nt} (w_L L + w_H H)}{L} = \gamma_{nt} (w_L + w_H H / L) \Rightarrow w \equiv \frac{w_H}{w_L} = \frac{1-\gamma_{nt}}{\gamma_{nt}} \frac{L}{H}$$

At full employment:

$$w_{FO} = \frac{1-\gamma_{nt}}{\gamma_{nt}} \frac{\bar{L}}{\bar{H}} \tag{B6}$$

Result B1: *In Germany, the full-offshoring full-employment skill premium is higher than the without-offshoring skill premium.*

Proof. $w_{NO} = \frac{(1-\alpha)(1-\gamma_{nt})}{\alpha + (1-\alpha)\gamma_{nt}} \frac{\bar{L}}{\bar{H}} < \frac{1-\gamma_{nt}}{\gamma_{nt}} \frac{\bar{L}}{\bar{H}} = w_{FO}$

Skill premium in Eurother

Result B2. *As long as Eurother's firms do not outsource, Eurother's skill premium remains unchanged and equal to:*

$$\tilde{w}_{FO} = \tilde{w}_{NO} = \frac{(1-\alpha)(1-\gamma_{nt})}{\alpha + (1-\alpha)\gamma_{nt}} \frac{\tilde{L}}{\tilde{H}} \tag{B7}$$

Proof. $\tilde{L}^d = \tilde{L}_{\tilde{h}} + \tilde{L}_{nt}$. $\tilde{w}_L \tilde{L}_{\tilde{h}} = \alpha p_{\tilde{h}} \tilde{Y}_{\tilde{h}}$ and $\tilde{w}_H \bar{\tilde{H}} = (1-\alpha) p_{\tilde{h}} \tilde{Y}_{\tilde{h}} \Rightarrow \tilde{L}_{\tilde{h}} = \frac{\alpha}{1-\alpha} \frac{\tilde{w}_H}{\tilde{w}_L} \bar{\tilde{H}} = \frac{\alpha}{1-\alpha} \tilde{w} \bar{\tilde{H}}$

$$\tilde{L}_{nt} = \gamma_{nt} \frac{\tilde{I}}{\tilde{w}_L} = \gamma_{nt} \frac{\tilde{w}_L \bar{\tilde{L}} + \tilde{w}_H \bar{\tilde{H}}}{\tilde{w}_L} = \gamma_{nt} (\bar{\tilde{L}} + \tilde{w} \bar{\tilde{H}})$$

$$\tilde{L}^d = \frac{\alpha}{1-\alpha} \tilde{w} \bar{\tilde{H}} + \gamma_{nt} (\bar{\tilde{L}} + \tilde{w} \bar{\tilde{H}}) = \bar{\tilde{L}} \Rightarrow \tilde{w}_{FO} = \frac{(1-\alpha)(1-\gamma_{nt})}{\alpha + (1-\alpha)\gamma_{nt}} \frac{\bar{\tilde{L}}}{\bar{\tilde{H}}}$$

Comparison of the skill premia inside Eurozone

Result B3. *Outsourcing increases the skill premium in Germany compared to Eurother*.

Proof. From (B6) and (B7): $\frac{w_{FO}}{\tilde{w}_{FO}} = \left(1 + \frac{\alpha}{1-\alpha} \gamma_{nt}^{-1}\right) \frac{\tilde{H}/\tilde{L}}{H/L} > \frac{w_{NO}}{\tilde{w}_{NO}} = \frac{\tilde{H}/\tilde{L}}{H/L}$

Balanced trade in the South and determination of I*

Balanced trade of the South allows defining *I** in terms of I and $\tilde{I}$.
Let M* and M_i^* be respectively the South total imports and the import of good *i* by the South, and X* and X_j^* the South total exports and the South's exports of good *j*.
Total import is $M^* = M_h^* + M_{\tilde{h}}^*$:

$$M_h^* = \frac{a^\sigma \gamma_h I^*}{p_h{}^{\sigma-1}\left(a^\sigma p_h{}^{1-\sigma} + \tilde{p}_h{}^{1-\sigma}\right)}; \quad M_{\tilde{h}}^* = \frac{\gamma_h I^*}{\tilde{p}_h{}^{\sigma-1}\left(a^\sigma p_h{}^{1-\sigma} + \tilde{p}_h{}^{1-\sigma}\right)}$$

$$M^* = M_h^* + M_{\tilde{h}}^* = \gamma_h I^*$$

Total export is $X^* = X_l^* + X_{SL}^*$

$$X_l^* = \gamma_l (I + \tilde{I});$$

$$\left.\begin{aligned} X_{SL}^* &= \omega L_{SL}^* = \alpha p_h Y_h \\ w_H H &= (1-\alpha) p_h Y_h \end{aligned}\right\} \Rightarrow X_{SL}^* = \frac{\alpha}{1-\alpha} w_H H$$

$$X^* = X_l^* + X_{SL}^* = \gamma_l (I + \tilde{I}) + \frac{\alpha}{1-\alpha} w_H H$$

Balanced trade implies *X** = *M**. By inserting the above relations in this equality:

$$I^* = \frac{\gamma_l}{\gamma_h} (I + \tilde{I}) + \frac{\alpha}{1-\alpha} \gamma_h{}^{-1} w_H H \qquad \text{(B8)}$$

Balanced trade in Germany

Germany exports the final good *h* (including both segments) and imports (i) the total of segment S_L from the South, (ii) good *l* from the South and (iii) good $\tilde{h}$ from the Eurother.

$$M_l = \gamma_l I, M_{\tilde{h}} = \tilde{p}_h Y_{\tilde{h}}^- = \frac{\gamma_h I}{\left(a^\sigma (\tilde{p}_h / p_h)^{\sigma-1} + 1\right)}, M_{SL} = X_{SL}{}^* = \frac{\alpha}{1-\alpha} w_H H; \; X_h = \frac{a^\sigma \gamma_h (\tilde{I} + I^*)}{\left(a^\sigma + (p_h / \tilde{p}_h)^{\sigma-1}\right)}.$$

Balanced trade $M_l + M_{\tilde{h}} + M_{SL} = X_h$ entails:

$$\gamma_l I + \frac{\gamma_h I}{\left(a^\sigma (\tilde{p}_h / p_h)^{\sigma-1} + 1\right)} + \frac{\alpha}{1-\alpha} w_H H = \frac{\gamma_h (\tilde{I} + I^*)}{\left(1 + a^{-\sigma} (p_h / \tilde{p}_h)^{\sigma-1}\right)}$$

After re-arranging:

$$\left(a^\sigma (\tilde{p}_h / p_h)^{\sigma-1} + 1\right)\gamma_l I + \gamma_h I + \left(a^\sigma (\tilde{p}_h / p_h)^{\sigma-1} + 1\right)\frac{\alpha}{1-\alpha} w_H H = a^\sigma (\tilde{p}_h / p_h)^{\sigma-1} \gamma_h (\tilde{I} + I^*)$$

By inserting $\gamma_h I^* = \gamma_l (I + \tilde{I}) + \frac{\alpha}{1-\alpha} w_H H$ (B8):

$$(1-\gamma_{nt}) I + \frac{\alpha}{1-\alpha} w_H H = a^\sigma (\tilde{p}_h / p_h)^{\sigma-1} (1-\gamma_{nt}) \tilde{I} \qquad \text{(B9)}$$

Inserting $\frac{p_h}{\tilde{p}_{\tilde{h}}} = \left(\frac{w}{\tilde{w}}\right)^{1-\alpha} \frac{\omega}{\tilde{w}_L}$ (B1):

$$\bar{L} + \frac{\alpha + (1-\alpha)(1-\gamma_{nt})}{(1-\alpha)(1-\gamma_{nt})} w_{FO} \bar{H} = a^\sigma \left(\frac{\tilde{w}_{FO}}{w_{FO}}\right)^{(1-\alpha)(\sigma-1)} \left(\frac{\tilde{w}_L}{\omega_{FO}}\right)^\sigma (\bar{\tilde{L}} + \tilde{w}_{FO} \bar{\tilde{H}})$$

Thus:

$$\bar{L} + \frac{\alpha + (1-\alpha)(1-\gamma_{nt})}{(1-\alpha)(1-\gamma_{nt})} w_{FO} \bar{H} = a^\sigma \left(\frac{\tilde{w}_{FO}}{w_{FO}}\right)^{(1-\alpha)(\sigma-1)} \left(\frac{\tilde{w}_L}{\omega_{FO}}\right)^\sigma (\bar{\tilde{L}} + \tilde{w}_{FO} \bar{\tilde{H}}) \qquad \text{(B10)}$$

By inserting $w_{FO} = \frac{1-\gamma_{nt}}{\gamma_{nt}} \frac{\bar{L}}{\bar{H}}$ (B6) and $\tilde{w}_{FO} = \frac{(1-\alpha)(1-\gamma_{nt})}{\alpha + (1-\alpha)\gamma_{nt}} \frac{\tilde{L}}{\tilde{H}}$ (B7) in (B10):

$$\frac{\omega_{FO}}{\tilde{w}_L} = \left(\frac{(1-\alpha)\gamma_{nt}}{\alpha + (1-\alpha)\gamma_{nt}}\right)^{\frac{(1-\alpha)\sigma+\alpha}{\sigma}} a \left(\frac{\bar{\tilde{L}}}{\bar{L}}\right)^{1/\sigma} \left(\frac{\bar{H} / \bar{L}}{\bar{\tilde{H}} / \bar{\tilde{L}}}\right)^{\frac{(1-\alpha)(\sigma-1)}{\sigma}}$$

As $\frac{w_L^{NO}}{\tilde{w}_L} = a \left(\frac{\tilde{L}}{L}\right)^{1/\sigma} \left(\frac{H / L}{\tilde{H} / \tilde{L}}\right)^{\frac{(1-\alpha)(\sigma-1)}{\sigma}}$, $\frac{\omega_{FO}}{\tilde{w}_L} = \frac{w_L^{FO}}{\tilde{w}_L} < \frac{w_L^{NO}}{\tilde{w}_L}$

Appendix C. Partial offshoring of the German quality with full employment

We make the cost of the offshore production decrease from $\frac{w_L^{NO}}{\tilde{w}_L} = a \left(\frac{\bar{\tilde{L}}}{\bar{L}}\right)^{1/\sigma} \left(\frac{\bar{H} / \bar{L}}{\bar{\tilde{H}} / \bar{\tilde{L}}}\right)^{\frac{(1-\alpha)(\sigma-1)}{\sigma}}$

to $\frac{\omega_{FO}}{\tilde{w}_L} = \left(\frac{(1-\alpha)\gamma_{nt}}{\alpha + (1-\alpha)\gamma_{nt}}\right)^{\frac{(1-\alpha)\sigma+\alpha}{\sigma}} a \left(\frac{\bar{H} / \bar{L}}{\bar{\tilde{H}} / \bar{\tilde{L}}}\right)^{\frac{(1-\alpha)(\sigma-1)}{\sigma}} \left(\frac{\bar{\tilde{L}}}{\bar{L}}\right)^{1/\sigma}$.

Because of full employment and partial outsourcing $w_L = \omega$

Because of the Cobb-Douglas technologies:

$$\frac{p_h}{p_{\tilde{h}}} = \left(\frac{w_H}{\tilde{w}_H}\right)^{1-\alpha}\left(\frac{\omega}{\tilde{w}_L}\right)^{\alpha} = \left(\frac{w}{\tilde{w}}\right)^{1-\alpha}\left(\frac{\omega}{\tilde{w}_L}\right) \qquad \text{(C1)}$$

Demand for labour in Sector nt

Demand for *nt* = Supply *of nt* $\Rightarrow Y_{nt}^d = Y_{nt}^s$

$$\left.\begin{array}{l} p_{nt}Y_{nt}^d = \gamma_{nt} I \\ \text{zero profit} \Rightarrow \omega L_{nt} = p_{nt}Y_{nt}^s \end{array}\right\} \Rightarrow L_{nt} = p_{nt}Y_{nt}^s / \omega = \gamma_{nt} I / \omega$$

$$L_{nt} = \gamma_{nt} I / \omega \qquad \text{(C2)}$$

Demand for labour in Germany

$$L^d = L_h^d + L_{nt}^d$$

Skill premium in Eurother

We know that, as Eurother 's firms do not outsource, the skill premium is (Appendix B):

$$\boxed{\tilde{w}_{PO} = \frac{(1-\alpha)(1-\gamma_{nt})}{\alpha + (1-\alpha)\gamma_{nt}} \frac{\tilde{L}}{\tilde{H}}} \qquad \text{(C3)}$$

Balanced trade in the South

Imports of the South: $M^* = M_h{}^* + M_{\tilde{h}}{}^* = \gamma_h I^*$

Exports of the South: $X^* = X_l{}^* + X_{SL}{}^* = \gamma_l (I + \tilde{I}) + \omega S_L{}^*$,

where $S_L{}^*$ is the portion of the unskilled-intensive segment of *h* which is relocated to the South and fully exported to Germany to be combined with segment S_H to produce *h*.

Let S_L^W be the complete unskilled-intensive segment (concurrently produced by the South and Germany) and S_L the part of S_L^W produced in Germany. Hence:

$$S_L{}^* = S_L^W - S_L$$

Because of the Cobb-Douglas technology:

$$\omega S_L^W = \alpha p_h Y_h = \frac{\alpha}{1-\alpha} w_H \bar{H}$$

As we stand at full employment, $S_L = L_h^d = \bar{L} - L_{nt}^d$, and:

$$S_L = \bar{L} - L_{nt} = \bar{L} - \gamma_{nt} I / \omega \Rightarrow \omega S_L = \omega \bar{L} - \gamma_{nt} I$$

Hence:

$$\omega S_L{}^* = \omega S_L^W - \omega S_L = \frac{\alpha}{1-\alpha} w_H \bar{H} - \omega \bar{L} + \gamma_{nt} I$$

And for the total exports from the South:

$$X^* = \gamma_l(I+\tilde{I}) + \frac{\alpha}{1-\alpha} w_H \bar{H} - \omega\bar{L} + \gamma_{nt} I = \gamma_l(I+\tilde{I}) + \frac{\alpha}{1-\alpha} w_H \bar{H} - \omega\bar{L} + \gamma_{nt} I$$

Equalising $M^* = X^*$:

$$\gamma_h I^* = \gamma_l \tilde{I} + \frac{\alpha}{1-\alpha} w_H \bar{H} - \omega\bar{L} + (1-\gamma_h) I \qquad \text{(C4)}$$

Balanced trade in Eurother and relation between $\omega / \tilde{w}_L$ ***and*** w_{PO}

Exports:

$$\tilde{X} = \tilde{X}_{\tilde{h}} = \frac{\gamma_h (I + I^*)}{a^\sigma (p_{\tilde{h}} / p_h)^{\sigma-1} + 1} = \frac{\gamma_h I + \gamma_l \tilde{I} + \frac{\alpha}{1-\alpha} w_H \bar{H} - \omega\bar{L} + (1-\gamma_h) I}{a^\sigma (p_{\tilde{h}} / p_h)^{\sigma-1} + 1}$$ because of (C4). As $I = \omega\bar{L} + w_H \bar{H}$:

$$\tilde{X} = \frac{\gamma_l \tilde{I} + \frac{1}{1-\alpha} w_H \bar{H}}{a^\sigma (p_{\tilde{h}} / p_h)^{\sigma-1} + 1}$$

Imports:

$$\tilde{M} = \tilde{M}_l + \tilde{M}_h$$

$$\tilde{M}_l = \gamma_l \tilde{I} \; ; \quad \tilde{M}_h = \frac{a^\sigma \gamma_h \tilde{I}}{a^\sigma + (p_h / p_{\tilde{h}})^{\sigma-1}} \Rightarrow \tilde{M} = \gamma_l \tilde{I} + \frac{a^\sigma \gamma_h \tilde{I}}{a^\sigma + (p_h / p_{\tilde{h}})^{\sigma-1}}$$

Balanced trade:

$$\tilde{X} = \tilde{M} \Rightarrow \frac{\gamma_l \tilde{I} + \frac{1}{1-\alpha} w_H \bar{H}}{a^\sigma (p_{\tilde{h}} / p_h)^{\sigma-1} + 1} = \gamma_l \tilde{I} + \frac{a^\sigma (p_{\tilde{h}} / p_h)^{\sigma-1} \gamma_h \tilde{I}}{a^\sigma (p_{\tilde{h}} / p_h)^{\sigma-1} + 1}$$

$$\Rightarrow \gamma_l \tilde{I} + \frac{1}{1-\alpha} w_H \bar{H} = \left(a^\sigma (p_{\tilde{h}} / p_h)^{\sigma-1} + 1\right) \gamma_l \tilde{I} + a^\sigma (p_{\tilde{h}} / p_h)^{\sigma-1} \gamma_h \tilde{I}$$

$$\Rightarrow (p_h / p_{\tilde{h}})^{\sigma-1} w_H \bar{H} = a^\sigma (1-\alpha)(\gamma_h + \gamma_l)(\tilde{w}_L \bar{\bar{L}} + \tilde{w}_H \bar{\bar{H}})$$

$$\Rightarrow (p_h / p_{\tilde{h}})^{\sigma-1} \omega w_{PO} \bar{H} = a^\sigma (1-\alpha)(1-\gamma_{nt})(\bar{\bar{L}} + \tilde{w}_{PO} \bar{\bar{H}})$$

Inserting (C1) and (C3):

$$\boxed{w_{PO} = a^{\frac{\sigma}{(1-\alpha)\sigma+\alpha}} \frac{(1-\alpha)(1-\gamma_{nt})}{\alpha + (1-\alpha)\gamma_{nt}} \frac{\bar{\bar{L}}}{\bar{\bar{H}}} \left(\frac{\bar{\bar{H}}}{\bar{H}}\right)^{\frac{1}{(1-\alpha)\sigma+\alpha}} \left(\frac{\omega}{\tilde{w}_L}\right)^{-\frac{\sigma}{(1-\alpha)\sigma+\alpha}}}$$

$$\frac{\partial w_{PO}}{\partial(\omega / \tilde{w}_L)} = -\frac{\sigma a^{\frac{\sigma}{(1-\alpha)\sigma+\alpha}}}{(1-\alpha)\sigma+\alpha} \frac{(1-\alpha)(1-\gamma_{nt})}{\alpha + (1-\alpha)\gamma_{nt}} \frac{\bar{\bar{L}}}{\bar{\bar{H}}} \left(\frac{\bar{\bar{H}}}{\bar{H}}\right)^{\frac{1}{(1-\alpha)\sigma+\alpha}} \left(\frac{\omega}{\tilde{w}_L}\right)^{-\frac{\sigma}{(1-\alpha)\sigma+\alpha}-1} < 0$$

Hence, $\frac{\partial w_{PO}}{\partial(\omega / \tilde{w}_L)} < 0$ and:

Result C2. The decrease in $(\omega / \tilde{w}_L)$ induces an increase in w_{PO}.

D. Reservation wage & Unemployment

$\underline{w}$ is the reservation wage and w_{RW} the reservation skill premium in Germany

We suppose that the German reservation wage is higher than the cost of unskilled labour in the outsourced segment S_L, $\underline{w} > \omega$, and higher than the full employment unskilled labour wage with full outsourcing of S_L, $\underline{w} > w_L^{FO}$. Thus, Germany fully outsources the unskilled segment S_L of the production of *h* whereas this segment is still domestically produced in Eurother. Then, German unskilled workers are only employed by the non-tradable sector and the demand for non-tradables is determined by the reservation wage. As this wage is higher than that which ensures full employment within this production configuration, w_L^{FO}, this generates unemployment.

Because of the Cobb-Douglas technology:

$$p_h = A^{-1}\left(\frac{w_H}{1-\alpha}\right)^{1-\alpha}\left(\frac{\omega}{\alpha}\right)^{\alpha} \; ; \quad p_{\tilde{h}} = A^{-1}\left(\frac{\tilde{w}_H}{1-\alpha}\right)^{1-\alpha}\left(\frac{\tilde{w}_L}{\alpha}\right)^{\alpha}$$

And:

$$\frac{p_h}{p_{\tilde{h}}} = \left(\frac{w_{RW}}{\tilde{w}_{RW}}\right)^{1-\alpha}\left(\frac{\omega}{\underline{w}}\right)^{\alpha}\left(\frac{\underline{w}}{\tilde{w}_L}\right) \qquad \text{(D1)}$$

Proof: $\frac{p_h}{p_{\tilde{h}}} = \left(\frac{w_H}{\tilde{w}_H}\right)^{1-\alpha}\left(\frac{\omega}{\tilde{w}_L}\right)^{\alpha} = \left(\frac{w_H}{\tilde{w}_H}\right)^{1-\alpha}\left(\frac{\tilde{w}_L}{\underline{w}}\frac{\underline{w}}{\omega}\right)^{-\alpha}\left(\frac{\tilde{w}_L}{\underline{w}}\right)\left(\frac{\underline{w}}{\tilde{w}_L}\right) = \left(\frac{w_{RW}}{\tilde{w}_{RW}}\right)^{1-\alpha}\left(\frac{\omega}{\underline{w}}\right)^{\alpha}\left(\frac{\underline{w}}{\tilde{w}_L}\right)$

Unskilled Labour demands

From the non-tradable sectors. Because of zero profit, and as the total of unskilled labour is employed in sector *nt* in Germany. Hence:

Germany $\quad \underline{w}L_{nt} = p_{nt}Y_{nt} \Rightarrow L_{nt} = \gamma_{nt} I / \underline{w}$

Eurother $\quad \tilde{L}_{nt} = \gamma_{nt}\tilde{I} / \tilde{w}_L$

From the sector of skill-intensive goods. Because of the Cobb-Douglas technology and relations (2) and (3):

$$\tilde{L}_{\tilde{h}} = \frac{\alpha p_{\tilde{h}}\tilde{Y}_{\tilde{h}}}{\tilde{w}_L} = \frac{\alpha\gamma_h I_W}{\tilde{w}_L p_{\tilde{h}}^{\sigma-1}\left(a^{\sigma} p_h^{1-\sigma} + p_{\tilde{h}}^{1-\sigma}\right)}$$

Total demand for L in each Eurozone country

In Germany, $L_{RW} = L_{nt}$. Hence:

$$L_{RW} = \frac{\gamma_{nt}}{1-\gamma_{nt}} w_{RW}\bar{H} \qquad \text{(D2)}$$

Proof: $L_{RW} = \frac{\gamma_{nt} I}{\underline{w}} = \gamma_{nt}(L_{RW} + w_{RW}\bar{H}) \Rightarrow L_{RW} = \frac{\gamma_{nt}}{1-\gamma_{nt}} w_{RW}\bar{H}$

We know that $\bar{L} = \frac{\gamma_{nt}}{1-\gamma_{nt}} w_{FO}\bar{H}$ (see Appendix B). Hence, if $w_{FO} > w_{RW}$, then $L_{RW} < \bar{L}$.

In Eurother:

$$\tilde{L}^{-} = \tilde{L}_{\tilde{h}} + \tilde{L}_{nt} = \frac{\alpha\gamma_h I_W}{\tilde{w}_L p_{\tilde{h}}^{\sigma-1}\left(a^{\sigma} p_h^{1-\sigma} + p_{\tilde{h}}^{1-\sigma}\right)} + \gamma_{nt}\frac{\tilde{I}}{\tilde{w}_L} \qquad \text{(D3)}$$

Skill premium in Eurother

As Eurother's firms do not outsource:

$$\tilde{w}_{RW} = \frac{(1-\alpha)(1-\gamma_{nt})}{\alpha + (1-\alpha)\gamma_{nt}} \frac{\bar{\tilde{L}}}{\bar{\tilde{H}}} \qquad \text{(D4)}$$

Balanced trade in the South and determination of I*

Balanced trade of the South allows defining *I** in terms of I and $\tilde{I}$. Let M_i^* be the import of good *i* by the South and X_j^* the South's exports of good *j*. we have:

Imports:

$$M^* = M_h^* + M_{\tilde{h}}^* = \gamma_h I^*$$

Exports:

$$X^* = X_l^* + X_{SL}^*$$

$$X_l^* = \gamma_l(I + \tilde{I})$$

As $w_R > \omega$, segment S_L is fully produced in the South. Hence: $X_{SL}^* = \omega L_{SL}^* = \alpha p_h Y_h$. And since $w_H\bar{H} = (1-\alpha)p_h Y_h$, we have: $X_{SL}^* = \frac{\alpha}{1-\alpha} w_H\bar{H}$. Hence:

$$X^* = X_l^* + X_{SL}^* = \gamma_l(I + \tilde{I}) + \frac{\alpha}{1-\alpha} w_H\bar{H}$$

Balanced trade implies *X** = *M**. By inserting the relations above in this equality:

$$\gamma_h I^* = \gamma_l(I + \tilde{I}) + \frac{\alpha}{1-\alpha} w_H\bar{H} \qquad \text{(D5)}$$

Balanced trade in Eurother and determination of the skill premium w_{RW}

Exports: $\tilde{X} = \tilde{X}_{\tilde{h}} = \frac{\gamma_h(I + I^*)}{a^{\sigma}(p_{\tilde{h}} / p_h)^{\sigma-1} + 1} = \frac{(\gamma_h + \gamma_l)I + \gamma_l\tilde{I} + \frac{\alpha}{1-\alpha} w_H\bar{H}}{a^{\sigma}(p_{\tilde{h}} / p_h)^{\sigma-1} + 1}$

Imports: $\tilde{M} = \tilde{M}_l + \tilde{M}_h = \gamma_l\tilde{I} + \frac{\gamma_h\tilde{I}}{1 + a^{-\sigma}(p_h / p_{\tilde{h}})^{\sigma-1}}$

Balanced trade: $\tilde{X} = \tilde{M} \Rightarrow \frac{(\gamma_h + \gamma_l)I + \gamma_l\tilde{I} + \frac{\alpha}{1-\alpha} w_H\bar{H}}{a^{\sigma}(p_{\tilde{h}} / p_h)^{\sigma-1} + 1} = \gamma_l\tilde{I} + \frac{\gamma_h\tilde{I}}{1 + a^{-\sigma}(p_h / p_{\tilde{h}})^{\sigma-1}}$

$$\Leftrightarrow \frac{(\gamma_h+\gamma_l)I+\gamma_l\tilde{I}+\frac{\alpha}{1-\alpha}w_H\bar{H}}{a^\sigma(p_{\tilde{h}}/p_h)^{\sigma-1}+1}=\gamma_l\tilde{I}+\frac{a^\sigma(p_{\tilde{h}}/p_h)^{\sigma-1}\gamma_h\tilde{I}}{a^\sigma(p_{\tilde{h}}/p_h)^{\sigma-1}+1}$$

$$\Leftrightarrow (\gamma_h+\gamma_l)I+\gamma_l\tilde{I}+\frac{\alpha}{1-\alpha}w_H\bar{H}=\left(a^\sigma(p_{\tilde{h}}/p_h)^{\sigma-1}+1\right)\gamma_l\tilde{I}+a^\sigma(p_{\tilde{h}}/p_h)^{\sigma-1}\gamma_h\tilde{I}$$

$$\Leftrightarrow (\gamma_h+\gamma_l)I+\frac{\alpha}{1-\alpha}w_H\bar{H}=a^\sigma(p_{\tilde{h}}/p_h)^{\sigma-1}(\gamma_h+\gamma_l)\tilde{I}$$

$$\Leftrightarrow I=a^\sigma(p_{\tilde{h}}/p_h)^{\sigma-1}\tilde{I}-\frac{\alpha}{(1-\alpha)(\gamma_h+\gamma_l)}w_H\bar{H}$$

By inserting $I=\underline{w}L+w_H\bar{H}$ and $\tilde{I}=\tilde{w}_L\bar{\bar{L}}+\tilde{w}_H\bar{\bar{H}}$:

$$\underline{w}L+w_H\bar{H}=a^\sigma(p_{\tilde{h}}/p_h)^{\sigma-1}(\tilde{w}_L\bar{\bar{L}}+\tilde{w}_H\bar{\bar{H}})-\frac{\alpha}{(1-\alpha)(\gamma_h+\gamma_l)}w_H\bar{H}$$

$$L+w_{RW}\bar{H}=a^\sigma(p_{\tilde{h}}/p_h)^{\sigma-1}(\bar{\bar{L}}+\tilde{w}_{RW}\bar{\bar{H}})\frac{\tilde{w}_L}{\underline{w}}-\frac{\alpha}{(1-\alpha)(1-\gamma_{nt})}w_{RW}\bar{H}$$

Inserting $\frac{p_{\tilde{h}}}{p_h}=\left(\frac{\tilde{w}_{RW}}{w_{RW}}\right)^{1-\alpha}\left(\frac{\underline{w}}{\omega}\right)^{\alpha}\left(\frac{\tilde{w}_L}{\underline{w}}\right)$ and $L=\frac{\gamma_{nt}}{1-\gamma_{nt}}w_{RW}\bar{H}$:

$$w_{RW}\bar{H}=a^\sigma(1-\alpha)(1-\gamma_{nt})\left(\frac{\tilde{w}_{RW}}{w_{RW}}\right)^{(1-\alpha)(\sigma-1)}\left(\frac{\underline{w}}{\omega}\right)^{\alpha(\sigma-1)}\left(\frac{\tilde{w}_L}{\underline{w}}\right)^{\sigma}(\bar{\bar{L}}+\tilde{w}_{RW}\bar{\bar{H}})$$

$$w_{RW}{}^{(1-\alpha)\sigma+\alpha}\bar{H}=a^\sigma(1-\alpha)(1-\gamma_{nt})\tilde{w}_{RW}{}^{(1-\alpha)(\sigma-1)}\left(\frac{\underline{w}}{\omega}\right)^{\alpha(\sigma-1)}\left(\frac{\tilde{w}_L}{\underline{w}}\right)^{\sigma}(\bar{\bar{L}}+\tilde{w}_{RW}\bar{\bar{H}})$$

Inserting $\tilde{w}_{RW}=\frac{(1-\alpha)(1-\gamma_{nt})}{\alpha+(1-\alpha)\gamma_{nt}}\frac{\bar{\bar{L}}}{\bar{\bar{H}}}$:

$$w_{RW}=a^{\frac{\sigma}{(1-\alpha)\sigma+\alpha}}\frac{(1-\alpha)(1-\gamma_{nt})}{\alpha+(1-\alpha)\gamma_{nt}}\frac{\bar{\bar{L}}}{\bar{\bar{H}}}\left(\frac{\bar{\bar{H}}}{\bar{H}}\right)^{\frac{1}{(1-\alpha)\sigma+\alpha}}\left(\frac{\underline{w}}{\omega}\right)^{\frac{\alpha(\sigma-1)}{(1-\alpha)\sigma+\alpha}}\left(\frac{\tilde{w}_L}{\underline{w}}\right)^{\frac{\sigma}{(1-\alpha)\sigma+\alpha}} \qquad \text{(D6)}$$

Remember than: $w_{PO}=a^{\frac{\sigma}{(1-\alpha)\sigma+\alpha}}\frac{(1-\alpha)(1-\gamma_{nt})}{\alpha+(1-\alpha)\gamma_{nt}}\frac{\bar{\bar{L}}}{\bar{\bar{H}}}\left(\frac{\bar{\bar{H}}}{\bar{H}}\right)^{\frac{1}{(1-\alpha)\sigma+\alpha}}\left(\frac{\omega}{\tilde{w}_L}\right)^{-\frac{\sigma}{(1-\alpha)\sigma+\alpha}}$

So: $w_{RW}<w_{PO}\Leftrightarrow\left(\frac{\underline{w}}{\omega}\right)^{\frac{\alpha(\sigma-1)}{(1-\alpha)\sigma+\alpha}}\left(\frac{\tilde{w}_L}{\underline{w}}\right)^{\frac{\sigma}{(1-\alpha)\sigma+\alpha}}<\left(\frac{\tilde{w}_L}{\omega}\right)^{-\frac{\sigma}{(1-\alpha)\sigma+\alpha}}\Leftrightarrow\underline{w}>\omega$, which is true by definition of $\underline{w}$.

Result D1: *Assume a reservation wage* $\underline{w}$ *such that* $\underline{w}>\omega$ *and* $\underline{w}>w_L^{FO}$. *Then, the German skill premium with reservation wage is lower than the skill premium without.*

Proof. Because $w_{RW}<w_{PO}$.

Result D2: *The German skill premium* w_{RW} *decreases with both the reservation wage* $\underline{w}$ *and the offshore production cost* ω .

Proof. Because $\frac{\partial w_{RW}}{\partial \underline{w}} < 0$ and $\frac{\partial w_{RW}}{\partial \omega} < 0$.

Result D3. *Assume a reservation wage* $\underline{w}$ *such that* $\underline{w} > \omega$ *and* $\underline{w} > w_L^{FO}$. *Then, there is unemployment of the German unskilled workers, and unemployment increases with the reservation wage* $\underline{w}$ *and decreases with the decrease in* ω.

Proof. $w_{PO} < w_{FO}$ because $\omega_{FO} < \omega_{PO}$, $\partial w_{PO} / \partial \omega < 0$ and $w_{PO} = w_{FO}$ for $\omega = \omega_{FO}$.
We know that if $w_{FO} > w_{RW}$, then $L_{RW} < \bar{L}$. As $w_{RW} < w_{PO}$ and $w_{PO} < w_{FO}$, then $w_{FO} > w_{RW}$ and finally $L_{RW} < \bar{L}$. In addition, as $L_{RW} = \frac{\gamma_{nt}}{1-\gamma_{nt}} w_{RW} \bar{H}$, we have $\frac{\partial L_{RW}}{\partial w_{RW}} > 0$ and $\frac{\partial U}{\partial w_{RW}} < 0$ with $U = \bar{L} - L_{RW}$, and thus $\frac{\partial U}{\partial \underline{w}} > 0$ and $\frac{\partial U}{\partial \omega} > 0$ because $\frac{\partial w_{RW}}{\partial \underline{w}} < 0$ and $\frac{\partial w_{RW}}{\partial \omega} < 0$.

Remark:

$$\frac{w_{RW}}{\tilde{w}_{RW}} = a^{\frac{\sigma}{(1-\alpha)\sigma+\alpha}} \left(\frac{\tilde{\bar{H}}}{\bar{H}} \right)^{\frac{1}{(1-\alpha)\sigma+\alpha}} \left(\frac{\underline{w}}{\omega} \right)^{\frac{\alpha(\sigma-1)}{(1-\alpha)\sigma+\alpha}} \left(\frac{\tilde{w}_L}{\underline{w}} \right)^{\frac{\sigma}{(1-\alpha)\sigma+\alpha}} \qquad \text{(D7)}$$

The German Exports/Income ratio (x = X/I)

Firstly consider the moment when the declining offshore production cost attains the German reservation wage, i.e., $\omega = \underline{w}$. At that time, there is a one-shot relocation to the South of the portion of segment S_L still produced in Germany. At the moment of this jump, the wages, and thus the prices, remain unchanged. In contrast, (i) Germany's total income decreases because the unskilled labour formerly utilised in the production of S_L becomes unemployed, (ii) the income of the South increase because of the relocation of S_L in this country. Finally, the German exports of *h* increase[8] (because of the income-driven increase in the demand from the South) and trade is balanced by the increase the German imports of segment S_L. Consequently, both the decrease in the German income and the increase in German exports raise the Exports/Income ratio. Hence:

Result D4. *When the declining offshore production cost* ω *attains the German reservation wage* $\underline{w}$ *, there is a downward jump of the Exports/Income ratio in Germany.*

We now calculate ratio *x = X/I* so as to study its behaviour, (i) once the whole of segment S_L has been offshored because of the reservation wage, and (ii) when the German government set a labour market reform that lessens the reservation wage.

[8] Note that the import-content of German exports increases because segment S_L is now fully offshored.

$$X = X_h = \frac{\gamma_h(\tilde{I} + I^*)}{1 + a^{-\sigma}(p_h / p_{\tilde{h}})^{\sigma-1}}$$

$$\gamma_h I^* = \gamma_l(I + \tilde{I}) + \frac{\alpha}{1-\alpha} w_H \bar{H} \Rightarrow x = \frac{X}{I} = \frac{(1-\gamma_{nt})\tilde{I}/I + \gamma_l + \frac{\alpha}{1-\alpha} w_H \bar{H}/I}{1 + a^{-\sigma}(p_h / p_{\tilde{h}})^{\sigma-1}}$$

$$x = \frac{(1-\gamma_{nt})\dfrac{\bar{\bar{L}} + \tilde{w}_{RW}\bar{\bar{H}}}{L + w_{RW}\bar{H}}\dfrac{\tilde{w}_L}{\underline{w}} + \gamma_l + \dfrac{\alpha}{1-\alpha}\dfrac{w_{RW}\bar{H}}{L + w_{RW}\bar{H}}}{1 + a^{-\sigma}(p_h / p_{\tilde{h}})^{\sigma-1}}$$

As $L = \dfrac{\gamma_{nt}}{1-\gamma_{nt}} w_{RW}\bar{H}$: $\qquad x = (1-\gamma_{nt})\dfrac{(1-\gamma_{nt})\dfrac{\bar{\bar{L}} + \tilde{w}_{RW}\bar{\bar{H}}}{w_{RW}\bar{H}}\dfrac{\tilde{w}_L}{\underline{w}} + \dfrac{\gamma_l}{1-\gamma_{nt}} + \dfrac{\alpha}{1-\alpha}}{1 + a^{-\sigma}(p_h / p_{\tilde{h}})^{\sigma-1}}$

As $\left(\dfrac{p_h}{p_{\tilde{h}}}\right)^{\sigma-1} = \left(\dfrac{w_{RW}}{\tilde{w}_{RW}}\right)^{(1-\alpha)(\sigma-1)} \left(\dfrac{\omega}{\underline{w}}\right)^{\alpha(\sigma-1)} \left(\dfrac{\underline{w}}{\tilde{w}_L}\right)^{\sigma-1}$ (D1):

$$x = (1-\gamma_{nt})\frac{(1-\gamma_{nt})\dfrac{\bar{\bar{L}} + \tilde{w}_{RW}\bar{\bar{H}}}{w_{RW}\bar{H}}\dfrac{\tilde{w}_L}{\underline{w}} + \dfrac{\gamma_l}{1-\gamma_{nt}} + \dfrac{\alpha}{1-\alpha}}{1 + a^{-\sigma}\left(\dfrac{w_{RW}}{\tilde{w}_{RW}}\right)^{(1-\alpha)(\sigma-1)}\left(\dfrac{\omega}{\underline{w}}\right)^{\alpha(\sigma-1)}\left(\dfrac{\underline{w}}{\tilde{w}_L}\right)^{\sigma-1}}$$

$$x = (1-\gamma_{nt})\frac{(1-\gamma_{nt})\dfrac{\bar{\bar{L}} + \tilde{w}_{RW}\bar{\bar{H}}}{w_{RW}\bar{H}} + \left(\dfrac{\gamma_l}{1-\gamma_{nt}} + \dfrac{\alpha}{1-\alpha}\right)\dfrac{\underline{w}}{\tilde{w}_L}}{\dfrac{\underline{w}}{\tilde{w}_L} + a^{-\sigma}\left(\dfrac{w_{RW}}{\tilde{w}_{RW}}\right)^{(1-\alpha)(\sigma-1)}\left(\dfrac{\omega}{\underline{w}}\right)^{\alpha(\sigma-1)}\left(\dfrac{\underline{w}}{\tilde{w}_L}\right)^{\sigma}}$$

As $\dfrac{w_{RW}}{\tilde{w}_{RW}} = a^{\frac{\sigma}{(1-\alpha)\sigma+\alpha}}\left(\dfrac{\bar{\bar{H}}}{\bar{H}}\right)^{\frac{1}{(1-\alpha)\sigma+\alpha}}\left(\dfrac{\underline{w}}{\omega}\right)^{\frac{\alpha(\sigma-1)}{(1-\alpha)\sigma+\alpha}}\left(\dfrac{\tilde{w}_L}{\underline{w}}\right)^{\frac{\sigma}{(1-\alpha)\sigma+\alpha}}$ and thus

$\left(\dfrac{w_{RW}}{\tilde{w}_{RW}}\right)^{(1-\alpha)(\sigma-1)} = a^{\frac{\sigma(1-\alpha)(\sigma-1)}{(1-\alpha)\sigma+\alpha}}\left(\dfrac{\bar{\bar{H}}}{\bar{H}}\right)^{\frac{(1-\alpha)(\sigma-1)}{(1-\alpha)\sigma+\alpha}}\left(\dfrac{\underline{w}}{\omega}\right)^{\frac{\alpha(\sigma-1)(1-\alpha)(\sigma-1)}{(1-\alpha)\sigma+\alpha}}\left(\dfrac{\tilde{w}_L}{\underline{w}}\right)^{\frac{\sigma(1-\alpha)(\sigma-1)}{(1-\alpha)\sigma+\alpha}}$ (D7):

$$x = (1-\gamma_{nt})\frac{(1-\gamma_{nt})\left(\dfrac{\bar{\bar{L}}}{w_{RW}\bar{H}} + \dfrac{\tilde{w}_{RW}}{w_{RW}}\right) + \left(\dfrac{\gamma_l}{1-\gamma_{nt}} + \dfrac{\alpha}{1-\alpha}\right)\dfrac{\underline{w}}{\tilde{w}_L}}{\dfrac{\underline{w}}{\tilde{w}_L} + a^{-\frac{\sigma}{(1-\alpha)\sigma+\alpha}}\left(\dfrac{\bar{\bar{H}}}{\bar{H}}\right)^{\frac{(1-\alpha)(\sigma-1)}{(1-\alpha)\sigma+\alpha}}\left(\dfrac{\omega}{\underline{w}}\right)^{\frac{\alpha(\sigma-1)}{(1-\alpha)\sigma+\alpha}}\left(\dfrac{\underline{w}}{\tilde{w}_L}\right)^{\frac{\sigma}{(1-\alpha)\sigma+\alpha}}}$$

$$x = (1-\gamma_{nt})\frac{(1-\gamma_{nt})\left(\dfrac{\bar{\bar{L}}}{w_{RW}\bar{H}} + a^{-\frac{\sigma}{(1-\alpha)\sigma+\alpha}}\left(\dfrac{\bar{H}}{\bar{\bar{H}}}\right)^{\frac{1}{(1-\alpha)\sigma+\alpha}}\left(\dfrac{\omega}{\underline{w}}\right)^{\frac{\alpha(\sigma-1)}{(1-\alpha)\sigma+\alpha}}\left(\dfrac{\underline{w}}{\tilde{w}_L}\right)^{\frac{\sigma}{(1-\alpha)\sigma+\alpha}}\right) + \left(\dfrac{\gamma_l}{1-\gamma_{nt}} + \dfrac{\alpha}{1-\alpha}\right)\dfrac{\underline{w}}{\tilde{w}_L}}{\dfrac{\underline{w}}{\tilde{w}_L} + a^{-\frac{\sigma}{(1-\alpha)\sigma+\alpha}}\left(\dfrac{\bar{\bar{H}}}{\bar{H}}\right)^{\frac{(1-\alpha)(\sigma-1)}{(1-\alpha)\sigma+\alpha}}\left(\dfrac{\omega}{\underline{w}}\right)^{\frac{\alpha(\sigma-1)}{(1-\alpha)\sigma+\alpha}}\left(\dfrac{\underline{w}}{\tilde{w}_L}\right)^{\frac{\sigma}{(1-\alpha)\sigma+\alpha}}}$$

As $w_{RW} = a^{\frac{\sigma}{(1-\alpha)\sigma+\alpha}} \frac{(1-\alpha)(1-\gamma_{nt})}{\alpha+(1-\alpha)\gamma_{nt}} \frac{\bar{\tilde{L}}}{\bar{\tilde{H}}} \left(\frac{\bar{\tilde{H}}}{\bar{H}}\right)^{\frac{1}{(1-\alpha)\sigma+\alpha}} \left(\frac{\underline{w}}{\omega}\right)^{\frac{\alpha(\sigma-1)}{(1-\alpha)\sigma+\alpha}} \left(\frac{\tilde{w}_L}{\underline{w}}\right)^{\frac{\sigma}{(1-\alpha)\sigma+\alpha}}$ (D6) and since $1+(1-\alpha)(\sigma-1) = (1-\alpha)\sigma+\alpha$:

$$x = (1-\gamma_{nt}) \frac{a^{-\frac{\sigma}{(1-\alpha)\sigma+\alpha}} \left(\frac{\omega}{\underline{w}}\right)^{\frac{\alpha(\sigma-1)}{(1-\alpha)\sigma+\alpha}} \left(\frac{\underline{w}}{\tilde{w}_L}\right) \left(\frac{\alpha}{1-\alpha} + \gamma_{nt} + (1-\gamma_{nt}) \left(\frac{\bar{H}}{\bar{\tilde{H}}}\right)\right) + \left(\frac{\gamma_l(1-\alpha)+\alpha(1-\gamma_{nt})}{(1-\alpha)(1-\gamma_{nt})}\right)}{1+a^{-\frac{\sigma}{(1-\alpha)\sigma+\alpha}} \left(\frac{\omega}{\underline{w}}\right)^{\frac{\alpha(\sigma-1)}{(1-\alpha)\sigma+\alpha}} \left(\frac{\underline{w}}{\tilde{w}_L}\right)}$$

Let us denote $g = a^{-\frac{\sigma}{(1-\alpha)\sigma+\alpha}} \left(\frac{\omega}{\underline{w}}\right)^{\frac{\alpha(\sigma-1)}{(1-\alpha)\sigma+\alpha}} \left(\frac{\underline{w}}{\tilde{w}_L}\right) = a^{-\frac{\sigma}{(1-\alpha)\sigma+\alpha}} \left(\frac{\omega}{\tilde{w}_L}\right)^{\frac{\alpha(\sigma-1)}{(1-\alpha)\sigma+\alpha}} \left(\frac{\underline{w}}{\tilde{w}_L}\right)^{2\frac{(1/2-\alpha)\sigma+\alpha}{(1-\alpha)\sigma+\alpha}}$

Analysis of function g

We have: $\partial g / \partial(\omega / \underline{w}) > 0$, $\partial g / \partial \omega > 0$.
In contrast, the impact of $\underline{w}$ upon g is not straightforward:

a) If $\alpha < 1/2 \Rightarrow 2\frac{(1/2-\alpha)\sigma+\alpha}{(1-\alpha)\sigma+\alpha} > 0 \Rightarrow \frac{\partial g}{\partial\left(\underline{w} / \tilde{w}_L\right)} > 0$

b) If $\alpha > 1/2 \Rightarrow$ (i) $\frac{\partial g}{\partial\left(\underline{w} / \tilde{w}_L\right)} > 0$ if $(1/2-\alpha)\sigma+\alpha > 0 \Leftrightarrow \sigma < \frac{\alpha}{\alpha-1/2}$, and

(ii) $\frac{\partial g}{\partial\left(\underline{w} / \tilde{w}_L\right)} < 0$ if $(1/2-\alpha)\sigma+\alpha < 0 \Leftrightarrow \sigma > \frac{\alpha}{\alpha-1/2}$

Note that, for plausible values of α and σ, we are typically in the case $\frac{\partial g}{\partial\left(\underline{w} / \tilde{w}_L\right)} > 0$. As a matter of fact we have $\frac{\alpha}{\alpha-1/2} > 2$, and $\frac{\alpha}{\alpha-1/2} > 2$ is typically very high for plausible values of α (note that normally α is close to ½).

Analysis of function $x(g)$

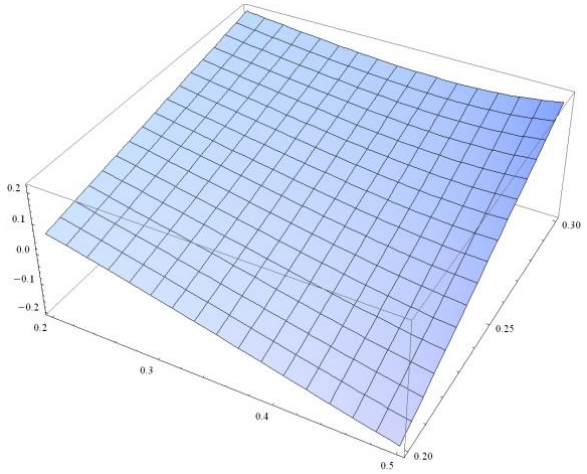
$$x(g) = (1-\gamma_{nt}) \frac{g\left(\frac{\alpha}{1-\alpha} + \gamma_{nt} + (1-\gamma_{nt})\left(\frac{\bar{H}}{\bar{\tilde{H}}}\right)\right) + \frac{\gamma_l}{1-\gamma_{nt}} + \frac{\alpha}{1-\alpha}}{1+g}$$

$$\frac{\partial x}{\partial g} = (1-\gamma_{nt}) \frac{(1+g)\left(\frac{\alpha}{1-\alpha} + \gamma_{nt} + (1-\gamma_{nt})\left(\frac{\bar{H}}{\bar{\tilde{H}}}\right)\right) - g\left(\frac{\alpha}{1-\alpha} + \gamma_{nt} + (1-\gamma_{nt})\left(\frac{\bar{H}}{\bar{\tilde{H}}}\right)\right) - \frac{\gamma_l}{1-\gamma_{nt}} - \frac{\alpha}{1-\alpha}}{1+g}$$

$$\partial x / \partial g = (1-\gamma_{nt}) \frac{\gamma_{nt} + (1-\gamma_{nt})\left(\frac{\bar{H}}{\bar{\tilde{H}}}\right) - \frac{\gamma_l}{1-\gamma_{nt}}}{1+g}$$

$$\partial x / \partial g > 0 \Leftrightarrow (1-\gamma_{nt})\left(\frac{\bar{H}}{\bar{\tilde{H}}}\right) > \frac{\gamma_l}{1-\gamma_{nt}} - \gamma_{nt} \Leftrightarrow \frac{\bar{H}}{\bar{\tilde{H}}} > \frac{\gamma_l - \gamma_{nt} + \gamma_{nt}^2}{\left(1-\gamma_{nt}\right)^2} = \frac{\gamma_l}{(1-\gamma_{nt})^2} - \frac{\gamma_{nt}}{1-\gamma_{nt}}$$

It can be noted that for plausible values of the couple (γ_l, γ_{nt}), i.e. for $(\gamma_l, \gamma_{nt}) \in \{[0.2, 0.3] \times [0.2, 0.5]\}$, the value $\frac{\gamma_l}{(1-\gamma_{nt})^2} - \frac{\gamma_{nt}}{1-\gamma_{nt}}$ belongs to $[-0.2, +0.22]$, as shown in the figure below:



As $\frac{\bar{H}}{\tilde{\bar{H}}}$ is clearly higher than 0.22, then $\partial x / \partial g > 0$.

1) $\partial x / \partial g > 0$ and $\partial g / \partial \omega > 0 \Rightarrow \partial x / \partial \omega > 0$ a decrease in the offshore production cost ω lessens the export/Income ratio.

2) $\partial x / \partial g > 0$ and $\frac{\partial g}{\partial (\underline{w} / \tilde{w}_L)} > 0 \Rightarrow \frac{\partial x}{\partial (\underline{w} / \tilde{w}_L)} > 0$ an increase in the reservation wage increases the ratio x and a decrease in the reservation wage decreases it.
Hence:

Result D5. *Assume a reservation wage* $\underline{w}$ *such that* $\underline{w} > \omega$ *and* $\underline{w} > w_L^{FO}$. *Then:*

1) *The decrease in* ω *lowers the ratio of exports on GDP in Germany.*
2) *A decrease in the reservation wage due to a labour market reform also lessens the ratio of exports on GDP.*