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External income, De-industrialisation and Labour Mobility

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Abstract

Relaxing the assumption of fixed labour in a general equilibrium model studying the impact of resource income on the allocation of labour across sectors offers insights on how labour mobility may mitigate adverse effects such as de-industrialisation caused by resource income. The theoretical model suggests clear signs of the impact of labour (downward) and the resource income (upward) on the relative size of the service sector. Indirect effects are visible through the interactions of both variables on each other. The model is estimated in a fixed effect panel model, which offers support to the model's direct and indirect effects.

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1 Introduction

The research area on Dutch disease has continued to attract interest and has resulted in a vast literature on the topic. The phenomenon may be summarized by two effects following a real income shock coming from a booming sector or external revenues: firstly, de-industrialisation through a decline of the tradable sector against a non-tradable sector, secondly, a real appreciation, as seen in an increase in the price of non-tradable goods in terms of tradable goods. Aside from the special distinction of tradable versus non-tradable goods, some critical assumptions are needed in order to obtain the results as given above: firstly, a fixed labor force while perfect labour mobility within a country between sectors, secondly, some form of immobile capital including between sectors within a country. The first assumption assures that income spent on both goods will increase the marginal product of labor in the non-tradable sector so that labor moves accordingly to that sector. The second makes sure that prices are not fully determined by exogenous factors but are a function of demand too. Most studies in the research hold on to at least the first (fixed labor) assumption, and some to the second (inperfect capital mobility). Early papers on the issue already note that international labour migration might mitigate the phenomenon (Corden, 1984) or

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even transmit the effect (Wahba, 1998). Nonetheless, not many other studies consider this aspect in this context thoroughly.

This paper aims to contribute to existing literature by exploring the role of labour mobility in the context of de-industrialisation en Dutch disease. This is done firstly, by extending a conventional general equilibrium model with non-constant labour and deriving the implications of labour force growth relative to an income shock. Secondly, the model is empirically tested against a panel of developed countries. The theoretical model is derived in such a way to express the share of labour in the service sector as a function of exogenous variables. It shows that an external resource works as an upward force, while labour growth as a downward force on the share of service sector employment aside from the effect of the sectors' relative productivities. The equilibrium condition is tested on a panel of 20 developed countries over 18 years (1990-2008) whenever the data allows. The findings remain to hold at smaller time spans. The data offers support to the model by showing the opposing effects of external income and labour mobility on service sector employment and their interaction shows that once there is a sectoral boom its effects on de-industrialisation is diminished in presence of a positive labour immigration.

1.1 Literature

The seminal work on booming sectors and de-industrialisation is by Corden and Neary (1982). This early work is still of interest because the model set up is on the one hand more specific, for instance by explicitly modelling a third sector (energy) that experiences a boom, and on the other hand poses less restrictions on production and consumption relations compared with more recent work. Additionally, in a follow up work, Corden (1984) mentions briefly that international labour migration may have a mitigating effect on the results found in the previous work.[1]

In another direction, Palma (2008) related Dutch disease to structural change literature that looks at relative output or employment of sectors in the economy over the course of general economic development. The study shows that countries that experience an extensive commodity export boom are subject to a faster and earlier de-industrialisation relative to countries that have not experienced such boom. This paper fits in that context as it derives and tests an explicit function of the service sector employment that are comparable to the test exercised by Rowthorn and Ramaswamy (1999).

Sachs and Warner (1999, 2001) model and test for the impact of external resource income on economic growth to give a better idea to what extend titles such as "Dutch disease" and "resource curse" are appropriate. The way of modeling the external resource is more simplistic to those earlier attempts because the focus lay on economic growth, and thus one could abstain from distinguishing between sectoral developments. This literature coincided with the interest that economics of growth drew and resulted in a large literature on the topic, of which a survey has come available recently (Frankel, 2010).

[1] In fact, it is possible to relax the assumption of a fixed labour force in their model. The result of such an exercise will find that capital income is shifted more towards the energy sector, while wage increases are diminishing with labour growth.

This paper does not model economic growth and abstains from modelling the booming sector, but uses the external income variable, while following an industry and service sector explicitly.

Recent studies have emphasized that external income can be regarded more broadly than resource exports and empirical tests have shown that income in the form of foreign aid (see for instance McKinley, 2005; Prati and Tressel, 2006; Arellano et al., 2009) and remittances (for instance Lartey et al., 2008; Loser et al., 2006) have effects that resemble income streams from a sector such as gas and oil exploration. Finally, migration issues, including remittances, have attracted much attention, yet despite this fact general equilibrium or other macro models often maintain an assumption of a fixed labour force. However, some exercises are available, mostly in a dynamic business cycle framework (Braun, 1993; Mandelman and Zlate, 2008; Klein and Ventura, 2009).

The relevance of the assumption of fixed labor is important. The increase of wages that follows from a booming sector gives a natural incentive for workers to move towards the region that experiences rapid economic development. Previous studies have discussed this effect and in some countries the process is central to the economic policy. For instance, Beine et al. (2009) note the inter-regional migration that occurred with the development of Canada's oil tar sands in a relatively sparsely populated area. In Europe, the decision by the Luxembourg government to facilitate the development of a financial industry and host European institutions have substantially altered the structure of Luxembourg's economy. Currently, Luxembourg attracts a massive amount of foreign commuters from the border region of Germany, France and Belgium as well as its large population of high skilled foreigners working in the financial services industry and European Union institutions (Banque Central de Luxembourg, 2009). Finally, Merrien and Becker (2005) discuss how Switzerland actively uses labor policy to regulate the flow of foreign migrants from places such as Italy, Spain and Portugal in order to control domestic price levels while ensuring that domestic workers continue to earn high wages and the unemployment rate remains low.

The remainder of the paper is divided in three parts. Section 2 builds up a general equilibrium model that derives the effect of labor growth and external resource income on the sectoral allocation of labour. The result is used as the baseline for the empirical estimations. Section 3 empirically tests the model's predictions. Finally, the last section summarizes and concludes.

2 Model

2.1 Firms

The model will follow a typical general equilibrium setup such as proposed in Obstfeld and Rogoff (1996, Chapter 4). There are two representative firms that have Cobb-Douglas technology, producing in a

perfectly competitive market. One good is internationally traded, the other is not.

$$\begin{aligned} Y_i &= p_i A_i K_i^{\alpha_i} (n_i L)^{1-\alpha_i}, \quad i = N, T, \\ & n_T + n_N = 1, \\ & \alpha_i \leq 1. \end{aligned} \tag{1}$$

With N for non-traded and T for traded. Typically the non-traded good is seen as services, the traded good as manufacturing. Both sectors have their own capital stock, K_i, and total factor productivity variable, A_i. The share of labor in either sector is given by n_i. The total labor force is exogenous but not constant. The fact that those shares add up to one reflects that there is no explicitly modeled third sector from which additional income might come, as was set out in the model discussed of Corden and Neary (1982), or that this sector does not require any labor to produce its income. Capital is perfectly mobile between sectors and internationally, labour is mobile between sectors but it's overall growth is hold exogenous.

2.2 Households

Aggregate consumption is modeled assuming homothetic preferences so that the level of income does not change the share of income used for either product nor with the size of the population.

$$\begin{aligned} U &= \left[\gamma^{1/\theta} (C_T)^{\theta-1/\theta} + (1-\gamma)^{1/\theta} (C_N)^{\theta-1/\theta}\right]^{\theta/\theta-1} \\ & 0 \leq \gamma \leq 1, \ \theta \geq 0, \end{aligned} \tag{2}$$

with budget constraint,

$$Z = C_T + pC_N = wL + r(Q + R). \tag{3}$$

non-tradable consumption is measured in terms of tradables, which have a normalized price of one, so that throughout the model $p = p_N$ and $p_T = 1$. The parameters γ and θ define the choice between traded and non-traded goods in the utility function, where θ is the elasticity of substitution between the two goods. The budget Z is further defined by income and endowments, where w is the wage and r the interest rate. Q represents the total capital owned by citizens, both domestically and abroad.[2] Q will be held fixed throughout so that any changes in the domestic capital ownership are offset by foreign ownership.

R represents the exogenous resource capital which is assumed to earn an income equal to the interest rate. It is not modeled as a separate sector that requires labor input, but rather as "free-money". This

[2]The capital owned, that which is in the budget constraint, is not automatically equal to the sum of capital that appears in the production functions. Capital in the budget constraint might be located abroad, while the capital used in the sectors might be owned by foreigners. One way to solve for this in the budget constraint is through the following specification

$$Q = B + \kappa(K_T + K_N)$$

So that κ is the fraction of domestic productive capital owned at home, while B is the net foreign asset position which includes productive capital located abroad.

much more limited view is a convenient short-cut that summarizes the income from which ever source it comes. R is very general and under the assumption that it is fully exogenously determined may capture anything from easily produced and highly valued commodities to remittances and foreign aid.

2.3 Equilibrium

To obtain the share of employment in either sector, rewrite (1) as

$$\begin{aligned} n_i &= \frac{Y_i}{p_i A_i k_i^{\alpha_i} L}, \\ & k_i \equiv \frac{K_i}{n_i L},\ i = N, T. \end{aligned}$$

For convenience n will represent the share of labor in the non-tradable sector and $1-n$ the corresponding part in the tradable sector. Domestic consumption of non-tradable goods equals domestic output,

$$C_N = Y_N. \tag{4}$$

The resulting equation is,

$$n = \frac{C_N}{p A_N k_N^{\alpha_N} L}. \tag{5}$$

In order to determine how productivity, labor growth and wealth changes affect the equilibrium level of non-tradable employment the task is to express C_N and k_N in terms of exogenous variables and parameters. The first order conditions of (1), and (2) subject to (3), are

$$p_i \alpha_i A_i k_i^{\alpha_i - 1} = r, \tag{6}$$

$$p_i (1-\alpha_i) A_i k_i^{\alpha_i} = w\ i = N, T, \tag{7}$$

$$\frac{\gamma}{1-\gamma}\frac{C_N}{C_T} = p^{-\theta}. \tag{8}$$

Using the budget constraint, the last line can be rewritten as

$$C_N = \frac{Z(1-\gamma)p^{-\theta}}{\gamma + (1-\gamma)p^{1-\theta}}. \tag{9}$$

Price p can be derived by combining (6) and (7),

$$p = \left(\frac{1-\alpha_T}{1-\alpha_N}\right)^{1-\alpha_N} \frac{\alpha_T^{\alpha_T \frac{1-\alpha_N}{1-\alpha_T}}}{\alpha_N^{\alpha_N}} \frac{A_T^{\frac{1-\alpha_N}{1-\alpha_T}}}{A_N} r^{\alpha_N - \frac{\alpha_T(1-\alpha_N)}{1-\alpha_T}}. \tag{10}$$

Forms and adaptions of this equation have been used to test for the Balassa-Samuelson hypothesis, which states that the (long-term) price level in a country is determined by the productivity differential of the two sectors (Asea and Mendoza, 1994; De Gregorio et al., 1994). An increase of tradable productivity increases the price ratio, meaning the number of tradable goods a unit of services can buy. The effect would become more pronounced the higher the capital intensity of the tradable sector relative to non-tradable. The assumption of perfect international and domestic capital mobility makes p independent of

the budget.

The model is now fully defined and it is important to note the role labor plays. The effect of labor will solely be observed in the marginal product of labor and because neither consumption demand, (8) nor prices, (10), are affected by the size of the labor force. The issue of growing or declining labor is completely separate from the consumption decision. This will discard interesting questions such as whether new incoming workers would consume in a different pattern with different preferences relative to the old established workers. Similarly, on the production side there's no distinction between natives and migrants labour productivity.

Rewriting (5) by using (6)-(9) gives

$$n = \left(\frac{(1-\alpha_N)(1-\gamma)p^{1-\theta}}{\gamma+(1-\gamma)p^{1-\theta}}\right)\left(1+\left(\frac{r}{\alpha_T^{\alpha_T}A_T}\right)^{\frac{1}{1-\alpha_T}}\left(\frac{Q+R}{(1-\alpha_T)L}\right)\right). \tag{11}$$

Note that p could be further expressed as a function of parameters and exogenous variables using (10). All parameters and variables are positive. Therefore, the share of non-tradable employment is increasing with wealth $(Q+R)$ and decreasing with labor L.

The first large bracket on the right hand side can be analyzed using the knowledge of the price change following a productivity increase in the tradable sector as given by (10). Assuming an elasticity of substitution smaller than 1, the ratio increases with price, showing an increase of the non-tradable employment with increasing price.[3] However, the term in the second pair of large brackets has an opposite effect with productivity in the tradable sector. The two forces at play here are the preferences of consumption as given by (9) as a function of the price and the wage level given in terms of tradable sector productivity relative to non-tradable productivity. Demand for non-tradable goods rises with a general wealth increase, so that non-tradable employment has to increase. labor growth will decrease the overall marginal product of labor so that the tradable sector can employ a larger share of the labor force.

2.4 Comparative Statics

In order to derive comparative statics it is more convenient to go step by step through the equations (3)-(10) then to crunch (11). Let hatted characters be log differentiated variables, $\hat{x} = \mathrm{d}\log x$. Equation (5), first order conditions, (6), (7) and (9), constraint (3) and finally equilibrium price equation (10) respectively become,[4]

[3] Backus et al. (100, p.305) quote an empirical estimate of tradable to non-tradable elasticity of substitution of -1.27, in the following setup $[\gamma c_T^{\rho} + (1-\gamma)c_N^{\rho}]^{1/\rho}$, so that in the utility function above this results to $\theta = 1/2{,}27 \approx 0.44$. Some other empirical studies on the elasticity of substitution are available in Reinhart and Ostry (1998); Mendoza (1995); Stockman and Tesar (1995). The studies indicate that richer nations have lower elasticity values, which are typically below 1, but not significantly so. Mendoza (1995, p.120) is the only of the three cited studies that exclusively looks at industrial nations and estimates an elasticity of 0.74 with a standard error of 0.44.

[4] $\hat{R} \equiv \frac{\mathrm{d}R}{Q+R}$, in (16), so that the change in the income is measured relative to the entire financial wealth of an economy. This expression is used for easy reference and the only occurrence of a hatted variable which does not express the rate of change from its own level. In (15), the derivation uses an initial value of $p = 1$.

$$\hat{n} = \hat{c}_N - \hat{p} - \alpha\hat{k}_N - \hat{A}_N - \hat{L}, \tag{12}$$

$$0 = \hat{p}_i + \hat{A}_i + (\alpha_i - 1)\hat{k}_i, \tag{13}$$

$$\hat{w} = \hat{p}_i + \hat{A}_i + \alpha_i\hat{k}_i, \tag{14}$$

$$\hat{c}_N = \hat{z} - [\gamma\theta + (1-\gamma)]\hat{p}, \tag{15}$$

$$\hat{z} = \psi_L(\hat{w} + \hat{L}) + \psi_K\hat{R}, \tag{16}$$

$$\hat{p} = \frac{1-\alpha_N}{1-\alpha_T}\hat{A}_T - \hat{A}_N. \tag{17}$$

The first order conditions for production, (13) and (19), are expressed in their general form. However, $\hat{p}_T = 0$ by choice of numeraire. A wage change, which is equal between the two sectors by assumption of full intra-industry labor mobility, can be expressed fully in exogenous variables and parameters by combining (13) and (14) for the tradable sector,

$$\hat{w} = \frac{1}{1-\alpha_T}\hat{A}_T.$$

In (16), ψ_j refers to the share of income of factor $j = K,\ L$ of total income, which is defined as

$$\psi_L = \frac{wL}{wL + r(Q+R)}, \quad \psi_K = \tfrac{r(Q+R)}{wL+r(Q+R)}, \quad \psi_L + \psi_K = 1.$$

In general, these ratios have proved rather stable over time. However, because w, L and R are not constant in the model, the ratios are not constant either. The critical issue here is the exogenous capital R will have the effect that it decreases the labour income share, and increases the capital income share.

Price equation (17) reflects again how price changes will only be subject to changes in productivity.

All those expressions may now be plugged back into the expression for $\hat{n}$, (12), and rewriting

$$\hat{n} = \psi_L\hat{w} + \psi_K\hat{R} - \left(1 + \gamma\theta + (1-\gamma) + \frac{\alpha_N}{1-\alpha_N}\right)\hat{p} - \frac{\alpha_N}{1-\alpha_N}\hat{A}_N - (1-\psi_L)\hat{L}. \tag{18}$$

The Obstfeld and Rogoff (1996, (18) p.224) model is a reduced form of this, notably $\hat{A}_N = \hat{R} = \hat{L} = 0$, while $\hat{w}$ and $\hat{p}$ are expressed in the relevant productivity parameters.

A rise in wages increases the demand for non-tradables and consequently has a positive effect on n, the share of workers in the non-tradable sector. Productivity changes will affect the wage and price together, which will be addressed below. For most conventional values of capital income share, α_N, the elasticity of substitution, θ, and share of tradables in the consumption basket, γ, i.e. each of them positive, there is a negative relation between $\hat{n}$ and $\hat{p}$. The foreign exchange income will increase the non-tradable labor share in a similar fashion as increased wages does.

All together, it is directly observed that an income shock through R shifts labor to the non-tradable

sector. The term relating to $\hat{R}$ may be rewritten as,

$$\psi_K \hat{R} = \frac{r(Q+R)}{wL + r(Q+R)} \frac{\mathrm{d}R}{(Q+R)} = r\frac{\mathrm{d}R}{\mathrm{GNP}},$$

so that the coefficient on the resource wealth change in terms of GNP is equal to its rate of return.[5] Furthermore the expression provides convenient and natural interpretation to measure the resource income flow as a fraction of a country's GNP. Additionally, using (13) and (14) to replace for $\hat{w}$, equation (18) may be further rewritten to,

$$\hat{n} = r\frac{\mathrm{d}R}{\mathrm{GNP}} - (1-\psi_L)\hat{L} - \left(1 + \gamma\theta + (1-\gamma) + \frac{\alpha_N}{1-\alpha_N}\right)\hat{p} + \frac{\psi_L}{1-\alpha_T}\hat{A}_T - \frac{\alpha_N}{1-\alpha_N}\hat{A}_N. \qquad (19)$$

This equation suggests a clear sign for each exogenous variable $\frac{\mathrm{d}R}{\mathrm{GNP}}$, $\hat{L}$, $\hat{p}$, $\hat{A}_T$ and $\hat{A}_N$ on $\hat{n}$. A resource income will have a positive effect. For $\hat{L}$ there is a negative effect on $\hat{n}$. However, the coefficient ψ_L is not a constant parameter but changes with the variables R and L. The term $(1-\psi_L)$ increases with labour force and decreases with the resource income, hence the impact of the labour force growth increases the bigger is the resource income and decreases with newly added labour.

A real exchange appreciation has a negative effect on non-tradables sector employment which comes from the fact that a relative price increase of non-tradables decreases consumption demand for these goods and thus production. Theoretically one could substitute $\hat{p}$ but doing so complicates the interpretation on the productivity variables while increasing the error in later estimations as the relation between the real exchange rate and productivity is empirically not as sharp as (17) suggest.

The signs on the productivity variables are positive for manufacturing and negative for the service sector. These relations follow from the marginal product of labour in either sector which affects the demand for labour negatively if the productivity in the corresponding sector rises. One of the explanations of general de-industrialization of developed economy is the fact that productivity growth in the tradable/manufacturing sector is larger than in the non-tradable/service sector so that manufacturing slowly loses labor against services (Rowthorn and Ramaswamy, 1999; Palma, 1995). Similar to the findings here, Obstfeld and Rogoff (1996, p.224) argue that a correct interpretation is an increasing employment in non-tradable with tradable sector productivity.

In summary, the static general equilibrium model developed here has the interesting finding that there are opposing effects of resource income and labour force growth on the employment growth of the service sector. While a resource income will facilitate de-industrialisation as can be found in previous studies and other models, the potential effect of a labour force growth is often discarded.

[5] GNP is used because the budget constraints following footnote 2 excludes domestically employed capital not own by its citizens while including domestically owned capital employed abroad.

3 Empirics

3.1 Regression models

The equations (17), called Balassa-Samuelson, and (19), called Employment, are tested. The former is used to establish some links with previous literature on the subject. The second is of main interest to this study. In order to test for the predicted effect of income wealth and employment growth on the change of non-tradable employment a fixed effect estimation in log-differences is used. The estimated models can be summarized as follows,

$$\begin{aligned} \Delta \log(P^N_{i,t}/P^T_{i,t}) &= \beta_1 \Delta \log \mathbf{A}_{i,t} + \beta_2 \mathbf{x}_{i,t} + c_i + y_t + u_{it}, & (20) \\ \Delta \log(L^{NT}_{i,t}/L_{i,t}) &= \beta_1 \Delta \log(P^N_{i,t}/P^T_{i,t}) + \beta_2 \Delta \log \mathbf{A}_{i,t} + \beta_3 \Delta R_{i,t} + \beta_4 \Delta \log L_{i,t} \\ &\quad + \beta_5 \mathbf{x}_{i,t} + c_i + y_t + u_{it}, & (21) \end{aligned}$$

With subscripts i for the cross-section, and t for the time, dimension. The first equation shows the construction of the real exchange rate on the left hand side. Δ indicates the first time-difference, $\mathbf{A}$ indicates a vector of productivity, $\mathbf{x}$ a vector of control variables, c_i a country specific effect, y_t a time dummy, and u_{it} the error term. As the structural equation of the model is in log-difference terms, there is no reason not to expect heterogeneity among the cross-section. For this reason a fixed effect estimation in log-differences is estimated rather than a first differences alone. According to (17), the coefficient in (20) should be positive, ideally close to one, on $\frac{1-\alpha^{NT}}{1-\alpha^T}\hat{A}^T - \hat{A}^{NT}$, or when taken apart, positive on A^T and negative on A^{NT}. Employment equation (21) has the employment ratio in the non-tradable sector on the left hand side in log-differences and the real exchange rate and productivity, both in log-differences, on the right hand side. Equation (18) predicts a positive sign on $\hat{A}^T$ and negative on $\hat{A}^{NT}$. The additional terms in (21) are R, an external wealth or resource income flow which is predicted to have a positive sign, and $\hat{L}$, for employment growth which is predicted to have a negative sign.

All models include time dummies as well as the country fixed effects. The combination of both controls is supposed to capture much of the heterogeneity across countries and certain effects that the countries share over time.

3.2 Data

Annual data on productivity, prices and labour shares on a sectoral level are taken from the EUKLEMS database (O'Mahony and Timmer, 2009).[6] The database is a substitute for an older project by the OECD which maintains the STAN/ISDB database. The former attempts to bring data on sectoral production factors together in a more comparable way. Nonetheless the two databases are complementary for many variables. A major advantage of the EUKLEMS database is the supplied total factor productivity index. Previous studies that used the OECD database had to construct their own measure which makes it hard

[6] Freely available at http://www.euklems.net/

to replicate and to extend if the way to calculate productivity is not equal.

The distinction between tradables and non-tradables has been thoroughly discussed in empirical studies, with often converging outcomes (De Gregorio et al., 1994).[7] It implies for the data set at hand that "utilities" (Gas, electricity and water supply), "construction" and "community social and personal services" (education, health, public administration, personal services, etc.) are designated non-tradable, while everything else (Agriculture, mining, manufacturing, financial services, whole sale and hotel restaurants, and transportation) as tradable. A breakdown on more detailed sector is possible but does not change the result. Using the distinction of sectors according to tradability an aggregate is constructed for the measures of productivity, factor shares and price levels. Productivity and prices are given as indices with base year 1995.

A suitable measure for external income flow is required. For the employment regression net commodity exports over GDP is used. This is a compromise as there is no exclusivity of commodities in being the booming sector for the included countries. Other sectors, such as financial services, may just as well be considered in the theoretical framework. On the other hand, commodities includes natural resources often associated as the driving force for Dutch disease dynamics. Secondly, the data is available for the set of countries over the relevant timespan in a harmonized fasion. This data comes from OECD databases on trade.

For labour force growth, data on migration is used. Labour force data does not show much variability over time while it is used to create the independent variable causing an endogeneity issue, further addressed below. Migration on the other hand may be taken as exogenous to the share of the service sector, while it constitutes a clear addition to the labour force and has a larger variability usefull for the estimation. The OECD migration database has measures on the stock of foreign nationals in countries, as well as data on some other related variables such as inflow and outflow of foreigners and acquisitions of nationality. This data is far from perfect as countries tend to either produce one variable of several that are related but not easily merged to create one migration variable for all. For instance stocks based on country of birth are collected by country one, while stocks based on nationality are collected by country 2, but neither provides data of the other measure and the measures are not directly substitutable. The issue is further addressed below. As an alternative, and only available for European countries, a measure of migration from Eurostat used for a robustness test.

Interest rates and government deficit are taken from Thomson Datastream with a variety of underlying sources. For some countries observations on these extra variables are not complete with lacking observations mostly in later years.

In order to get a balanced panel a subset of 20 countries is taken for the period 1995-2005. These

[7] An alternative method on geographical location of business based on Jensen and Kletzer (2006) and applied to the current database is used in Schmillen (2010) and yields essentially the same brake down on the division of sectors. Another study on sectoral productivities and the real exchange rate uses a similar split of sectors (Canzoneri et al., 1999).

include mostly European countries along with the USA, Canada, Australia, Japan and South Korea.[8] The set is diverse with middle income countries next to the most developed countries, net commodity exporters, and countries that have different rates of employment growth and immigration attractiveness. Unfortunately the balanced panel breaks down with the addition of control and other variables in the models.

3.3 Econometric issues

Several issues arise when working with the model and data. Firstly, the theoretical model as set out above determines a equilibrium relation which is not likely to hold year-on-year. One way to address this is to use log-differences over a longer periods, such as two or more years, instead of one. However, implementing such strategies will result in a loss of observations. The results as presented below show that first-difference models do not perform much worse to 2-periods differences and although the size of the coefficients tends to increase with time-span, the signs of the coefficients and the statistical significance levels rarely change.

Secondly, although the theoretical model predicts a linear relation between the variables, some coefficients are not constant in the theoretical model. For this reason as well as the possibility of measurement errors and the restrictiveness of the theoretical model, regressions are tried with non-linear specification. In particular the model is extended by including level dummies of some variables and by including quadratic specifications.

Thirdly, there is an issue of serial correlation in the error terms of both estimated models. For instance Wooldridge (2002, Chapter 10) produces a test for serial correlation in the error, this test is always rejected for the null-hypothesis of no serial correlation. The reason of this serial correlation lies possibly in the nature of the data, where the variables such as service sector employment are persistent even in their growth rates. The serial correlation remains an issue even with year dummies included. Robust statistics are noted to be valid with serial correlation present, "provided that T [time] is small relative to N [cross section]". This result is further confirmed by Wooldridge (2006) and Kézdi (2004). Based on this information the fixed effect model with robust standard errors (always reported) is justified. Alternative estimation procedures may be considered however. In particular Difference and System GMM estimators may be able to provide valid estimates under serial correlation and other potential issues in a panel of this size. Nevertheless, such estimation procedures offer their own set of barriers, such as the large number of instruments relative to the cross-section that are used under these GMM estimators.

Thirdly, it is tempting to include data on employment from the EUKLEMS data as a measure of labour force growth in the estimation of (21). However, doing so results in endogeneity as the same measure is used to calculate the share of service sector employment to the total employment. To avoid

[8]The full list of countries is: Australia, Austria, Belgium, Canada, Czech Republic, Germany, Denmark, Spain, Finland, France, Great Britain, Hungary, Ireland, Italy, Japan, South Korea, Luxembourg, The Netherlands, Poland, Portugal, Sweden and the United States.

this and to get a closer measure of how international labour mobility impacts the labour allocation the labour force growth is substituted by migration data. However, as mentioned above, this data is not directly available in a standardized way for each country in the data set.

This is the final problem, Comparable data on labour mobility among the countries in the sample is not readily available. The OECD database on migration and foreign workers provides statistics by country per year on foreigners by nationality or country of birth. Here only data of the total amount is used as bilateral relations are not of use in the current setup. The variables include in- and outflows of migrants by nationality, stock of labour and stock of population by nationality and by country of birth, the inflows of asylum seekers by nationality and the acquisition of nationalities. The construction of an appropriate international migration variable is discussed next.

3.4 Migration variable

For the current setup a measure of either flows or a change of stock based on nationality is preferred. However, the flows and stock of nationals data is not available for all countries, while the variables that are available for those countries are often not available for the others. The variables with observations available for all countries in the OECD Databse are asylum seeker inflows, acquisition of nationality and inflows of foreign population by nationality. These variables and lagged values are regressed against the Stock of foreign population by nationality.

Population instead of labour was used after regressions showed that the constructed population data performs much better in replicating observed data then labour based variables did. Nevertheless, for the later regressions this may affect the results as the model relies on labour changes explicitly. Under the assumption that the movements of labour, are strongly correlated with the corresponding population data this is an acceptable trade off for the constructrion of a more reliable measure.

The procedure is as follows. The coefficients of the regression are obtained and used to create a fitted version of the stock variable. From this fitted stock version, flows are retrieved as a first difference from of the fitted stock. Alternatively, the first difference is also directly estimated in a regression on the differenced stock.

The exact specification can be summarized as follows,

$$\begin{aligned} spn_{i,t} &= \underset{(35.822)}{-94.260} + \underset{(0.002)}{0.004} \cdot ian_{i,t} + \underset{(0.001)}{0.012} \cdot acqn_{i,t} + \underset{(0.564)}{0.560} \cdot ipn_{i,t} + \underset{(0.604)}{6.355} \cdot ipn_{i,t-2}, \\ & R^2 = 0.93 \quad \text{observations} : 270, \end{aligned} \tag{22}$$

where *spn* is Stock of foreign Population by Nationality, *ian* the Inflow of Asylum seekers by Nationality, acqn the ACQuisition of Nationality by country of former Nationality and *ipn* Inflow of Population by Nationality. The standard errors of the coefficients are reported in brackets under the corresponding coefficients. The twice lagged value of the inflow measure has the largest explanatory power. The

estimated coefficients are used to compose a new measure of a fitted spn, $spnf$. This measure is used in the estimation for the first difference in stock of foreign population by nationality,

$$\begin{aligned}\Delta spn_{i,t} &= \underset{(9.609)}{-1.076} - \underset{(0.092)}{0.072} \cdot spnf_{i,t} + \underset{(0.026)}{0.124} \cdot \Delta spnf_{i,t} + \underset{(0.172)}{1.514} \cdot ipn_{i,t} + \underset{(0.257)}{0.004} \cdot ipn_{i,t-1} \\ &\quad \underset{(0.648)}{-0.781} \cdot ipn_{i,t-2} - \underset{(0.002)}{0.001} \cdot acqn_{i,t} + \underset{(0.000)}{0.002} \cdot acqn_{i,t-1} - \underset{(0.001)}{0.001} \cdot acqn_{i,t-2}, \\ &\quad R^2 = 0.59 \quad \text{observations} : 237, \end{aligned} \tag{23}$$

where Δ notes the first difference. These specifications were used as they provided the best results in terms of overall standard errors (reported in brackets) and R^2, this includes specifications that used other variables, such as GDP per capita, to control for other factors outside the ones available in the database. Unsurprisingly the measure of Inflow of Population by Nationality (ipn) has the largest explanatory power in the regression. Table 1 presents some correlations in order to have an indication of how well these estimated variables approach the observed values. On the stock data in the first panel, the fit seems quite good. The fitted stock data, $spnf$, has a correlation of 96% to the observed stock data, spn, which corresponds to the high R^2 in (22). When compared to European migration data from Eurostat, EU, a variable not used in the regressions, the correlation is even higher. Looking at the first difference versions the results are more diverse, which corresponds to the regression on the first difference where the fit was not as good compared to the stock level. Nevertheless, it is clear that the *estimated difference of the stock*, $dspn$, performs better with 77% than the *difference of the estimated stock*, Δspn, with 57%. This difference is also visible when the variables are compared to the European differenced stock data. For this reason the preference for the use of migration data goes to the estimated difference of the stock variable, $dspnf$, in the regressions below. In order to create a proper measure of migration the relevant variables

Table 1: Correlations observed and fitted migration data

	spn	$spnf$	observations
$spnf$	0.962		273
EU	0.988	0.974	159

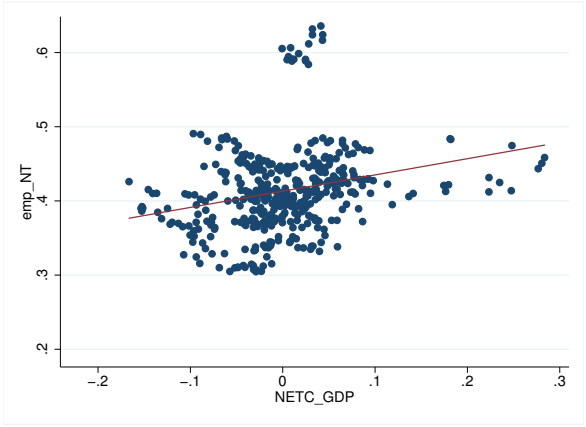
	Δspn	$\Delta spnf$	$dspnf$	observations
$\Delta spnf$	0.436			273
$dspnf$	0.770	0.567		273
ΔEU	0.821	0.482	0.824	159

Correlations of the series following the regressions (22) and (23)
spn is the stock of pop. by nationality, $spnf$ the fitted series,
EU the series from Eurostat, including only EU countries.
d indicates a estimated difference, Δ the difference of the stock.

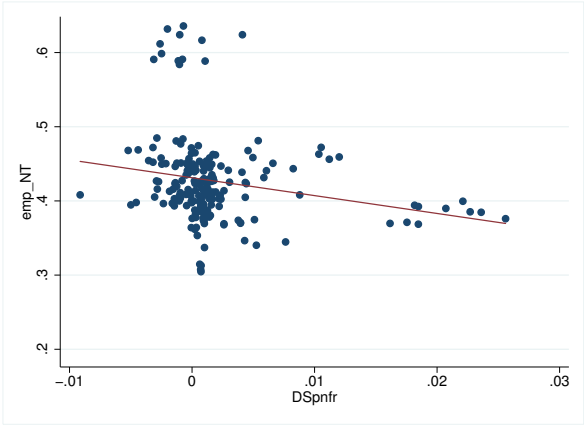
are divided by the population to create a migration rate.

Figure 1 presents scatter plots as an early indication of the relation between the service sector employment on the one hand and the net commodity exports and migration on the other. A straight line is fitted through the dots. The patterns are broadly as expected. While the commodity exports is positively

Figure 1: Scatter Plots



(a)
Service sector employment vs. Net commodity exports



(b)
Service sector employment vs. Migration

correlated with service sector employment, population mobility is negatively correlated. These relations will be formally tested in the regressions below. Figure 2 plots some time series of selected countries of the variables service sector employment, net commodity exports and migration. The countries have been selected for their scale of movement in some of the series. Firstly, the figures show a wide range of states and development among countries. Whereas Canada has one of the highest service sector shares close to 64%, and already above 60% in 1990, Portugal is 'only' at 41% coming from 34% in 1990. For commodity export the data ranges from large importers such as Spain and Portugal to large net exporters such as Ireland and Finland, and similar observations hold for the net change in the stock of foreign nationals. Secondly, from these individual series the relation between service sector employment on the one hand and commodity exports and migration on the other hand are not obvious. This is may be caused by other important factors that drive the prices of service sector employment such as productivity growth differences between the sectors as predicted by the model.

3.5 Results

The estimates for models (20) and (21) will be presented. The results of the first confirm the model to the extend it predicts the signs on the productivity parameters. On the other hand, even for longer time-difference, other factors related to a country's wealth, government policy and exports remain significant explanatory factors, thus arguing that the strict relation between the real exchange rate and sectoral productivity does not hold. The results corresponds broadly with De Gregorio et al. (1994). The results of the employment equation provide support for the model, and in particular with respect to the opposing effects of external income and labour migration. The model confirms that non-linear effects are important and that there is a direct interaction between external income and migration or non-tradable sector employment.

Table 2 presents the result of (20) under different specifications. The first four columns use 1-year

Figure 2: Resource income and service sector size

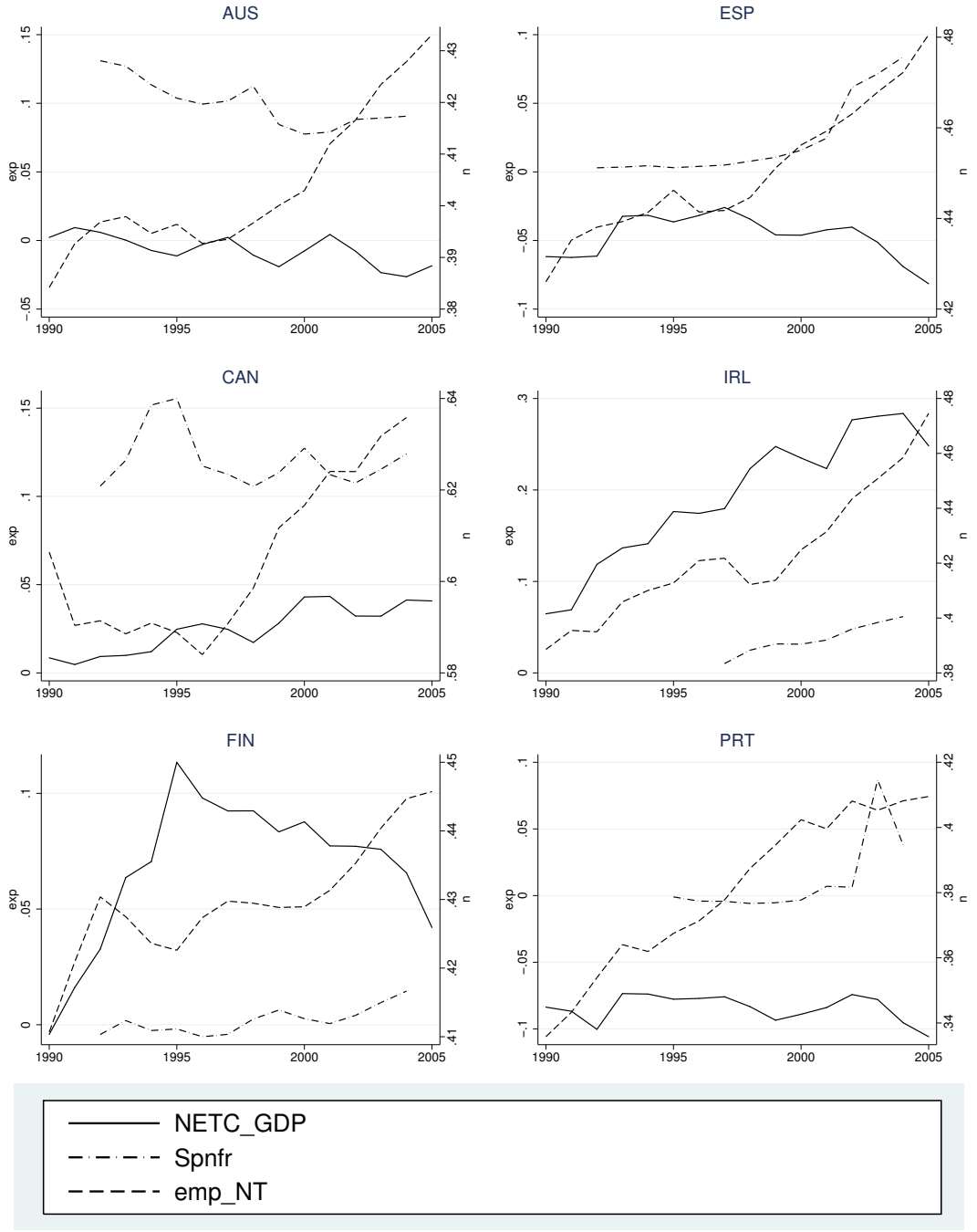


Table 2: Balassa-Samuelson.

	Dependend variable: $\log(P^N/P^T)$				
	(1)	(2)	(3)	(4)	(5)
Differences:	1-year				5-years
$\frac{1-\alpha^{NT}}{1-\alpha^T}\hat{A}^T - \hat{A}^{NT}$	0.176***				
	(2.89)				
$\log(A^{NT})$		−0.211**	−0.395***	−0.141*	−0.958***
		(2.69)	(3.16)	(1.91)	(15.05)
$\log(A^T)$		0.223**	0.396	0.433	0.760**
		(2.27)	(1.31)	(1.39)	(2.46)
log(GDP/ca)			9.023***	6.385***	13.030**
			(3.92)	(3.08)	(2.62)
$\log(\text{GDP/ca})^2$			−0.470***	−0.339***	−0.688***
			(3.78)	(3.10)	(2.66)
deficit			0.003*	0.002	0.007***
			(1.96)	(1.33)	(3.82)
gov. expen./GDP			0.004	0.004	0.006***
			(1.70)	(1.58)	(4.22)
N exports/GDP			−10.647*	−11.007*	16.799***
			(1.76)	(1.76)	(3.35)
lending rate			0.001	0.003*	0.006
			(0.57)	(1.78)	(1.55)
R^2	0.150	0.149	0.233	0.211	0.693
Observations	551	551	271	211	177
Countries	23	23	21	21	21
Time span	'71–'07	'71–'07	'89–'05	'95–'05	'95–'05

Fixed effect estimation with year dummies.
Absolute robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

difference of all variables, while the last column uses 5-year differences. All specifications include year dummies. Model 1, regresses the relation as predicted by (17). The labour shares of income in both sectors, $1-\alpha^i$, $i = N, T$, where calculated from the EUKLEMS by taking the ration of the wage compensation and value added. The model predicts a positive value equal to 1. This holds partly, as the sign is positive, and the value significant different from zero, but the value is too low. This result does not change much with additional explanatory variables (not shown). Separating the two productivity variables shows that the signs for both productivity variables are predicted correctly but the absolute values are small. Non-tradable productivity is significantly negative but not close to -1, while tradable productivity would have a predicted positive coefficient, likely to exceed 1. This follows from the observation that the labour income share in the non-tradable sector is likely to be higher than in the tradable sector. Adding variables such as in model 3 of table 2 does not change the result much. However a general observations for all results is that non-tradable productivity tends to perform better in the models than tradable productivity. Whereas non-tradable productivity is mostly significant with the correct sign, tradable productivity has the correct sign but is often less or not significant. Model 4 restricts the data for the time span to 1995-2005 to create a more balanced panel (but not completely so). The significance of the variables such as GDP per capita, and net exports argue against the theoretical model that predicts that only productivity differentials between sectors should affect the real exchange rate. As De Gregorio et al.

(1994) argued, this could be due to the fact that the theoretical model is an equilibrium model that is not supposed to hold in the short term of 1 year. Thus moving to a longer time spans helped that study to increase the absolute values of the productivity variables, while decreasing the relative importance of the other explanatory variables. Replicating that exercise here for the 5-year time difference, gives partial support to these claims. The productivity variables increase in absolute value, and cannot be rejected for equal to -1 for $\hat{A}^{NT}$ and 1 or larger for $\hat{A}^{T}$. Nevertheless, the other explanatory variables have still highly significant coefficients, arguing that even for longer time spans productivity differentials do not exclusively predict the movement of the real exchange rate. If one would want to replicate such behavior in a theoretical model, then a first start could be to relax some of the underlying assumptions such as perfect capital mobility and homothetic consumption preferences, while including a government of some sort.

Two findings are important for the further analysis. Firstly, the fact that the results correspond closely to earlier findings on (17) as reported in De Gregorio et al. (1994) and Froot and Rogoff (1995) is remarkable as the data here comes from different sources, uses a different country sample and different time spans.[9] The results lend support to using the data in the next model, and supports that the result found hence are unlikely to be caused by data specific characteristics. Secondly, given that other factors than productivity are significant explanatory variables in the regression on the real exchange rate, argues against substitution of the real exchange rate by the strict productivity relation given (17) in the theoretical model. For this reason in the next results the real exchange rate is kept in the models.

Having done all the preparatory work, the results on the employment equation can be presented in Table 3. The variables of the real exchange rate and productivity are the same as used above. The stock of foreign population is the estimated first difference as constructed by equation (23) and divided by the population size. The Net Commodity exports over GDP comes from the OECD trade database and is an attempt to replicate the external income that is relevant for the countries in the data set. In all models year dummies are included as well as GDP per capita and its squared form. Other control variables, such as those used in Table 2 were tried but did not improve the model.

For all models productivity shows with the correct sign and significant for the Non-tradable sector while it is never significant for the tradable sector. A similar observations as in Table 2. In the first two columns Employment growth as given in the EUKLEMS database is used and shows up highly significant with the right sign. Net commodity exports reports a significant negative coefficient in contrast to the prediction of the theoretical model. The difference between the two models is the time span of the data used, from which can be concluded that the extra observation included change little to the results.

A problem may exist with the use of employment growth as the same term is present on the left

[9]The EUKLEMS data relies on national accounts in the same way the OECD ISDB/STAN database does. Nevertheless, as productivity is not observed, the construction method is not identical between the study of De Gregorio et al. (1994) and that which the EUKLEMS database provides.

Table 3: Employment

	Dependend variable: $\log\left(L^{NT}/L\right)$				
	(1)	(2)	(3)	(4)	(5)
1-period differences	Base	Ext. time	Migration	Functional form	
log(RER)	0.026	0.016	0.024	0.010	0.038
	(1.052)	(0.480)	(1.207)	(0.587)	(1.590)
$\log(A^{NT})$	-0.143^{**}	-0.095^{*}	-0.131^{**}	-0.130^{*}	-0.137^{**}
	(2.773)	(1.983)	(2.176)	(1.882)	(2.283)
$\log(A^{T})$	−0.050	−0.067	0.027	0.064	0.030
	(1.254)	(1.288)	(0.411)	(1.304)	(0.457)
$\log(L)$	-0.272^{***}	-0.198^{***}			
	(3.436)	(3.157)			
Stock for. pop.			−0.099	0.251	−0.046
			(0.577)	(0.943)	(0.240)
(Stock for. pop.)^2				-52.116^{**}	
				(2.211)	
NC. exp./GDP	-0.117^{**}	-0.070^{**}	0.007	-0.111^{**}	−0.032
	(2.647)	(2.203)	(0.135)	(2.332)	(0.625)
(NC.exp./GDP^2				0.420^{*}	
				(1.913)	
NC. exp./GDP ×				−4.236	
Stock for. pop.				(1.190)	
$\mathrm{d}_{\text{NC.exp./GDP}\geq 0}$					−0.005
					(1.715)
Stock for. pop. ×					−0.249
$\mathrm{d}_{\text{NC.exp./GDP}\geq 0}$					(0.453)
$\mathrm{d}_{L^{NT}/L\geq 0.6}$					−0.004
					(0.450)
NC. exp./GDP ×					0.347
$\mathrm{d}_{L^{NT}/L\geq 0.6}$					(1.127)
R^2	0.388	0.272	0.431	0.530	0.446
Observations	223	343	189	166	189
Countries	21	21	21	21	21
Time span	'95–'05	'88–'07	'93–'04	'95–'04	'93-'04

Fixed effect estimation with year dummies, additional control variables are GDP/ca and (GDP/ca)^2. Absolute robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

hand side of the equation as the denominator in the share of service sector employment, thus creating a potential endogeneity issue. Columns 3 to 5 use migration as a measure for labour force growth. The first presents the correct signs for migration and net commodity exports but the coefficients are not significant.

Column 4 presents the model with squared relations for both migration and the net commodity exports as well as an interaction term on the two variables. This functional form is an attempt to control for possible non-linear relations between the variables for which there are indications in the theoretical model. The coefficients on the squared form are significant with the correct sign and can be used to calculate an optimum. For the migration the maximum lies around zero, so that any positive migration has a downward effect on non-tradable employment. For the net commodity exports variable the minimum lies around 5%. The interaction term of the two variables is not significant. However, the sign indicates that once there is a positive commodity export growth, increased migration will have a strong downward effect on non-tradable employment.

A second functional form replaces the quadratic terms with interaction dummies. Two dummies come from indicator functions. One, $d_{\text{NC.exp./GDP}\geq 0}$, equals 1 if commodity export is positive, and is interacted on the migration variable. The intuition is that the effect of migration may be more profound if a country is actually experiencing a dependence on commodity exports, so the expected sign of the interaction is negative. The dummy itself has an small value and is insignificant, its interaction with migration has the correct sign and is not significant. Another dummy, $d_{L^{NT}/L\geq 0.6}$, equals one for countries that have a relatively high service sector share, equal to 60%, and is interacted with the commodity export variable. This follows from the attempt to distinguish between what would be a normal de-industrialisation coming from structural change and what could be considered excessive de-industrialisation caused by an external income. Therefore a country that is well on its path of structural change will have an excess de-industrialisation in the presence of an export surge of commodities and the expected sign on the interaction is positive. In this model the interaction has the correct sign but does not appear significant. The first observation from these regressions is that the model appears to perform relatively well considering the large amount of measurement errors undoubtedly present in the variables such as productivity, the approximation of the resource income and labour migration. The overall fit is respectable with up to 53% and a large part is due to the labour and export variables. The non-linear relations for migrations and commodity experts are better captured by the quadratic structures then by level dummy-interactions.

Table 4 presents a robustness check of the model. It replicates models 1 and 3 to 5 of Table 3 but for 2-year differences to approach a more medium term equilibrium relation. There is an overall improvement of the model, with more coefficients statistically significant and an overall larger fit. Similar to the results on the real exchange rate in Table 2 the absolute coefficients increases and significance improves, nevertheless tradable productivity still performs weakly. The coefficients on labour force growth, migration and the

Table 4: Employment - Robustness I

	Dependend variable: $\log\left(L^{NT}/L\right)$			
	(1)	(2)	(3)	(4)
2-period differences	Base	Migration	Functional forms	
log(RER)	0.032	0.011	−0.006	0.077**
	(0.720)	(0.520)	(0.387)	(2.242)
$\log(A^{NT})$	−0.159**	−0.167*	−0.170*	−0.132
	(2.236)	(2.026)	(1.865)	(1.551)
$\log(A^{T})$	−0.083	0.027	0.069	0.044
	(1.321)	(0.333)	(1.042)	(0.572)
$\log(L)$	−0.370***			
	(3.810)			
Stock for. pop.		−0.001	0.279	0.176
		(0.006)	(0.755)	(0.599)
(Stock for. pop.)^2			−33.639**	
			(2.616)	
NC. exp./GDP	−0.248***	−0.023	−0.144	−0.108
	(4.584)	(0.258)	(1.556)	(1.323)
(NC.exp./GDP^2			0.708*	
			(1.884)	
NC. exp./GDP ×			−6.711**	
Stock for. pop.			(2.251)	
$d_{\text{NC.exp./GDP}\geq 0}$				−0.006*
				(1.823)
Stock for. pop. ×				−0.906
$d_{\text{NC.exp./GDP}\geq 0}$				(1.443)
$d_{L^{NT}/L\geq 0.6}$				−0.072**
				(2.646)
NC. exp./GDP ×				2.653***
$d_{L^{NT}/L\geq 0.6}$				(2.838)
R^2	0.452	0.513	0.593	0.548
Observations	220	167	156	167
Countries	21	21	21	21
Time span	'95–'05	'94–'04	'95–'04	'95–'04

Fixed effect estimation with year dummies and GDP/ca and $(\text{GDP/ca})^2$ as controls.
Absolute robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.
Stock of foreign population is the sum of 2 periods of the estimated first difference: $dspnf_t + dspnf_{t-1}$, with $dspnf$ as computed in (23).
Net commodity exports remains in first differences.

net commodity exports including their significant levels are similar to the results in Table 3.

More interesting are the results of the two functional form specifications. Model 4 gives correct signs for the coefficients on the squared variables for migration and commodity exports. The optima are similar as before, with the migration maximum around zero and the export minimum around a 5% of GDP surplus. Additionally the interaction of commodity exports and migration gives a significant negative coefficient in contrast to the insignificant negative coefficient before. The interpretation would be that once there is a positive commodity exports, a migration inflow reduces the effect of de-industrialisation. Alternatively, the effect of de-industrialisation caused by positive commodity exports is reduced when there is a migration inflow. The results on the level dummy-interactions have also improved relative to the 1-period differences case. The interaction of positive commodity exports on the migration has the correct sign, and although not statistically significant at the 10% level, the t-statistic on the coefficient has improved. The interaction of the service sector level with commodity export is highly significant, supporting the idea that excess de-industrialisation is facilitated by commodity exports. The overall results in this Table lend further support to the structural model. An explanation for the better performance is that a 2-period differences approaches better the equilibrium relation that is being tested and as such the overall improvement of the coefficient significance and fit is expected.

As a final robustness, Table (5) presents results of the model with two variations. Firstly, the measures for productivity have been replaces by labour productivity which is more directly observed in the data. Secondly, alternatives for international labour mobility are included, principally to test for accuracy of the estimations method used for migration before.

Using labour productivity as defined by the ratio of value added over wage compensation has both an advantage and disadvantage. The advantage is that both variables are observed and therefore not subject to a misspecification or calculation which underlies any total factor productivity variable. The disadvantage is that the theoretical model explicitly uses total factor productivity and one needs to be careful when substituting one measure for the other. The results in columns 1 and 2 of table (5) show that the new productivity measure improves all of the coefficients in terms of expected signs and significance. Firstly, it's noteworthy that tradable productivity is now highly significant while non-tradable productivity edges just above the 10% level. For the base model the coefficients on commodity exports and migration have the correct sign but are not significant. The quadratic form specification in column two, which may be directly compared to column 4 in Table 3, shows an improvement on the significance levels with correct signs on the coefficients.

Column 3 includes a dummy variables that limits to data to European countries only. Given the interest in the development of European labour mobility, this model could lend support to the potential benefits of a more flexibility on the European labour market (see for instance Bonin et al., 2008; Heinz and Ward-Warmedinger, 2006). The model continues to hold, including the quadratic terms and the

Table 5: Employment - Robustness II

	Dependend variable: $\log\left(L^{NT}/L\right)$					
	(1)	(2)	(3)	(4)	(5)	(6)
1-period differences	Base	Func. Form	EU	Migration alternatives		
$\log(P^N/P^T)$	0.169***	0.160***	0.261***	0.274***	0.086	0.156***
	(3.454)	(3.803)	(3.678)	(3.778)	(1.270)	(3.194)
$\log\left(VA^{NT}/w^{NT}\right)$	−0.097	−0.097	−0.134**	−0.153***	−0.049	−0.125*
	(1.677)	(1.592)	(2.364)	(3.255)	(0.631)	(1.825)
$\log\left(VA^{T}/w^{T}\right)$	0.156***	0.157***	0.161***	0.153***	0.043	0.095***
	(5.091)	(6.212)	(6.243)	(7.582)	(0.780)	(3.181)
NC. exp./GDP	0.001	−0.066	−0.178*	−0.169**	−0.160***	−0.193***
	(0.012)	(0.898)	(2.081)	(2.171)	(3.709)	(3.943)
(NC.exp./GDP)^2		0.843**	0.838*	0.823***	1.230***	0.368*
		(2.129)	(2.080)	(3.296)	(3.054)	(1.956)
Stock for. pop.	−0.016	0.504**	0.373			
	(0.083)	(2.426)	(1.489)			
(Stock for. pop.)^2		−78.384***	−62.502*			
		(3.905)	(1.896)			
NC. exp./GDP ×		−6.406***	−5.737*			
Stock for. pop.		(3.554)	(2.108)			
1st-Differences of estimated stock:						
Stock for. pop.				−0.052		
				(0.863)		
(Stock for. pop.)^2				−3.252*		
				(1.795)		
NC. exp./GDP ×				−0.526		
Stock for. pop.				(0.476)		
1st-Differences of observed stock:						
Stock for. pop.					0.689*	
					(1.898)	
(Stock for. pop.)^2					−71.956**	
					(2.572)	
NC. exp./GDP ×					2.713	
Stock for. pop.					(0.430)	
1st-Differences of observed stock. EUROSTAT data:						
Stock for. pop.						−0.104
						(0.347)
(Stock for. pop.)^2						−1.575
						(0.079)
NC. exp./GDP ×						−1.915
Stock for. pop.						(0.730)
R^2	0.376	0.425	0.481	0.503	0.383	0.505
Observations	197	197	147	153	179	121
Countries	22	22	17	18	16	17
Time span	'95–'05	'94–'04	'95–'04	'95–'04	'95-'04	'95–'04

Fixed effect estimation with year dummies and GDP/ca and (GDP/ca)^2 as controls.
Absolute robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

interaction of the commodity exports and migration variable.

As a final exercise, three alternative measures for migration are tried to compare the used estimated differences of the stock of foreign population thus-far. The first general observation is that the real exchange rate is positive and significant except for one model, and appears relatively stable in size between the different specifications. Secondly, the coefficients on the net commodity exports remain highly significant and remain to have similar magnitudes and the correct signs. The same holds on average for the productivity variables.

The first migration alternative is the first differences of the estimated stock, as computed by (22). The quadratic term is significant with the correct sign, but the interaction with the export variable is not significant. The theoretical minimum of migration lies around zero as before. The same holds when moving to observed variable of the stock of foreign population. By using these variables the amount of observations drops by 40 to 50 observations, which may explain the weaker performance of the variables. The last columns includes migration from Eurostat which decreases the amount of observations further. The coefficients on migration and the interaction are not significant.

Other control variables besides GDP per capita and functional forms have been tried but often without much success. The theoretical model includes five structural variables, the real exchange rate, productivity for each sector, the external income and labour force growth. This is an extended set of variables which together on average explain up to 60% of the variation in the non-tradable labour share. This would give space for other variables to add to the explanatory power, but part of the unexplained variation is likely to be caused by factors such as measurement errors and idiosyncratic variation.

As a final point, the quadratic relations are interpreted only on the positive part of the variable. As quadratic relations are symmetric significant negative values of both migration and commodity export could reach the same conclusion with respect to their effect on de-industrialisation. For migration this would not be a large issue, as for the included observations in the regressions the large majority is positive, and negative values, meaning a net outflow, do not exceed -1%, while on the positive side some observations exceed 2 percent.[10] Therefore the quadratic relation is rather driven by the positive part of the observations. For the net commodity exports variable the distribution is more symmetric, as was visible in Figure 2(a). The data set consists of large importers as well as exporters. So the negative part should not be as easily discarted. A possible interpretation could be that countries that have such large reliance on commodity imports will also not be in a good position to establish a raw material consuming manufacturing sector, thus pushing such countries also to earlier de-industrialisation relative to countries that have some self-production of commodities. However, this specific mechanism is not addressed in the theoretical model.

[10] For instance, for model 4 in Table (3), there are 53 observations with a negative migration rate, and 113 observations with a positive migration rate with mean 0.2%, minimum -0.9% and maximum 2.4%. See also Figure 1(b).

4 Conclusion

This study presented a general equilibrium model with an extension of labour force growth that is often ignored in studies on the topic of de-industrialisation and Dutch Disease. The theoretical model shows the potential of labour force growth as mitigation factor to the de-industrialisation force that comes from an external income. As such, interpreting labour force growth as international labour mobility predicts that countries that experience a large inflow of migrant are less prone to an excess de-industrialisation that is associated with Dutch disease.

These predictions are tested on a data set of developed countries over a ten to 20 years period in two parts. The first part establishes links with previously used data on productivity and real exchange rate, finding large similarities in the results which supports to use the data for next model. To proxy for external income, the variable of net commodity exports is used for data availability and conformity reasons. Labour force growth is captured by migration data that was constructed using several migration based measures. The model on service sector share finds support for structural parameters that are in the theoretical model, in particular service sector productivity, migration and net commodity exports. There is less support for real exchange rate and tradable productivity as significant explanatory variables.

The model benefits from the use of a non-linear form for migration and commodity exports, which is supported by the theoretical model. In particular migration is shown to have a significant downward effect on service sector employment growth, while net commodity exports have a significant positive effect. The interaction of the two variables support a direct relation between migration and external income, suggesting that in case of positive commodity exports additional labour inflow reduces the effect of de-industrialisation. As a special case, the limitation to European countries only links model to discussion on European labour mobility and argues for the beneficial effect of cross-European labour mobility in case one country experience a surge of external income.

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