Meistararitgerð

í fjármálahagfræði

Price Level of Non-tradable Goods in Iceland: Explanations by Economic Fundamentals

Ágúst Shi Jin Hallgrímsson

HÁSKÓLI ÍSLANDS

Hagfræðideild Háskóla Íslands

Leiðbeinandi: Gylfi Zoëga

Júní 2009

Meistararitgerð

í fjármálahagfræði

Price Level of Non-tradable Goods in Iceland: Explanations by Economic Fundamentals

Ágúst Shi Jin Hallgrímsson

HÁSKÓLI ÍSLANDS

Hagfræðideild Háskóla Íslands

Leiðbeinandi: Gylfi Zoëga

Júní 2009

Price Level of Non-tradable Goods in Iceland: Explanations by Economic Fundamentals

Abstract

Most non-tradable goods are much more expensive in Iceland than in China. During the last decade there had been an observable appreciation of non-tradable goods in Iceland against those in China. Both the magnitude of the price gap and the length and monotonicity of the gap enlargement are questionable whether fundamentals can sustain them. In attempt to answer the question the paper will introduce economic theories that look at the phenomena from the angle of economic fundamentals and present data to define the situation and examine relevance of the theories.

It'll be concluded that productivity difference in tradable sectors was not the cause for enlarging non-tradable price gap. However economic fundamental such as factor endowment can explain to some extent higher non-tradable price in Iceland. Various facts indicate that a boom started around 1997 and 1998 characterized by financial sector expansion had led to economic overheating which contributed to pushing up non-tradable price against tradable goods. This, in turn, caused non-tradable goods in Iceland to appreciate against those in countries that were not experiencing a comparable overheating. This is a classic demonstration of unsustainable 'Dutch disease'. Meanwhile increasing trade deficit helped to magnify the effect of the 'Dutch disease'.

Foreword

This paper counts for 30 ECTS and is written under the instruction of professor Gylfi Zoëga.

Index

Tables, Charts and Figures

Price Level on Non-tradable Goods in Iceland:
Explanations from Economic Fundamentals

When I was an exchange student in Akureyri in Iceland year 2000 I was surprised to see that a regular haircut costs 1,500 Krona. The cheap barbers in Shanghai offer one at only 5 CNY. At the time US dollar's exchange rate was 72 ISK/$ and 8.3 CNY/$ making a haircut 34.6 times as expensive in Iceland as in Shanghai.

After six years' dwell in Shanghai I came to Akureyri again in 2006, the price of a haircut became 2,700 Krona while it hadn't changed in Shanghai, still 5 CNY. Exchange rate of US dollar became 65 ISK/$ and 8 CNY/$. The price difference was enlarged to 66.46 times.

According to the absolute form of PPP theory the same goods shall cost the same everywhere (Rogoff, 1996). If haircut can be considered approximately homogeneous, its price shall be about the same everywhere in the world. Even if there is some difference in quality, it is very unlikely that the difference is big enough to cause the value to differ by as great as 66.46 times.

According to relative PPP the price ratio of same goods in different places shall stay fixed (Rogoff, 1996). While quality of haircut in both countries didn't appear to have changed much, the fact that haircut in China had depreciated almost by half against that in Iceland during the six years is bluntly contradictory to relative PPP.

It is of interest whether and how such deviation from PPP can be justified by economic fundamental.

In his paper dealing with purchasing power disparity, Dornbusch divided disparity into two catgories: long-term disparity sustained by economic fundamentals or 'structural departure' from PPP; and short-term disparity or 'transitory deviation' from PPP (Dornbusch, 1985). More emphasis will be laid on 'structural departure' in the following discussion although 'transitory deviation' also connects economic fundamentals in some way.

The first part will present Balassa-Samuelson hypothesis and the second will discuss Hecksher-Ohlin model. They show how differences in production capability can cause 'structural departure'. The third part will talk about the phenomenon and model of Dutch disease, which can be either a 'structural departure' or a 'transitory deviation'. Trade deficit will also be mentioned in that part for it delivers a similar effect as a short-run 'Dutch disease' and create 'transitory deviation' which is relevant in light of the crisis in Iceland. The conclusions follow after that.

1. Balassa-Samuelson Hypothesis

1.1 The Model

The Balassa-Samuelson hypothesis was presented in 1964 by Balassa and Samuelson in their papers which focus on the failure of PPP theory. The key argument of their explanation is that: the arbitrage mechanism that keeps price level in line with PPP is not present because not all goods are tradable; production factors, especially labour, are not mobile across countries therefore factor prices may vary if production capacity varies.

The explanation of disparity lies in that commerce of tradable goods will form a global market and partially link price systems of different countries together. Wage level in each country is determined by its productivity in producing tradable goods because factor markets are isolated. Prices of non-tradable goods are then determined by local wage level and productivity as they can't be imported. Therefore if productivity differs to a different degree in tradable and non-tradable sectors among countries, the price of non-tradable goods shall be different. In other words, if productivity gap is smaller among non-tradable sectors than among tradable sectors, non-tradable price shall be higher in the country where tradable productivity is higher (Balassa, 1964).

The hypothesis can be demonstrated with a simple two-country-two-product model with a few additional assumptions:

(1). Tradable and non-tradable goods and their price.

a. Goods can be divided into tradable and non-tradable ones. The former can be transported and sold around the world without much difficulty. Distribution cost is neglected. One perfect example of such products is computer software. The non-tradable can only be produced and consumed locally, such as most services like haircut and cleaning. The model assumes only two goods are produced, one tradable, the other non-tradable.

b. For tradable goods there's only one global market and for that reason one-price rule applies.

$$e \cdot P_{t1} = P_{t2} \tag{1}$$

e refers to nominal exchange rate between currency 1 and 2, that is, the number of currency 2 needed to buy one unit of currency 1; P_{t1} refers to price of tradable goods in country 1 and P_{t2} to that in country 2.

c. For the non-tradable goods, their prices, P_{nt1} in country 1 and P_{nt2} in country 2, are determined independently by the local markets.

(2). Labour mobility and profit maximization.

d. There's perfect mobility of labour within a country so that labour of comparable skills receives comparable income. Suppose the labour used in producing tradable and non-tradable requires comparable same skill level, their wage will be same in a same country.

e. Labour is the only factor of production and wage is the only source of cost.

f. Markets are perfectly competitive so that average cost of production equals unit price of product.

$$\frac{w_1}{A_{t1}} = P_{t1} \tag{2}$$

$$\frac{w_2}{A_{t2}} = P_{t2} \tag{3}$$

$$\frac{w_1}{A_{nt1}} = P_{nt1} \tag{4}$$

$$\frac{w_2}{A_{nt2}} = P_{nt2} \tag{5}$$

w_1 and w_2 are wage for unit labour in county 1 and 2, A_{t1} and A_{t2} are product of unit labour of the tradable sectors in country 1 and 2.

g. Due to immobility of labour factor across nations, wage levels do not need to equal between the two countries. In the model it is supposed that $w_1 \neq w_2$

(3). Differences in productivity

h. The differences in productivity are larger in production of the tradable than the non-tradable goods. Suppose country 1 has absolute advantage in producing both tradable and non-tradable goods but relative advantage in producing tradable goods, that'll make it:

$$\frac{A_{t1}}{A_{t2}} > \frac{A_{nt1}}{A_{n2}}$$

Suppose the differences ratio is a:

$$\frac{A_{t1}}{A_{t2}} = a \cdot \frac{A_{nt1}}{A_{nt2}} \qquad \text{where} \qquad a > 1 \tag{6}$$

(4). Inferences

Combining equation (1) (2) and (3) will derive:

$$\frac{e \cdot w_1}{w_2} = \frac{A_{t1}}{A_{t2}} \tag{7}$$

Combining equation (4) and (5) will derive:

$$\frac{w_1 \cdot P_{nt2}}{w_2 \cdot P_{nt1}} = \frac{A_{nt1}}{A_{nt2}} \tag{8}$$

Combining equation (6) (7) and (8) will derive:

$$\frac{e \cdot P_{nt1}}{P_{nt2}} = a \tag{9}$$

This means that the non-tradable good is more expensive in country 1 than in country 2.

More specifically, if non-tradable productivity gap is fixed across countries, suppose $\frac{A_{nt2}}{A_{nt1}} = c > 0$ c is a constant, then equation (7) and (8) will lead to the result that non-tradable price ratio is proportional to wage ratio or tradable productivity ratio:

$$\frac{e \cdot P_{nt1}}{P_{nt2}} = c \cdot \frac{e \cdot w_1}{w_2} = c \cdot \frac{A_{t1}}{A_{t2}} \tag{10}$$

This supposition isn't too unreal as productivity in non-tradable sector, especially traditional services, is hard to improve by developing technology and equipments unlike in manufacturing.

1.2 Data

To see if non-tradable price gap between Iceland and China behaves in the manner BS model prescribes, a regression by the model (10) will be run on real data. But before doing that, let's first look at the data that'll be used.

Practically it's very problematic to try to divide an economy into tradable and non-tradable. It's hard to decide which category an industry falls into as many industries are mixtures of both, not to mention that complete industrial data is not always available as in the case of China.

What is done is that typical tradable and non-tradable industries are selected to represent the sectors in the two countries. And their data is used in regression. The representing industries are chosen with sectoral nature and availability of data in mind.

On China's side, textile industry is chosen to represent the tradable. According numbers from 2004, the industry made up 1/6 of China's export value. It also captures a large share of the labour force, accommodated approximately 19 million people under direct employment and nearly 100 million indirect, mostly agricultural workers supplying industrial crops ("今年成功解决"，2005). The non-tradable sector is represented by 'service' before 2001 and 'personal service' since 2001 as the bureau of statistics of China made amendments to its category at that time.

On Iceland's side, fishery (the combination of fishing and fish-processing industry) is used to represent the tradable sector. The industry has been the biggest contributor to export. It constituted more than 70% of Iceland's export value until late

90s although its share has decline sharply to around 42% by now (Hagstofa). The 'other services' in the statistic bureau's category is used to represent the non-tradable sector.

Table 1.1 lists the annual output per worker in dollars of the Icelandic fishery and the major firms of Chinese textile industry and their ratio from 1997 to 2006 according to data acquired from Statistics Iceland and National Bureau of Statistics of China:

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
A_{t1} (Fishery)	58646	65526	62350	56450	65861	72616	80744	84880	95127	114565
A_{t2} (Textile)	1845	2126	2399	2935	3292	5471	4780	5452	7048	8089
A_{t1}/ A_{t2}	31.8	30.8	26.0	19.2	20.0	13.3	16.9	15.6	13.5	14.2

Table 1.1 Annual output per worker (Hagstofa)

A_{t1} (Fishery): Annual output per worker in dollars of the Icelandic fishery. A_{t2} (Textile): Annual output per worker in dollars of the major firms of Chinese textile industry.

Table 1.2 lists dollar price indices of personal services in China, other services in Iceland and hairdressing in Iceland from 1997 to 2006 using 1997 as base year.

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Hairdressing	100.00	105.37	109.59	107.60	95.39	107.17	130.50	151.74	180.16	178.26
I_{nt1} (O. Svc.)	100.00	107.25	111.99	103.95	86.99	97.66	120.08	132.80	161.76	159.35
I_{nt2} (P. Svc.)	100.00	103.93	106.23	106.76	108.59	109.90	110.78	112.77	116.11	122.30

Table 1.2 Dollar price indices (NBSC & The People's Bank of China)

I_{nt2} (P. Svc.): Dollar price indices of personal services in China. I_{nt1} (O. Svc.): Dollar price indices of other services in Iceland. Hairdressing: Dollar price indices of hairdressing in Iceland.

The time series are very short due to limited availability of data. The statistic system had undergone reconstructions during the last decade in China. Service industry was not recorded and output and employment data of textile industry not collected before 1997. Neither is there to find more recent from the Chinese statistic bureau. Also, these data are reported annually only making it impossible to obtain more data points.

For some extra illustration, chart 1.1 shows development of price indices in both countries using 1997 as the base year. An obvious appreciation of Icelandic product basket against the Chinese basket can be observed during this period. But while service price has been closely following the CPI in Iceland, it has surpassed the increase in the Chinese CPI. Hairdressing price in Iceland has also outgrown the CPI.

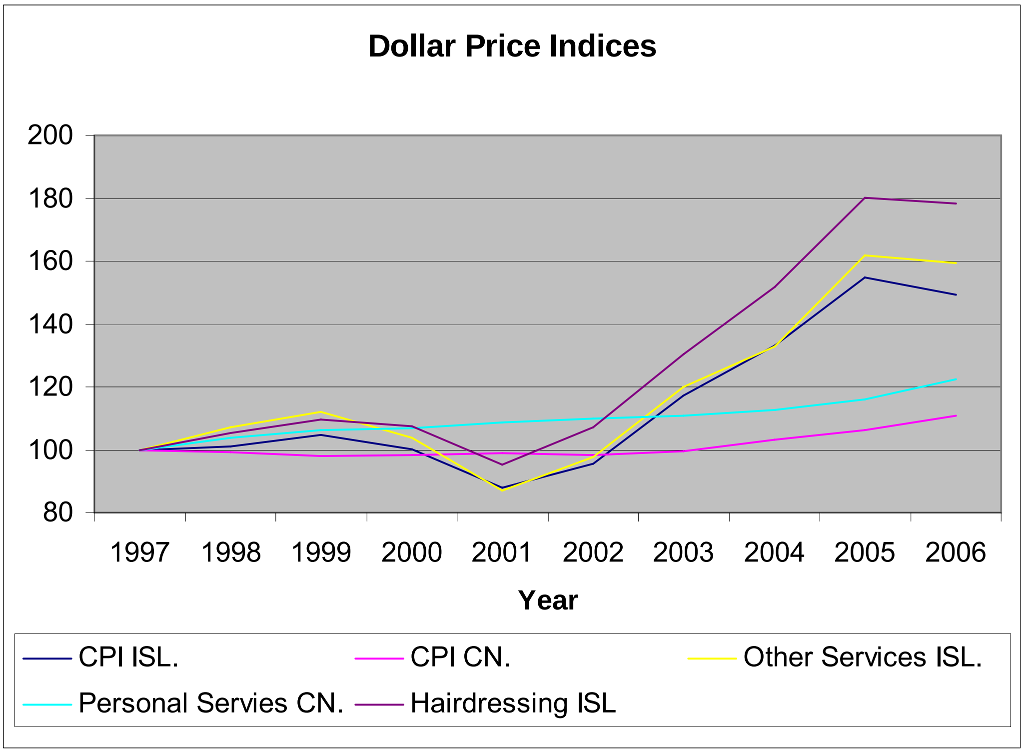


Chart 1.1 Dollar Price Indices (Hagstofa & NBSC)

CPI ISL.: Dollar CPI of Iceland. CPI CN.: Dollar CPI of China. Other Service ISL.: Dollar price indices of other services in Iceland. Personal Services CN.: Dollar price indices of personal services in China. Hairdressing ISL: Dollar price indices of hairdressing in Iceland.

1.3 Statistical tests

Using the data in table 1.1 and 1.2 we can run a test on equation (10) see if the data fits. Let $a = \frac{A_{1997t1}}{A_{1997t2}} = 31.8$, that is, the fishery productivity-textile productivity ratio to be a in 1997. Let $b = \frac{e \cdot P_{1997nt1}}{P_{1997nt2}} > 0$, that is, the price ratio of Iceland's other services to China's personal services to be b in 1997. Let $X = \frac{A_{t1}/A_{t2}}{A_{1997t1}/A_{1997t2}}$ for all years. Let $Y = \frac{I_{nt1}}{I_{nt2}}$ for all years. Plug X and Y into equation (10) it'll become:

$$Y = \frac{c \cdot a}{b} \cdot X \tag{11}$$

where c is supposed to be positive and fixed as well as a and b. The data shall support these assumptions about (11) if BS hypothesis is to hold.

Table 1.3 shows the time series of X and Y derived from table 1.1 and 1.2. Chart 1.2 is the scattergram of the two variables. Although the sample size is far too small to yield significant estimate, a bivariate single linear regression without constant term is run to examine the validity of equation (11).

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
$X=A_{t1}/ aA_{t2}$	1.000	0.970	0.817	0.605	0.629	0.417	0.531	0.490	0.425	0.445
$Y=I_{nt1}/I_{nt2}$	1.000	1.032	1.054	0.974	0.801	0.889	1.084	1.178	1.393	1.303

Table 1.3 The test variables transformed from table 1.1 and 1.2

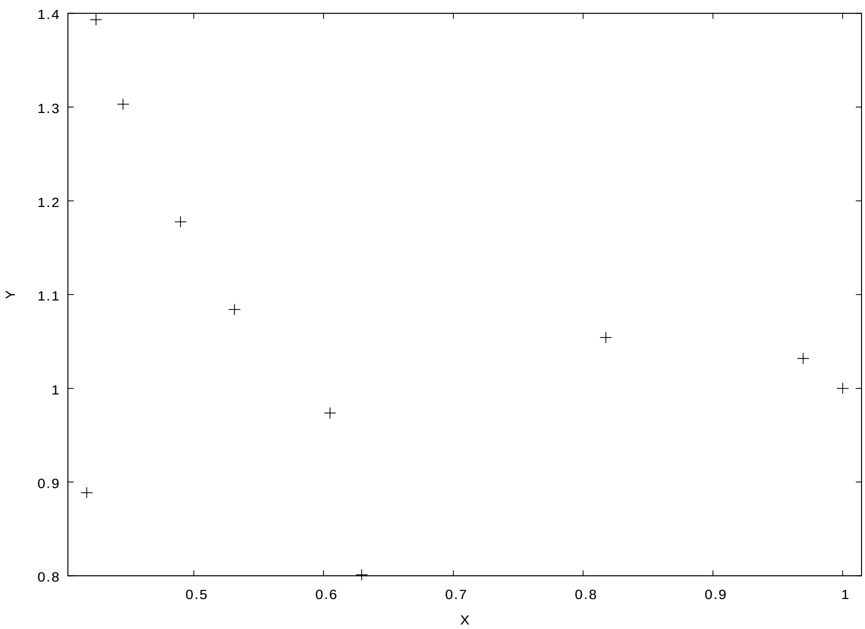


Chart 1.2 The scattergram of X and Y from table 1.3

The series don't look like ones that will support equation (11) or the BS hypothesis in chart 1.2. It is quite clear that that one variable tends to decrease while the other increases. They don't seem to exhibit positive correlation.

However the regression by GRETL returns the following report.

Dependent variable: Y

	coefficient	std. error	t-ratio	p-value
X	1.49616	0.212427	7.043	6.03E-05 ***

Mean of dependent variable = 1.07072
Standard deviation of dep. var. = 0.180013
Sum of squared residuals = 1.80536
Standard error of the regression = 0.447879
Unadjusted R-squared = 0.84643
Adjusted R-squared = 0.84643
Centered R-squared = -5.19030
F-statistic (1, 9) = 49.6062 (p-value = 6.03e-005)
Durbin-Watson statistic = 0.260315
First-order autocorrelation coeff. = 0.888946
Log-likelihood = -5.63026
Akaike information criterion (AIC) = 13.2605
Schwarz Bayesian criterion (BIC) = 13.5631
Hannan-Quinn criterion (HQC) = 12.9286

Surprisingly, all indicators appear to be very confirmative that the regression is valid and there's a strong positive correlation between tradable productivity and non-tradable price. The problem, however, lies in the regression model. As constant term is banned from the model, the function was forced to lean upwards through the first phase of the coordinate. This caused residual mean to deviate from 0, which is the basic assumptions of unbiasedness for a linear regression analysis. The sum of residual is 1.24 in this case. Therefore the regression is rendered meaningless concerning its support to BS hypothesis.

Even if a constant term is allowed in the regression function, which is theoretically hard to explain by BS hypothesis, it won't improve the situation. Such a regression using the same time series returns the following report.

Dependent variable: Y

	coefficient	std. error	t-ratio	p-value	
const	1.25335	0.179765	6.972	0.0001	***
X	-0.288511	0.269622	-1.070	0.3158	

Mean of dependent variable = 1.07072
Standard deviation of dep. var. = 0.180013
Sum of squared residuals = 0.255128
Standard error of the regression = 0.17858
Unadjusted R-squared = 0.12521
Adjusted R-squared = 0.01586
Degrees of freedom = 8
Durbin-Watson statistic = 0.602705
First-order autocorrelation coeff. = 0.724117
Log-likelihood = 4.1535
Akaike information criterion (AIC) = -4.307
Schwarz Bayesian criterion (BIC) = -3.70183
Hannan-Quinn criterion (HQC) = -4.97087

The t test for the slope estimate is not good enough. The R squares and information criterions do not yield confirmative results. And the estimate of slope is negative, meaning the result conflicts the presumption of positive linear correlation.

So in the case of Iceland-China service price comparison, BS hypothesis is not supported by the limited fact. Productivity difference in tradable sector doesn't turn out to be the cause of the enlarging price gap of haircut the way BS hypothesis proposes.

Beside data inadequacy, defects of the model have caused the failure of testing BS hypothesis. Just to name a few: First of all, tradable goods don't necessarily follow one-price rule in the long term. The global market is not completely unified firms can utilize obstacles to separate local markets from each other. There is observable practice of mark-to-market pricing that sets different prices on products in different areas. The difference in nature of currency and commodity market also causes dollar price of tradable goods in different countries to differ as exchange rates changes rapidly from one moment to another but commodity price stays relatively fixed (Okun, 1981).

Secondly, goods are not necessarily sold at cost because not all markets are perfect competitive and their degree of competitiveness may differ. If certain markets are less competitive in Iceland than in China, the products will likely to be sold at a higher margin in Iceland. In the case of haircut its margin is very likely to be lower in China than in Iceland due to the over-abundance of labour in China and the labour-intensive nature of haircutting.

The BS model is rather unsophisticated and over-simplified to be applied on the real world data. The model's merit is that it points out the two very key negligence of PPP: the non-tradability of certain goods and immobility of certain factors.

2. The Hecksher-Ohlin Model

Speaking of factor immobility, it is noteworthy that the examples used in the above analysis, fishery and textile, are different in factor intensities. The utilization of wild fish stock made fishery a lot more resource-intensive than textile which depends on crop cultivation and labour-intensive manufacturing. Because BS model takes labour to be the only production factor it is natural that production that's more intensive in other factors than labour yields higher unit labour output or lower labour-intensity. Therefore labour productivity does not need to be exogenous as BS model treats it. If more than one factor are considered the different factor intensities are able to explain labour productivity difference and non-tradable price difference.

Heckscher-Ohlin model (hereafter as HO model) offers such an improvement by bringing more production factors and offers explanations for non-tradable price difference from a prospect of factor endowment.

2.1 The Model

The HO model is based on the algebraic two-sector general equilibrium model described by Jones (1965). The simple 2x2x2 form of HO model can be demonstrated by the following premises:

i. There are two factors of production, let them be labour and capital.

ii. There are two countries and production technology is identical between them.

iii. There are two goods being produced, one is relatively intensive in labour and the other in capital, in this case one is tradable the other non-tradable.

iv. Production functions have constant return to scale.

v. Production factors are mobile within a country but immobile between countries.

vi. Aggregate utility function is homothetic and identical between countries.

So in additional to BS model, the 2x2x2 HO model introduces an extra production factor and consumer utility. The consumer information will enable HO model to look into commodity market as well as factor market and reach equilibrium in both of them.

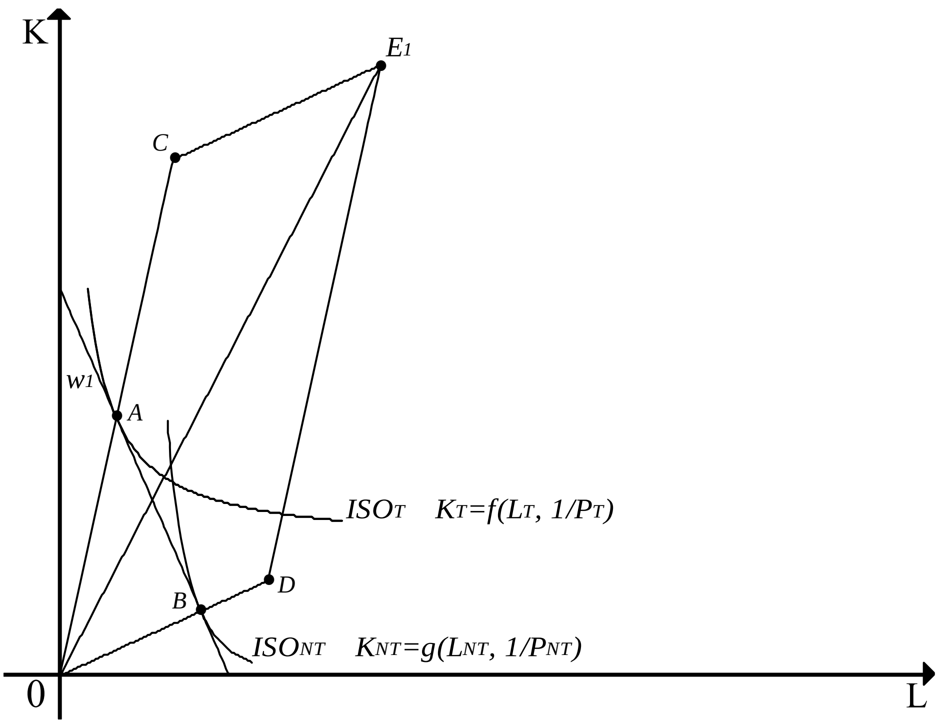


Figure 2.1 Factor market equilibrium of country 1

Figure 2.1 shows a state of equilibrium country 1's factor market where axis L indicates quantity of labour factor and axis K indicates quantity of capital factor. In this analysis country 1 serves as a reference against which country 2 will be checked. So it is supposed that country 1 is in equilibrium in both markets.

Point E_1 in figure 2.1 is the total factor endowment in country 1, the slope of OE_1 is the relative abundance of capital $\frac{K_1}{L_1}$.

Curve ISO_T is the isoquant of production of unit dollar tradable goods. It is the isoquant for production of one dollar's value of tradable goods or 1/ P_T unit of tradable goods, where P_T is price of the tradable goods. In the same way, curve ISO_{NT} is the unit dollar value isoquant for non-tradable goods. It is the set of possible combinations that generates one dollar in the non-tradable sector.

Line w_1 is the factor budget line for country 1, the set of factor combinations that cost the same. It is also the factor exchange line for country 1 as the absolute value of its slope represents the ratio at which capital factors exchange for one labour factor in the market. Because factors are perfectly mobile domestically (by premise v.) w_1 has to be a straight line as that there's only one price for each factor in a country. Under equilibrium, w_1 line shall be tangent on both isoquants so that factor cost of producing one dollar's value is equal in both sectors and the marginal rate of factor substitution in both sectors equals the market price ratio of factors.

w_1 must be tangent on at least one of the isoquants as a result of cost minimizing for unit dollar output. Then it must be tangent on both isoquants for otherwise one sector will be more profitable than the other. Under fixed commodity price factors will flow to the more profitable sector until the more intensively applied factor of that sector runs short and raise its relative price and restores the equality of unit dollar production cost in both sectors. The equilibrium will only be reached when the factor endowment line OE_1 lies within the diversification cone of *AOB* (Mckenzie, 1955), otherwise one or even both productions will not be possible due to endowment limit. It is for now assumed that endowment line lies inside diversification cone.

To start with, let the tradable goods be capital-intensive and the non-tradable labour-intensive. This is not necessary and doesn't affect the result of the analysis, although it is closer to reality when the non-tradable in question is haircut. As a result tradable production has a higher capital-labour ratio than non-tradable under equilibrium, seen as *OA* is steeper than *OB* in figure 2.1.

The factor market clears under equilibrium. By using parallelogram OCE_1D the total factor endowment OE_1 is broken down into vector *OC* and *OD*, each indicating the quantity of factors invested into tradable and non-tradable sectors.

According to premise iv., production functions exhibit CRS. Output shall be proportional to the number of factor baskets invested in each sector. The ratio of the length of investment vectors with same direction represents the output value. Therefore, in terms of dollar value, tradable output will equal $\frac{OC}{OA}$ and non-tradable output $\frac{OD}{OB}$.

So much for factor market equilibrium, let's turn to the commodity market. Figure 2.2 shows an equilibrium condition in country 1's commodity market.

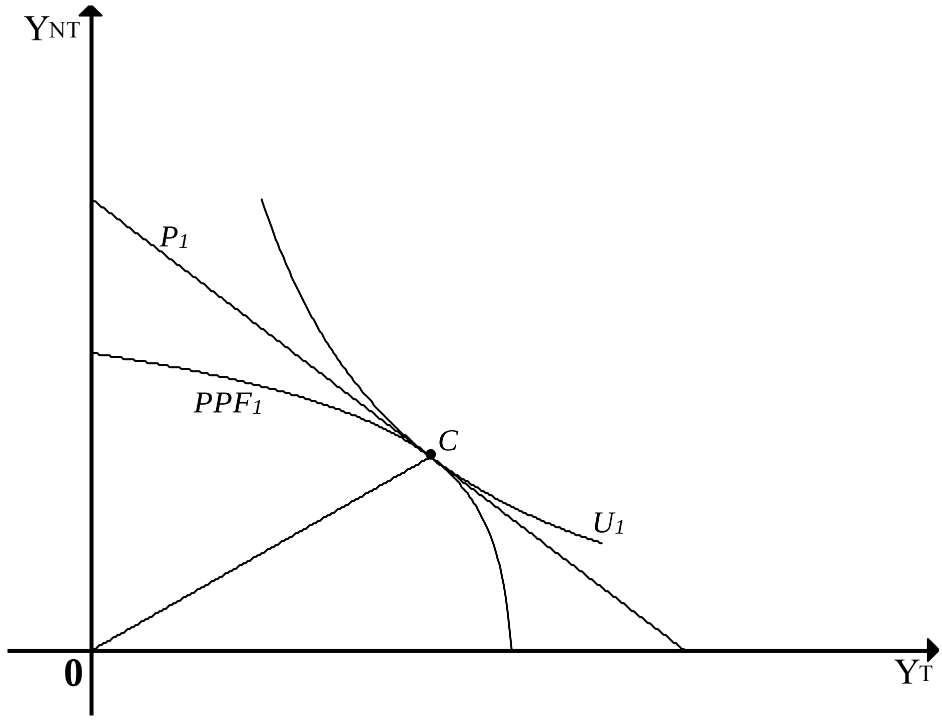


Figure 2.2 The goods market equilibrium of country 1

Axis Y_T designates the quantity of tradable product and axis Y_{NT} the quantity of non-tradable product.

Curve PPF_1 is the production possibility frontier of country 1, which is defined by the production functions and factor endowment. It features monotonic decreasing and concavity to origin O. The curve is the result of mapping the set of all possible *OC* and *OD* in figure 2.1 onto the Y_T-Y_{NT} space. The derivation of concave PPF in a two-goods two-factor model is presented by Savosnick (1958).

Indifference curve U_1 is defined by aggregate utility function of country 1. Under equilibrium, when utility is maximized, the two curves have a tangent point *C*. The tangent line P_1 that cuts through it is a kind of budget line. The absolute value of its slope indicates the equilibrium rate of exchange between the two products which is equal to their marginal rate of substitution on both demand and supply sides. And any consumption combination on line P_1 costs the same at this suggested exchange rate.

So country 1 is set to be in equilibrium, we now need to look at the object country, country 2, which faces the same environment except a different factor endowment and see what this difference will lead to.

Suppose country 2 is relatively more abundant in labour and scarce in capital than country 1: $\frac{K_1}{L_1} > \frac{K_2}{L_2}$ To begin with, suppose country 2 has reached exactly the same equilibriums as in country 1, that is, equilibrium at the same product prices and factor prices. Let's see if this will lead to contradictions and how this will have to adjust.

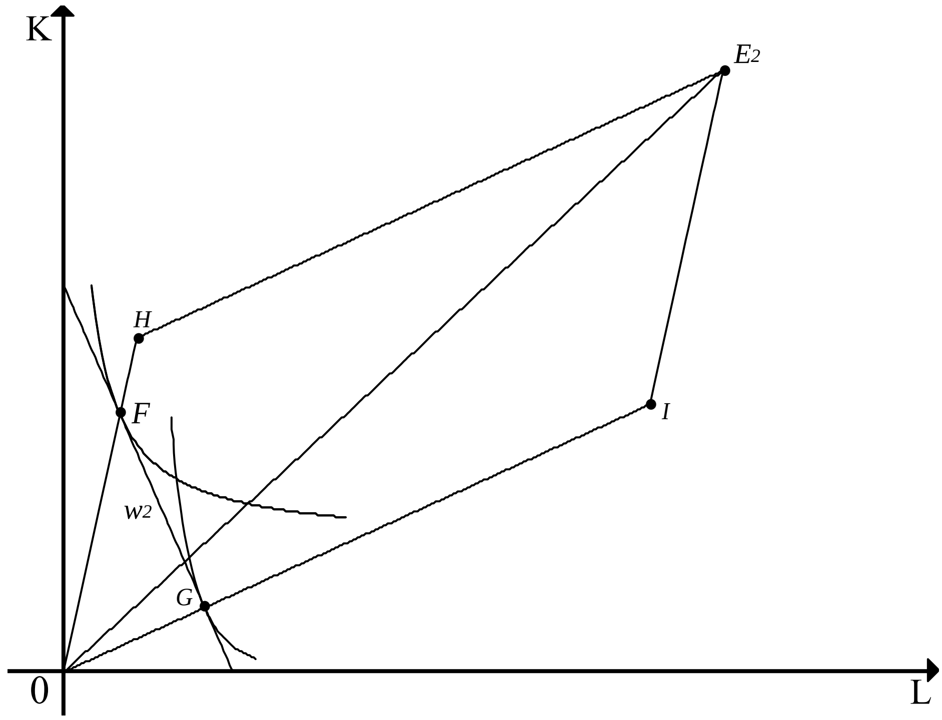


Figure 2.3 The unbalanced factor market of country 2

The factor endowment difference is reflected in figure 2.3 with a smaller slope of OE_2 than OE_1. All other elements of the figure are the same as in Figure 2.1: the two isoquants are the same since their production functions never change and unit prices of their products are supposed to stay unchanged, for now. Accordingly the equilibrium factor budget line w_2 is the same as w_1 indicating unchanged factor price ratio; these make the composition of factor baskets *OF* and *OG* to be the same as *OA* and *OB*.

The smaller slope of OE_2, however, lead to the result that relatively more factor baskets *G* are invested into the labour intensive sector (the non-tradable) and fewer of basket *F* are invested into the capital intensive sector (the tradable) than in country 1, in order for the factor market to clear. This being reflected in the figures is $\frac{OH}{OC} < \frac{OI}{OD}$ which can easily be proofed. This can also be understood as the country has to change its output structure to suit its factor endowment. It is forced to produce less of those that demand scarce resource and more of those that utilize abundant resource; otherwise it'll be left with a remnant of only the abundant factor which can hardly be used to produce anything (lying outside any diversification cone).

Turning to the commodity market of country 2 in figure 2.4, the slope of the original budget line P_2 is the same as that of P_1 in figure 2.2 because the prices of both goods are supposed to remain unchanged. Because the factor market suggests country 2's equilibrium output consists of more non-tradable and less tradable goods than country 1's, the original commodity market equilibrium, point *N*, shall have a higher $\frac{Y_{NT}}{Y_T}$ ratio than point *C* in figure 2.2, that is, *ON* has a larger slope than *OC*.

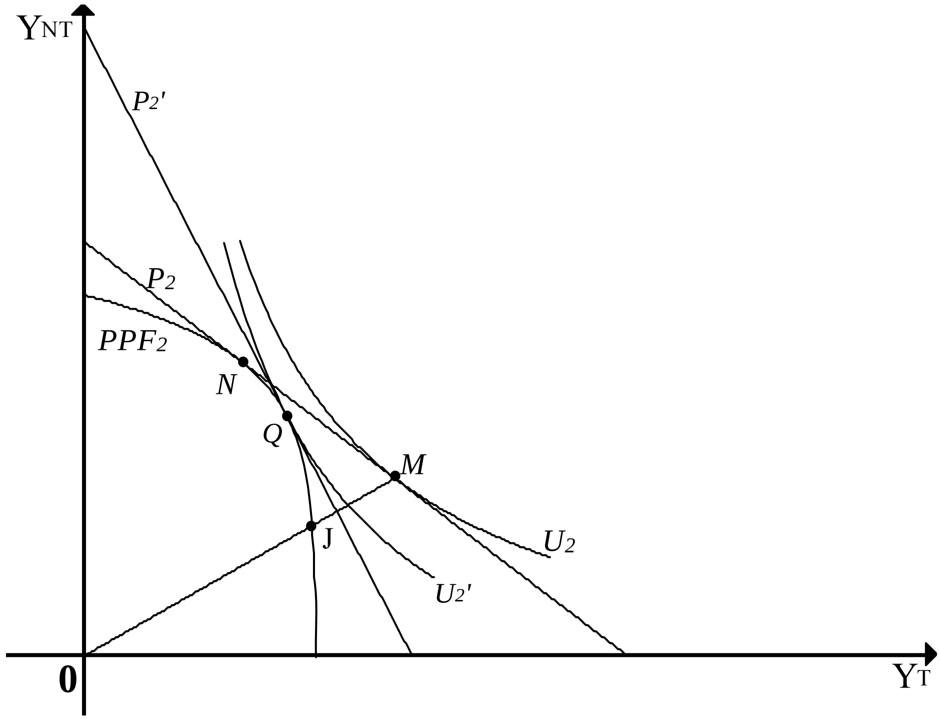


Figure 2.4 Balancing of goods market in country 2

By drawing a line from the origin that has the same slope as *OC* and intersect it with P_2 at point *M*, it can be inferred that country 2's aggregate utility curve U_2 will be tangent on budget line P_2 at point *M*. This is because of premise vi.: aggregate utility is homothetic and identical between nations, which means that marginal rate of substitution (MRS) remains the same if composition of consumption doesn't change ("120 Mathematical Economics"). Therefore the actual tangent point between PPF_2 and the aggregate utility curve, the new equilibrium point, cannot be at point *N*, where

$\frac{Y_{NT}}{Y_T}$ ratio is higher than at point *M*. Neither can it lie above point *N*, as from there first derivatives of the points with equal slope on the curves diverge further. Tangent point cannot be at point *J*, where consumption structure is the same as point *M* but first derivative of PPF_2 is not the same as of U_2. And downwards from *J* the first derivatives diverge further on points with equal slope. Therefore the tangent point or the new equilibrium must fall between *N* and *J* such as *Q*. Given the concavity of PPFs the first derivative at the new equilibrium *Q* shall be larger in absolute value than at *N*. One unit of tradable goods will exchange for a larger quantity of non-tradable. In other words, tradable goods will appreciate against non-tradable. Because tradable goods have a fixed global price non-tradable goods will depreciate in dollar in country 2 making it cheaper than in country 1.

The new equilibrium in country 2's commodity market, when compared to country 1's, is then characterized by a lower price on non-tradable and a higher output ratio of non-tradable to tradable.

Take a look at factor market again, as can be seen in figure 2.5, the price change and output structure change determined by the commodity market will affect several elements of the factor market.

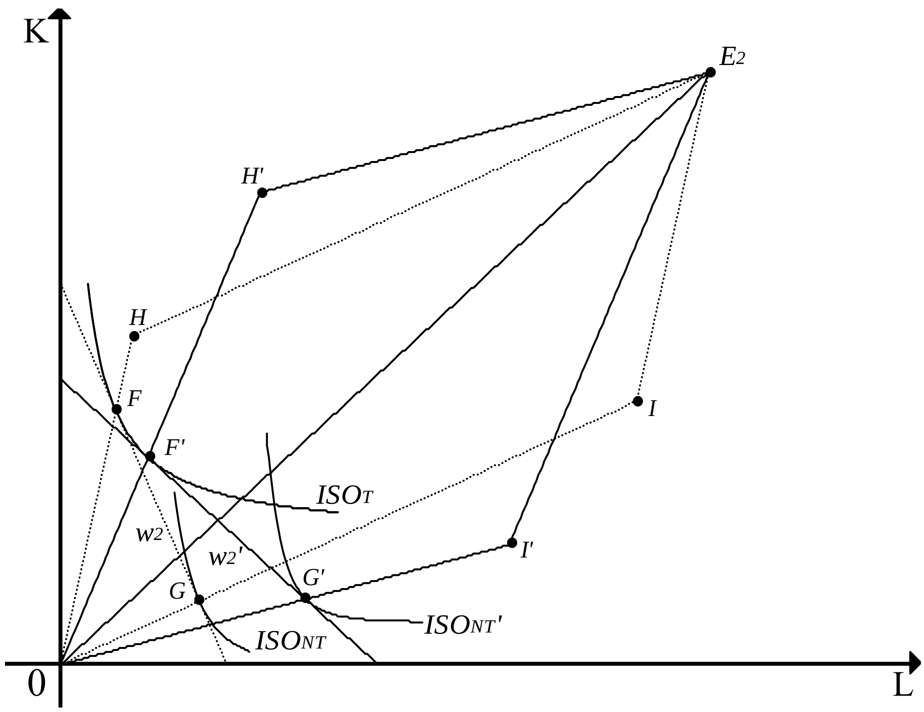


Figure 2.5 Balancing of factor market in country 2

At first, ISO_{NT}, the unit dollar isoquant of non-tradable sector, will move up and to the right, such as to ISO_{NT}', because the price of non-tradable falls and more units of non-tradable products need to be produced to make one dollar. After that, equilibrium factor budget line will rotate anti-clockwise to tangent on both isoquants to restore factor market equilibrium. After the rotation the new tangent point *F'* on ISO_T will lie to the lower right of the original point *F*. This means equilibrium factor composition of tradable goods production becomes more intensive in labour and less so in capital, fitting to the country's endowment. The rotation also indicates a relative price drop of labour factor, just as Stolper-Samuelson theorem suggests, one labour unit now exchanges for fewer capital units than before (Stolper & Samuelson, 1941). Cheaper labour relative to capital is also intuitively suitable for the labour-rich endowment of the country. Furthermore, by comparing w_2 (actually w_1) and w_2', we can conclude that capital factor is more expensive in country 2 than in country 1 (w_2' has a lower intercept on Y axis) and labour factor is more expensive in country 1 than in country 2 (w_2 has a shorter intercept on X axis).

Because production functions exhibit CRS their isoquants must be homothetic which means the first derivative of isoquants of the same production function is a function of factor composition (capital-labour ratio). For any well behaved isoquant its first derivative shall be monotonically decreasing in capital-labour ratio. Therefore, within a group of isoquants of the same production, a greater first derivative must correspond to a lower K-L ratio. As point *G'* has a greater first derivative than *G*, slope *OG'* shall be smaller than *OG*. In the same way *F'* is also lower in capital-labour ratio than *F*. These will lead to $OH' > OH$ and $OI' < OI$ or in another word: output quantity of tradable will increase, that of non-tradable will drop.

To summarize for the analysis: When labour-intensive goods is non-tradable and all is in equilibrium, the relatively labour-rich country (the object country) will have cheaper labour-intensive goods while producing proportionally more of it than the reference country. Labour will be cheaper and capital more expensive in the object country and both goods will be produced with a higher labour-capital investment than in the reference country.

The dynamics of equilibrium restoration is such that: once there's a supply-demand gap in the commodity market, e.g. excess demand for capital-intensive goods or lack of demand for labour-intensive goods, the market initiates a relative mark-up of the price of the capital-intensive goods. In its wake factors will be repriced to keep profitability of both sectors equal so that labour price will drop relative to capital. Factor price change creates a higher labour-capital investment ratio in both sectors. And due to the labour-abundant factor endowment this change in investment compositions will enable the country to produce more capital-intensive goods and less labour-intensive goods than before. The output change will eliminate the supply-demand gap.

Because the suppositions about factor endowment difference and factor requirement of productions can all be reversed without affecting the course of the analysis, we can conclude in a more general from.

When compared to other countries, the country that is richer in the factor that is more intensively used in non-tradable will:

1). have a lower nominal price on non-tradable goods.

2). produce proportionally more non-tradable goods.

3). have lower price on the abundant factor and higher price on the scarce factor.

4). more intensively use the abundant factor in the both sectors.

Look back to figure 2.3, where it was supposed that endowment line OE_2 lies within the diversification cone *FOG*. What if OE_2 lies outside *FOG*, that is, beneath *OG*? *OG* will need to sink below OE_2 in order to enable production of the capital-intensive tradable goods. That means ISO_{NT} must move to the right and relative price on labour must drop. The following of the analysis is the same as above but this time non-tradable price drop is evident without even referring to the commodity market. So factor endowment being outside of diversification cone calls itself for a new equilibrium, it actually makes an easier case than otherwise. Detailed discussion on this matter can be seen in Bhagwati (1984).

2.2 Adaptation

The model presented above needs some minor adjustment to adapt to the haircut case. The production function of haircut (represented by ISO_{NT} and ISO_{NT}') should be different from that of the tradable goods (ISO_T) in that haircut production is less elastic in factor substitution than tradable goods production. Capital and labour factors cannot be substituted as freely in haircut business as in, say, car production. Actually common sense suggests that haircut can be treated as not having any elasticity of factor substitution at all. This means haircut will be produced with same proportion of factor investments in both countries and *OI'* and *OI* in figure 2.5 will coincide with each other. Figure 2.6 shows the adjusted situation in country 2's factor market.

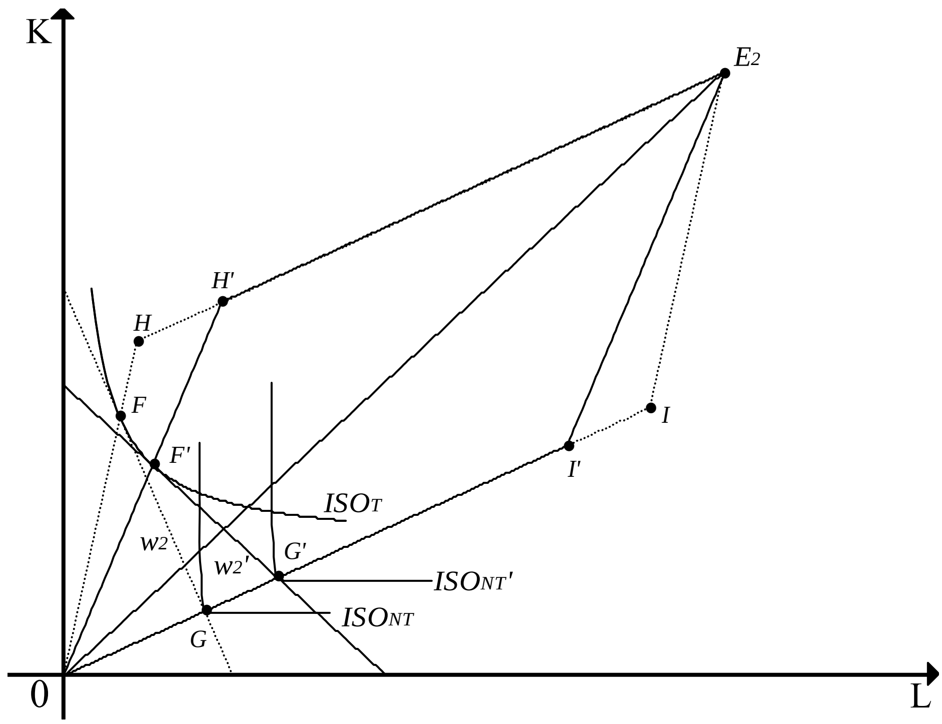


Figure 2.6 Balancing of factor market in country 2

All other conditions remaining the same, the adjustment won't change any qualitative indications of the original model so that the conclusions above shall hold.

What the adjusted model implies is that: China is relatively rich in labour factor and poor in capital factors. Iceland is relatively poor in labour but rich in capital factors such as natural resources like hydro power, geothermal power, valuable fish stock and accumulated capital product like know-how in geothermal energy development and the geographical advantage of being close to the world's major market. Tradable sector in Iceland utilizes these other-than-labour factors to produce at a lower labour intensity, while the non-tradable sector is labour-intensive and can't utilize the endowment of other factors to the same extent. This causes non-tradable products to be relatively more expensive against tradable products in Iceland than in China.

2.3 Data

It is hard to collect real data on factor endowment and intensity and output and price data by sectors which are required to run statistical tests for the HO model. Instead scratches of information are available to illustrate certain situation the model prescribes.

First of all, factor intensity difference does exist between tradable sectors. An example can be found in the two countries' energy and aluminium industry. Although energy is not very tradable, aluminium is. And aluminium smelting is highly energy consuming. It takes at average 14MW of electricity to produce one ton of aluminium (SustainableChoice) and energy cost constituted 37% of its unit cost in China ("氧化铝成本", 2008). Therefore factor intensity in power supply determines, to a great extent, factor intensity in aluminium production. This enables us to use data from energy industry to learn about aluminium production whose information is hard to find.

Table 2.1 lists the annual supply of electricity and employed population in all power plants in Iceland from 1994 to 2006 (Hagstofa). Labour intensity is also calculated and it has been lowered by half during this period.

	Electricity generated (GWh.)	Workers employed (L)	Labour intensity (L/GWh.)
1994	4773.9	1500	0.314
1995	4976.8	1400	0.281
1996	5112.4	1100	0.215
1997	5581	1200	0.215
1998	6275.8	1500	0.239
1999	7185.4	1200	0.167

2000	7679.5	1300	0.169
2001	8028.7	1500	0.187
2002	8411.1	1500	0.178
2003	8495	1600	0.188
2004	8618.8	1600	0.186
2005	8679.6	1500	0.173
2006	9924.9	1500	0.151

Table 2.1 Annual supply of electricity and employed population in Iceland

Resource: Hagstofa

The same data from the major power plants in China is listed in table 2.2 (NBSC). Labour intensity there had dropped by 2.5 times from 1994 to 2006 which is a bit more than in Iceland.

	Energy generated (GWh.)	Population employed (L)	Labour intensity (L/GWh.)
1994	928080	1910	0.486
1995	1007730	2010	0.501
1996	1080020	2120	0.509
1997	1134470	2200	0.516
1998	1166200	2180	0.535
1999	1239300	2191	0.566
2000	1355600	2180	0.622
2001	1471660	2197	0.670
2002	1640470	2205	0.744
2003	1910580	2262	0.845
2004	2203310	2275	0.969
2005	2500260	2268	1.102
2006	2865726	2342	1.224

Table 2.2

Annual supply of electricity and employed population in major power plants in China

Note: grey area contains estimated data as real figures are not available.

Resource: NBSC

The labour intensities from table 2.1 and 2.2 are compared in chart 2.1. It can be seen that although intensity has been dropping faster in China, it's still a lot higher than in Iceland.

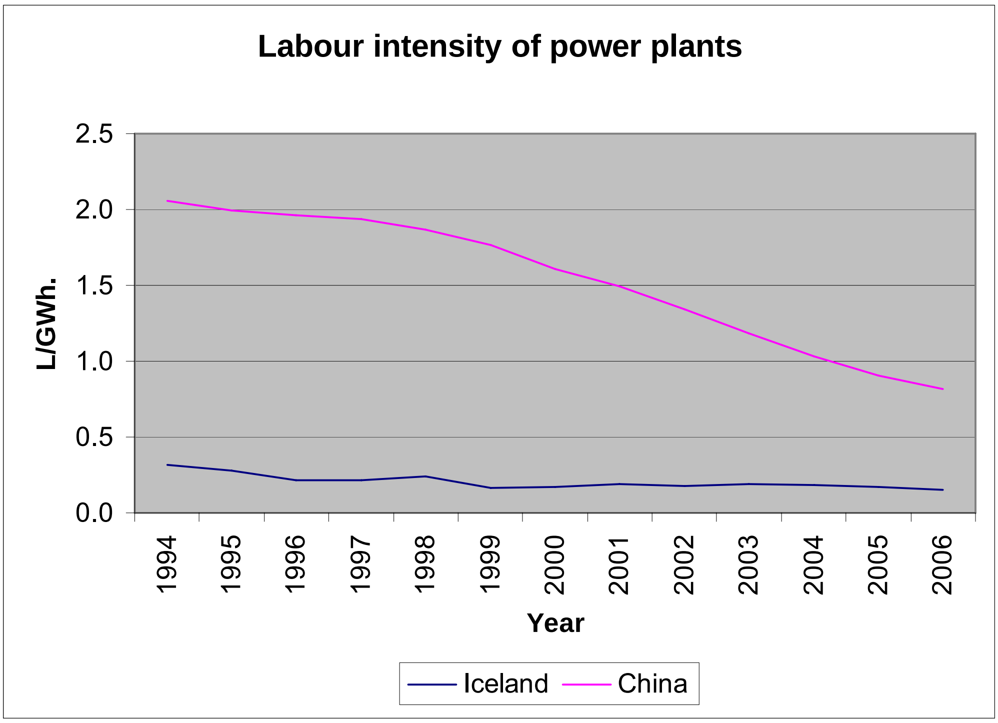


Chart 2.1 Labour intensity of power plants

One possible explanation for the labour-intensity difference between energy industries is the structure of energy source. In Iceland, hydro- and geothermo-power has been almost the only source of energy since the 90s. Both of them utilize natural resources and related technology intensively and require relatively little labour investment. In contrast China has a high proportion of fossil fuel power generation which is labour thirsty. Chart 4 shows the structure of energy source in Iceland from 1994 to 2006. Fossil fuel proportion was 0.1% in 1994 and became 0% after 2005. It is therefore invisible in the chart. Chart 2.3 shows the structure in China based on data from NBSC.

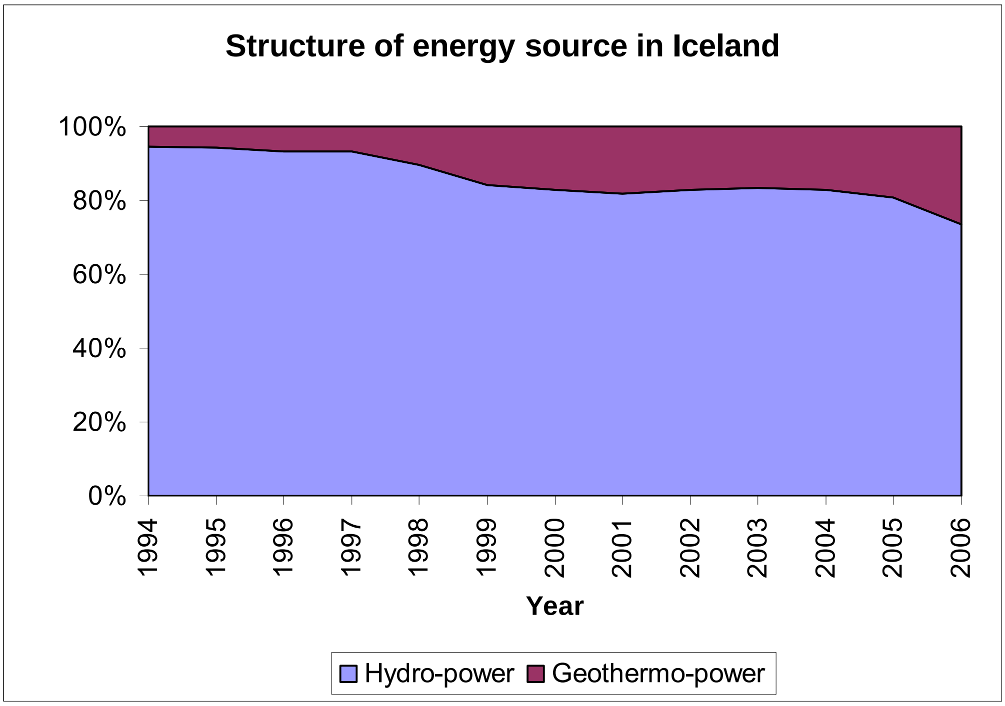


Chart 2.2 Structure of energy source in Iceland (Hagstofa)

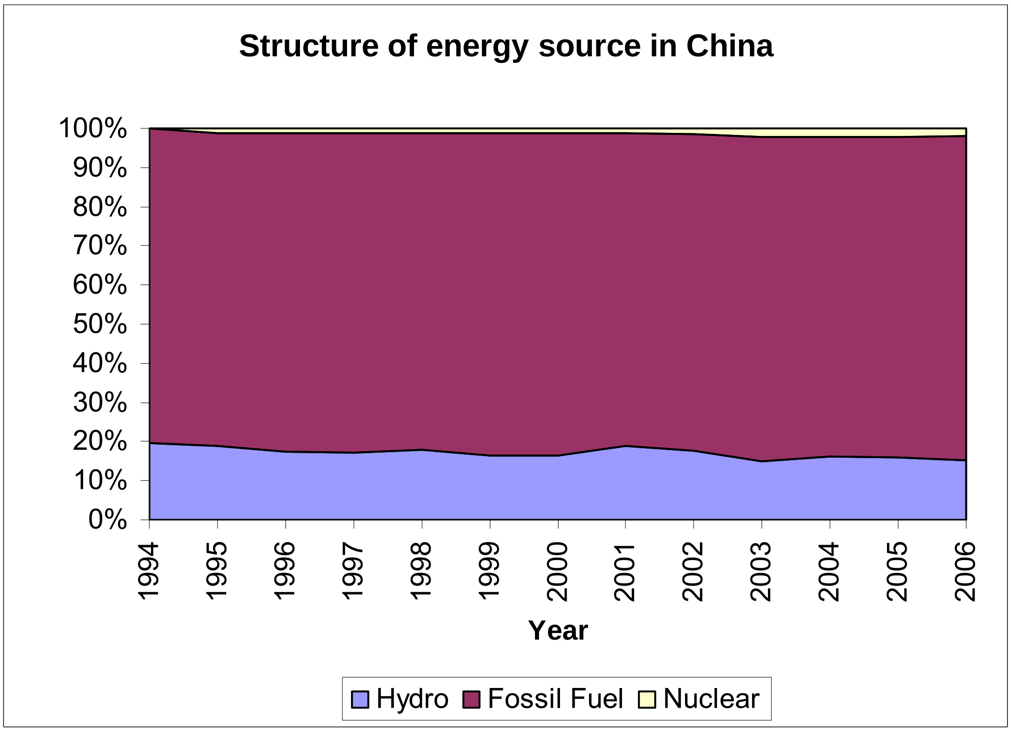


Chart 2.3 Structure of energy source in China (NBSC)

It is notable that 95% of fossil fuel power in China is coal-burning ("中国火力发电", 2004). As is known coal mining is a labour-intensive business and in China manual mining is quite common. This makes Chinese fossil fuel power and in turn Chinese energy industry more labour-intensive. Therefore Chinese aluminium industry shall be more labour-intensive than their Icelandic counterparts, just like what figure 2.6 proposed that OF' should lie beneath OF.

Although relevant survey is not provided by the authority, certain facts can be found to suggest that capital-intensive tradable goods are relatively cheaper in Iceland than in China, implied by P_2' being steeper than P_2 in figure 2.4.

Regarding capital-intensive tradable goods, we look at offers on a new 5-door yaris car from Toyota dealers in Shanghai and in Kópavogur Iceland on 31st. Dec. 2008. The average price was 66,500 Yuan (易车网) and 2,050,000 Krona (Toyota) which corresponds to \$ 9,730 and \$ 16960 according to the central banks' exchange rate on the day. Again haircut is used to represent labour-intensive non-tradable goods. The cheapest haircut still costs 5 Yuan in Shanghai but 3000 Krona in Akureyri, which were \$ 0.7316 and \$ 24.8195 respectively. Relative price of one such car is then 13299.6 haircuts in Shanghai and only 683.3 haircuts In Iceland.

Relative price of labour factor is higher in Iceland than in China. Example can be found in purchasing power of petroleum of personal disposable income. The average purchasing power of annual wage was around 4,000 litres in China and about 30,000 litres in Iceland year 2007 according to income data from the statistic bureaus.

Since labour is relatively more expensive and capital relatively cheaper in Iceland, aluminium production is more economic in Iceland for it utilizes capital to substitute for expensive labours at a larger scale. Haircut is uneconomic in Iceland because labour cannot be substituted by capital to the same extent in haircutting. It would result in that Iceland produces more aluminium relative to haircut than China. Since consumer preference is uniform between the two countries, the difference in supply causes haircut to be relatively more expensive in Iceland than in China. As aluminium has a fixed price all over the world, haircut should be more expensive in Iceland than in China.

The 2x2x2 HO model describes a simplified situation. When there's only one tradable goods and international payment is in balance there won't be international trade because trading a good for the same good (aluminium in this case) is the same as no trading at all. Every country produces all that its residents need. When tradable sectors include more than one good that are different in factor intensity trade will take place and diversification and specialization will happen in global economy. Countries with different endowment will specialize in providing the kind of tradable goods that best fit its resource limit. Bahgwati (1984) provided a discussion on this topic and yielded a similar outcome as the above one.

3. Summary

One key element BS and HO models base on is the immobility of production factors across countries, especially that of the labour factor. Pricing systems of factors and non-tradable goods are indirectly connected through trade and arbitrage of tradable goods which creates a standard measure of value. Due to differing production capability, caused by differing factor endowment and the hindrance for factors to move to even out the difference, demand for non-tradable goods is unequally met in different countries. This leads to non-tradable goods being unevenly valued against tradable goods in different countries.

A change of production function (through introduction of new technology for instance) or factor endowment in a country (by discovering natural resource, improving education etc.) will change its non-tradable price gap with other countries. Free flow of factor is another challenge to the structural price departure. Factors, especially labour, will probably never be able to move as efficiently as commodities. But the movement has already started and shown its effect in many countries as we're ourselves experiencing stronger influence of immigrants in Iceland.

As far as China is concerned, neither BS nor HO model fits well enough. China's huge population made unemployment constantly high which explains to some degree why inflation had been low and wage growth little in quite a long time, best reflected in the fact that the cheapest haircut had cost the same throughout the 8-year period. China has never got and will probably never get close to the kind of equilibrium these models define. A different outset will be needed for a model to explain the situation.

4. The Dutch Disease

4.1 The Model

The term 'Dutch disease' was coined to refer to the decline of traditional manufacturing sector in the Netherlands after the discovery of natural gas in the 60s ("The Dutch Disease", 1977). The model describing the phenomenon was presented by Corden and Neary (1982). Today the concept of 'Dutch disease' is used to refer to structural changes in economies therefore is not limited to a short-term rush type of change but also gradual and sustainable changes in economic structure. The 'disease' bridges across the division of 'structural departure' and 'transitory deviation' from PPP.

'Dutch disease' doesn't compare price level between countries. It deals with internal structural change in a small open economy and its impact on the economy. So the theory can be used to explain a rise on non-tradable price over time. The explanations are relevant especially in light of what's happening to the Icelandic economy before and after the financial crisis.

The simplest form of the model assumes that:

a). there's only labour factor and it is mobile across sectors within a country.

b). the tradable sector consists of two divisions. One experience a boom, called the booming industry, and the other doesn't, called the lagging industry. In the case of the Netherlands, the booming one is gas mining and the lagging one is manufacturing.

c). a single type of non-tradable goods is produced whose price is determined endogenously.

d). the economy always adjusts to equilibrium.

A 'Dutch disease', or structural change, starts with a boom in the booming industry. It exerts two kinds of effects on the economy. One is 'resource movement effect' and the other 'spending effect'. The former is the effect of the booming industry drawing factors from other sectors while demand is inelastic to income. This will cause decline in both non-tradable sector and lagging industry or 'direct deindustrialization'. The latter, the 'spending effect', is brought by the demand change due to income growth after the boom. Income growth will boost demand on all goods. Besides the booming industry, the non-tradable sector will catch up in output by raising price and retrieve factors back to it. The lagging industry, being unable to raise price, will lose investment and diminish in scale. This leads to what's called 'indirect deindustrialization' where service business flourishes but traditional manufacturing decays.

Let's first look at the 'resource movement effect' and the process of 'direct deindustrialization'. Figure 4.1 shows the conditions of factor (labour) market.

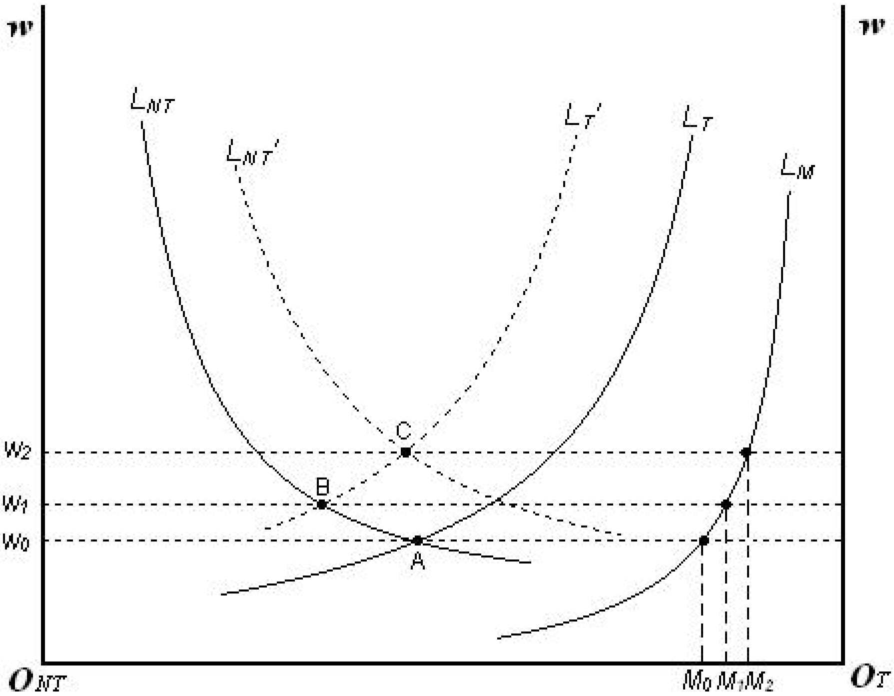


Figure 4.1 The effect of resource movement on labour market

Resource: Corden & Neary, 1982

Curve L_T is the original labour demand curve of the tradable sector. L_M is that of the lagging industry which represents part of the tradable sector demand. O_T is their origin. Curve L_{NT} is the original labour demand curve of the non-tradable sector and has its origin at O_{NT}. The original balance point A refers to a wage level of w_0 with lagging industry employment M_0. When boom struck the booming industry, factor demand of the tradable sector will increase at the same factor price level heaving up the demand curve from L_T to L_T'. A new wage level w_1 is reached and employment falls in both the lagging industry (from M_0 to M_1) and the non-tradable sector.

Turning to the commodity market, figure 4.2 shows how it responds to the employment change. To simplify the graph the axis Y_T is used to represent the output of the whole tradable sector. This is possible as the prices of tradable goods are supposed to be determined by the global market and are fixed during the analysis. So that the two types of tradable goods are substitutable at a given rate, they can be treated as one goods and measured in a common unit. The axis Y_{NT} measures output level of the non-tradable goods. Curve PPF_1 is the original production possibility frontier and U an indifference curve of aggregate demand. The original balance is at point a and the budget line that cuts through it indicates the exchange rate between tradable and non-tradable goods.

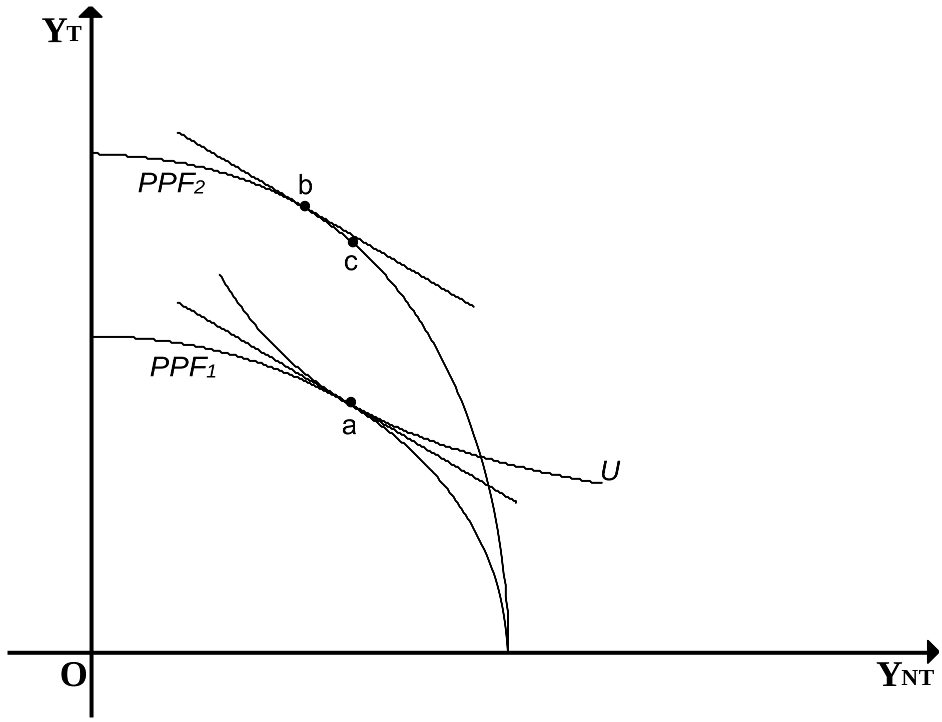


Figure 4.2 The effect of resource movement on goods market

Resource: Corden & Neary, 1982

After the boom the output capacity of the tradable sector is improved while that of the non-tradable remains the same. This shapes the new production possibility frontier PPF_2, with a higher intercept on Y_T axis and larger absolute value of first derivatives at each Y_{NT} value.

If the demand for the non-tradable goods is price-elastic and income-inelastic, indifference curves shall all have the same marginal rate of substitution (first derivative) at the same Y_{NT} position. An indifference curve of a higher utility would be found by lifting *U* straight upwards. This means that indifference curve will cut through point *c*, which is right above point *a*. In words, demand structure will be at point *c* if price ratio doesn't change. On the other hand, if price ratio doesn't change supply side will be producing at point *b* where marginal rate of transformation is the same as at point *a*. So indifference curve will touch PPF_2 somewhere between *b* and *c*. It gives rise to an output increase and relative price rise of the non-tradable goods, though the output is still lower than before the boom (the tangent point being to the left of point *c*).

The feedback from the commodity market is reflected in the factor market by raising labour demand curve of the non-tradable sector to L_{NT}'. A new equilibrium is found at point *C* where wage is even higher than before and factor loss is lessened in the non-tradable sector but worsened in the lagging industry. Such is the process of 'direct deindustrialization': after the boom the lagging industry will decline due to rising wage level, the non-tradable sector will also reduce in scale but to a lesser degree because of risen price.

Turn to focus on 'spending effect' and the process of 'indirect deindustrialization'. Suppose the booming industry doesn't require any factor investment so that there's going to be no factor movement directly caused by the boom, the labour demand of the tradable sector is the demand of the lagging industry. In figure 4.3, curve L_T and L_M coincide and don't move. The original equilibrium point is *D*.

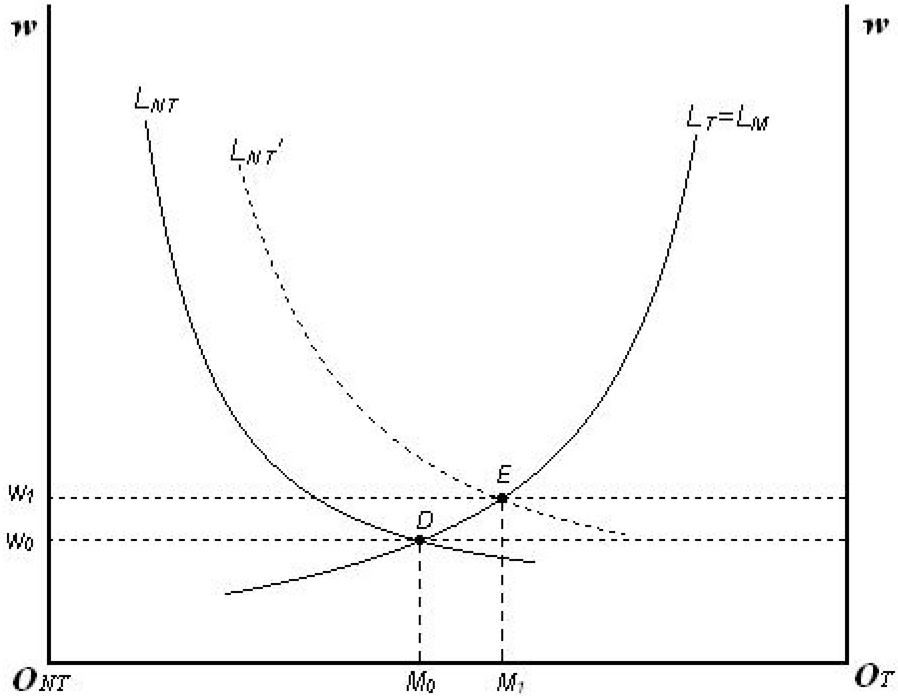


Figure 4.3 The effect of spending on labour market (Corden & Neary, 1982)

In the commodity market, the PPF is lifted vertically up from PPF_1 to PPF_3 in figure 4.4 when a boom struck. This is because that the booming industry brings an extra amount of output (the height by which PPF rises) without taking any labour force from the other departments and disturbing the output capacity of other businesses.

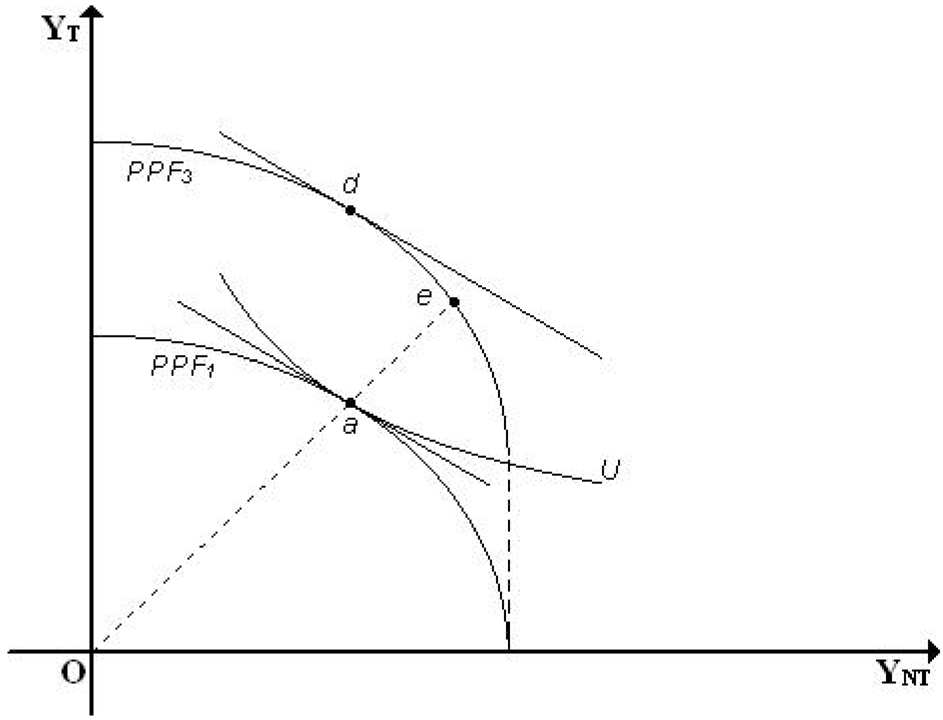


Figure 4.4. The effect of spending on goods market

The boom doesn't affect factor market so point *d* is the initial output scheme that corresponds to point *D* in figure 4.3, it's right above point *a* and has the same price ratio. The non-tradable sector and the lagging industry will not adjust output at unchanged price ratio and wage level. The aggregate demand is now income-elastic. Suppose it is homothetic, just like in HO model. An indifference curve will cut through point *e* at a same angle as *U* at point *a*, which means the demand structure will be at point *e* if price arrangement remains unchanged. These lead to the conclusion that an indifference curve will touch PPF_3 somewhere between *d* and *e*. The production of the tradable goods will drop, that of the non-tradable will rise and non-tradable goods will appreciate against the tradable.

Back to the factor market in figure 4.3, risen price and output will lift non-tradable labour demand upwards to L_{NT}' and the new equilibrium point *E* will be to the upper right of the original equilibrium *D*. Employment will increase in the non-tradable sector and drop in the lagging industry and wage level will rise.

The analyses of the two effects are based on different assumptions, so their results are only qualitative. It is clear that if 'resource movement effect' is stronger enough, that is, if the booming industry is relatively more factor-intensive than income-generating, employment and output will then drop in the non-tradable sector after all. If the 'spending effect' is stronger enough, that is if the booming sector is relatively more income-generating than is factor-intensive, the non-tradable sector will boom. In reality it's impossible to break a boom into two effects and study them independently. But whichever effect dominates, the lagging industry receives more damage than any other as both effects tend to reduce its magnitude. And when it comes to price level, 'Dutch disease' always pushes non-tradable price higher since both effects lead to mark-up in non-tradable price.

If we look at the whole process without discerning the two effects, the problem of non-tradable sector output will be about where an indifference curve touches PPF_2 in Figure 4.2, whether to the left or right of point *c*. And that depends on what assumptions we make about utility, the boom and others elements.

'Dutch disease' in itself is not necessarily a transitory or negative phenomenon. It only refers to a kind of structural change in an economy. The boom can be a permanent improvement to economy and therefore sustain all the changes made to the economy. It can also be a temporary fluctuation of the economic structure. If that is the case the economy would then retrieve to where it was once the boom is over. The resource movement and spending effect would be undone. Wage would fall back and employment structure switch back to where they were if production technology in lagging industry didn't fall behind during the boom period. Non-tradable sector would shrink and price of non-tradable goods fall relatively. The lagging industry would pick up more resource and increase output.

Therefore 'Dutch disease' can lead to 'structural departure' or 'transitory deviation' of non-tradable price depending on whether the 'disease' is a sustainable one or not. In the case of Iceland, a large part of the previous boom was unsustainable and therefore caused 'transitory deviation'.

4.2 The boom

The boom in Iceland in the last decade was characterized by over-sea expansions, especially those of the financial sector which was one of the most fast-growing parts of the economy. Given its international nature, financial service, especially banking, could be considered as tradable. It fits the definition of a booming industry.

Some data from Hagstofa is processed and presented below to help to shed lights on the boom. First there is evidence that employment structure had changed with a distinguishable pattern in the last few years. Chart 4.1 shows the percentage of work force employed in some industries of the economy from 1991 to 2007 which is the longest time series available.

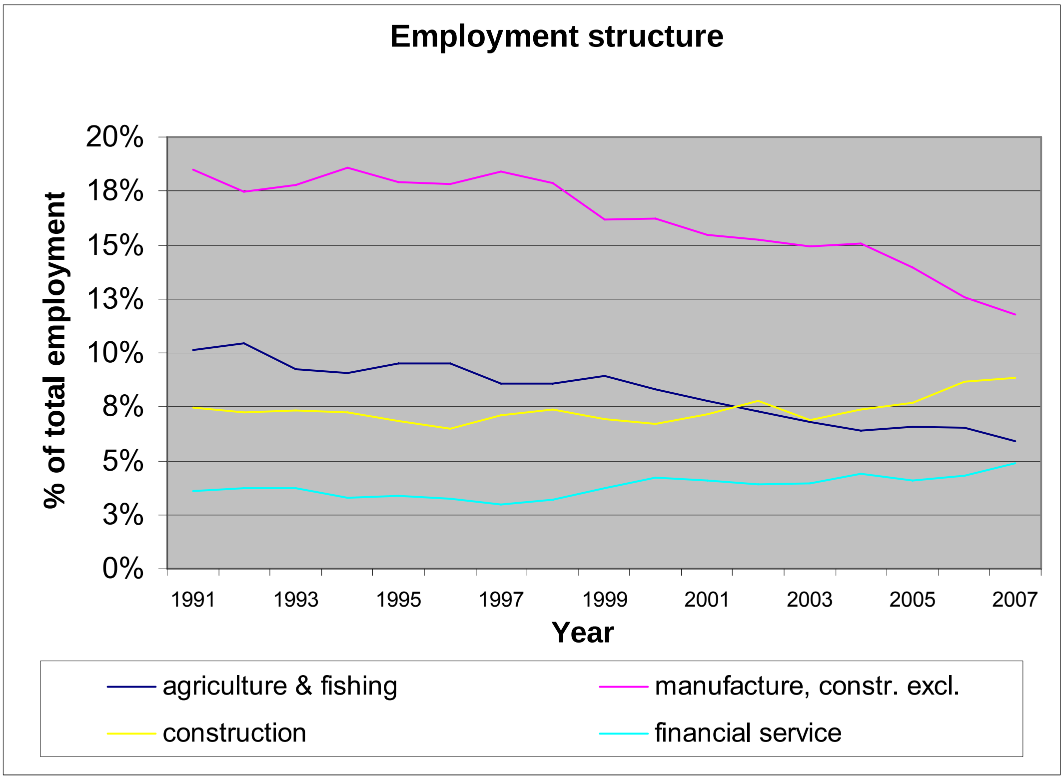


Chart 4.1 Employment structure of Iceland (Hagstofa)

Manufacture, constr. Excl.: manufacture industry where construction industry is excluded.

It shows that agriculture has throughout the period been steadily losing workforce. But manufacturing didn't decline until 1998 which is about the same time financial service began to rise. The first breakthrough in construction followed in later around 2002 and the employment proportion finally rose to new highs after 2005. Because of difficulty of incorporating all divisions into one chart, chart 4.2 below is used to display employment percentage of the rest of service sector (service sector less financial service).

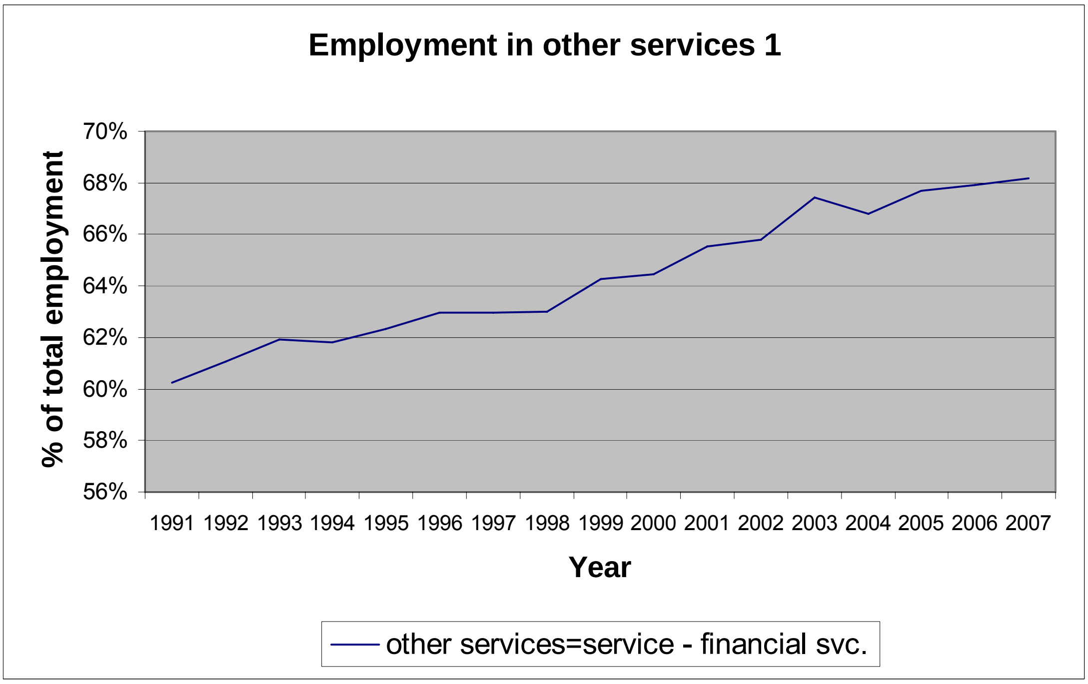


Chart 4.2 Employment in other services 1 (Hagstofa)

Other servies: all services less financial services.

Employment is shown to be steadily climbing up all the time without any particular pattern. But if real estate service is deducted from 'other services' we'll have chart 4.3 below.

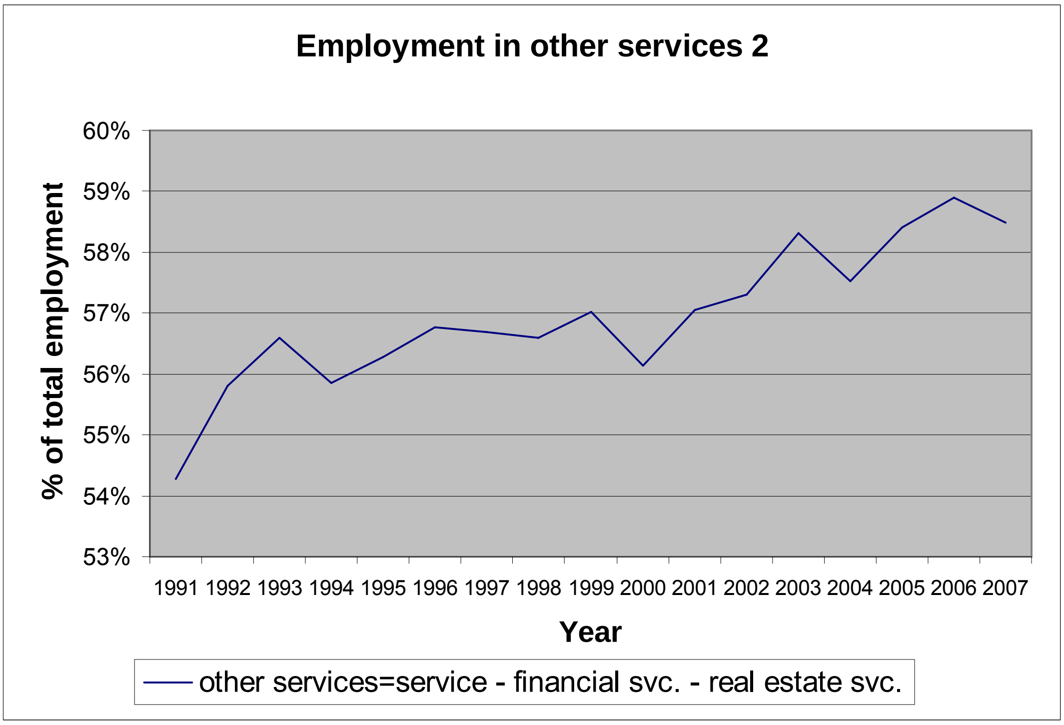


Chart 4.3 Employment in other services 2 (Hagstofa)

Other services: all services less financial and real estate services.

Now a relatively stable period appears before 2001 and an obvious rise followed after that. The rationale for extracting real estate service away from other services is that real estates are investment goods to a great extent. Real estate service, especially brokerage, relates directly to financial service. Secondly real estate investment was an international business as foreign capital influx was free. Due to its close association to the international financial market it is reasonable to exclude it from non-tradable services.

If construction is added to chart 4.3 as a supplement to non-tradable sector we'll have chart 4.4 below which shows an even clearer pattern.

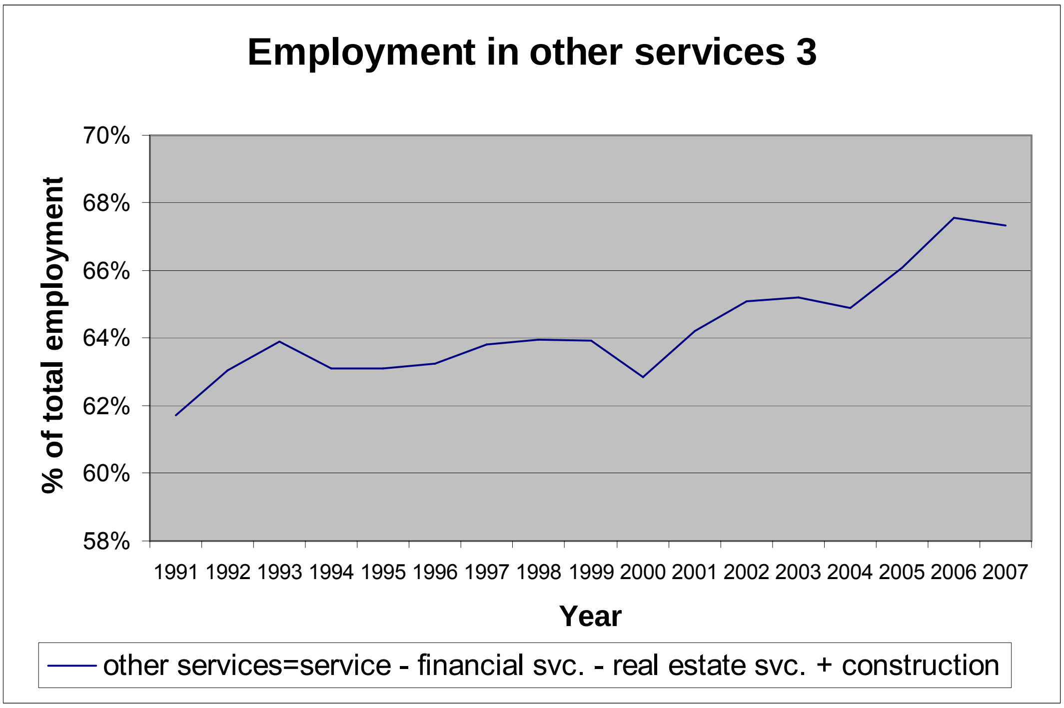


Chart 4.4 Employment in other services 3 (Hagstofa)

Other services: all services less financial, real estate services and construction.

The charts indicate that employment structure was generally more stable before 1998 and after that was a period of structural changes. To take a closer look at the changing period table 4.1 lists employment data from 1998 and 2007 and the changes in between.

	Percentage of total employment in 1998	Percentage of total employment in 2007	The changes
Agri. & fishing	8.6%	5.9 %	-31.0%
Manufacturing (constr. excl.)	17.8%	11.8%	-34.0%
Construction	7.4%	8.9%	+20.2%
Service	66.2%	73.1%	+10.4%
Retail & maintenance	13.9%	14.3%	+2.9%
Hotel & restaurants	3.0%	3.5%	+17.5%
Transportation	7.3%	6.3%	-14.3%

Financial & insurance service	3.2%	4.9%	+54.4%
Real estate service	6.4%	9.7%	+51.0%
Public administration	4.7%	5.0%	+6.1%
Education	6.5%	7.6%	+17.3%
Health care	14.0%	14.7%	+4.8%
Other social services	7.2%	7.1%	-0.8%

Table 4.1 Comparison of employment structure in 1998 and 2007 (Hagstofa)

The fastest growth of employment during the period took place in financial & insurance service business closely followed by real estate service. Most non-tradable industries, especially construction and restaurants, also enjoyed employment growth. Altogether the non-tradable sector, service and construction less financial and real estate service, had a positive growth of 5.3% in its share of total employment. The fastest recession took place in manufacturing and agriculture, the traditional tradable sector. Their total shrinkage was -33.0%.

The pattern of change happened to fit the description of 'Dutch disease'. The financial industry started a boom around 1998 sucking workforce to it. The lagging industry of manufacturing and agriculture lost employment meanwhile – likely the resource movement effect. After a period of stability non-tradable sector expansion followed in later after 2001 when, supposedly, the spending effect of the boom was mediated through commodity market. Meanwhile the lagging industries kept on shrinking their workforce.

To see this better, a rough grouping of industries is made and their employment weight displayed in chart 4.5. Agriculture & fishing and manufacturing were grouped together to represent the lagging industries; the financial & insurance and real estate service were tagged the booming industry; and the rest constitutes the non-tradable sector. It can be easily spotted that non-tradable sector and the booming industry thickened while the lagging industries dropped.

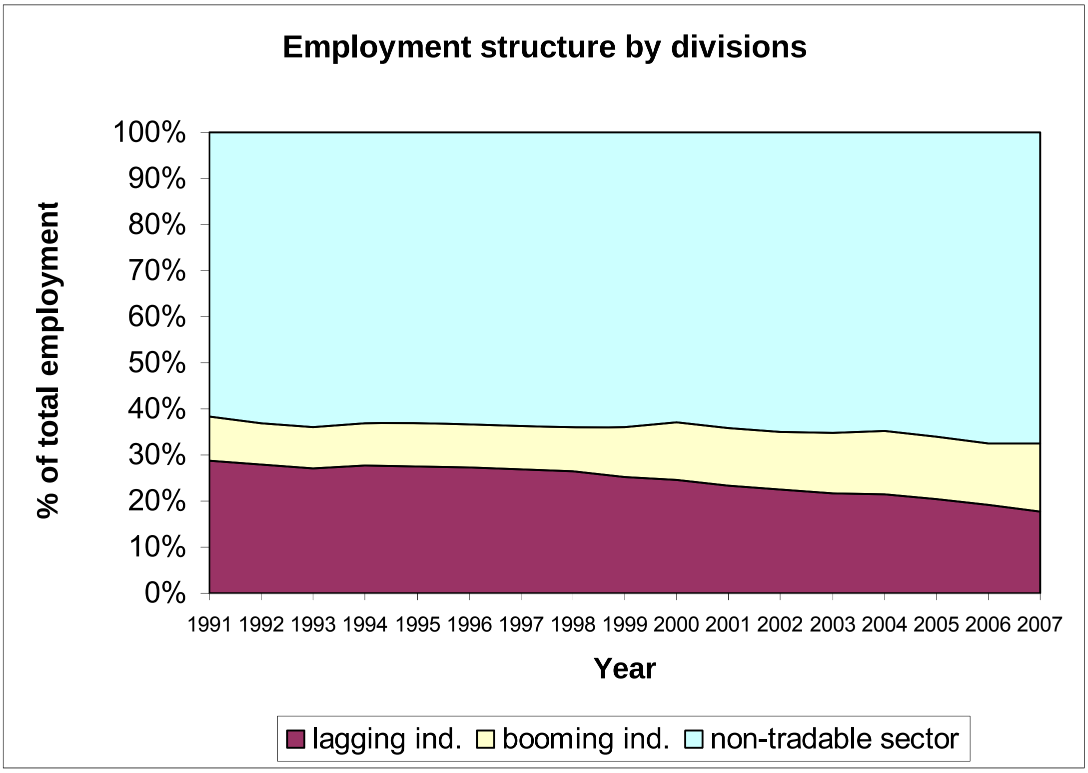


Chart 4.5 Employment structure by divisions (Hagstofa)

Lagging ind.: lagging industries. Booming ind.: booming industries

Real wage growth is another piece of evidence that's relevant to the 'Dutch disease' model. Purchasing power of average wage didn't surpass the 1989 level before the hike in 1998 and 1999. After that it rose all the way up till the subprime crisis hit in mid 2007 (chart 4.6). The breakthrough of wage level is almost simultaneous with the employment breakthrough in financial service.

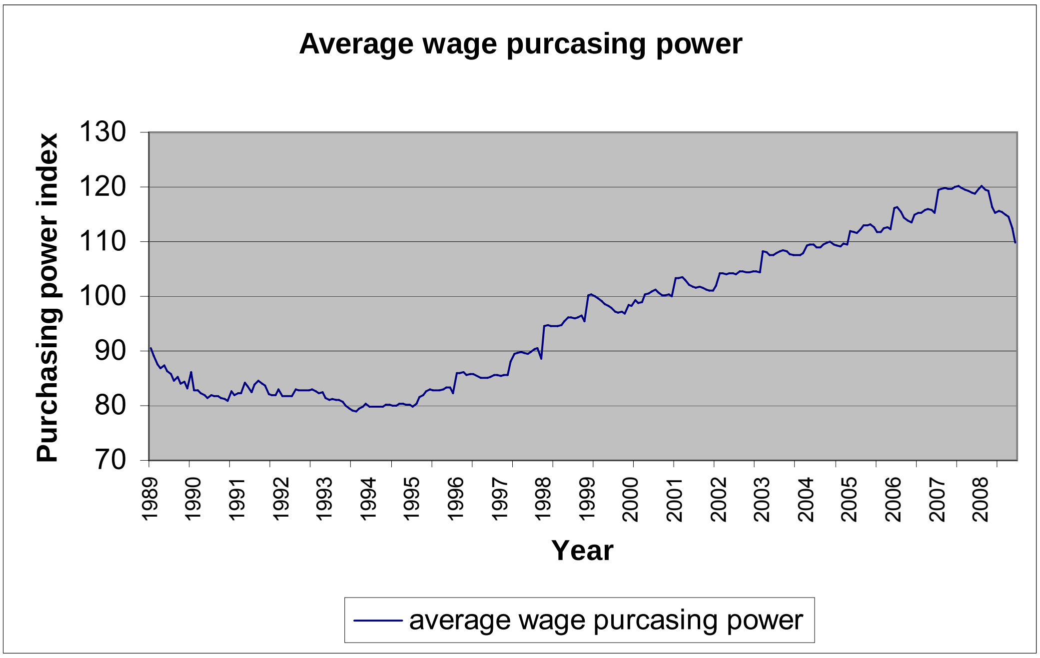


Chart 4.6 Average wage purchasing power in Iceland (Hagstofa)

Industrial output is the third kind of information that is relevant to the model. Chart 4.7 shows a panel data of the output proportion of all six surveyed sectors of the Icelandic economy from 1990 to 2007. Table 4.2 lists the same data but from year 1998 and 2007 and the change in between.

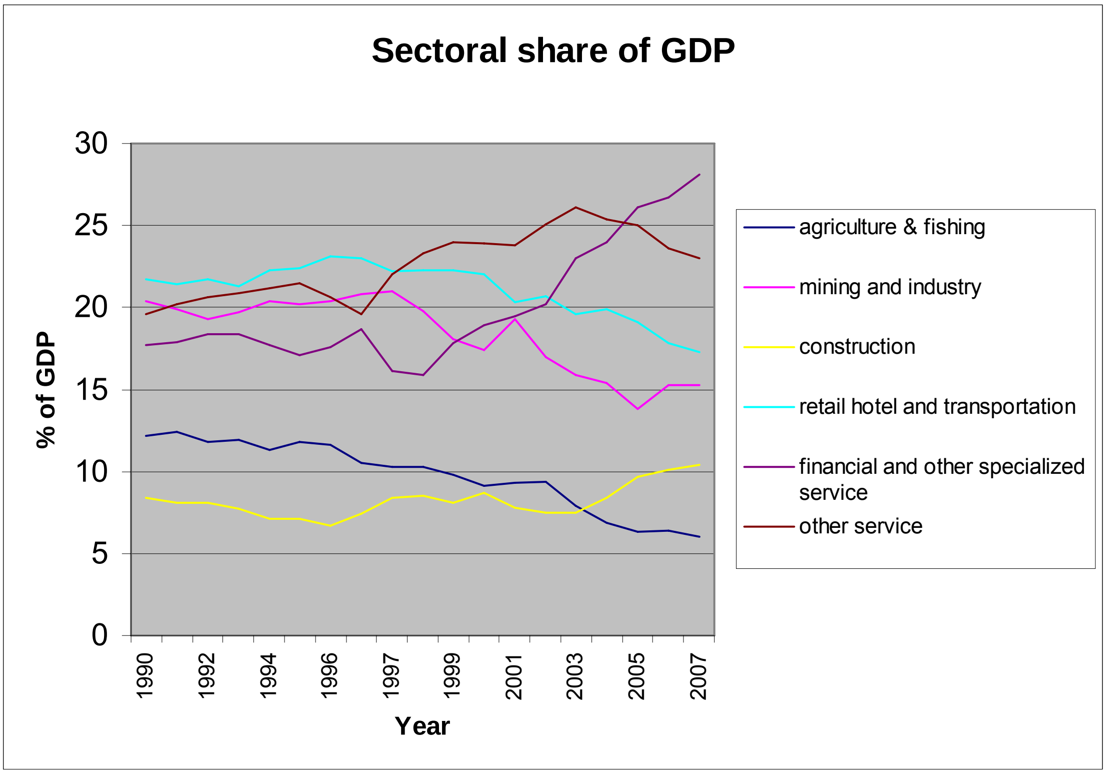


Chart 4.7 Sectoral share of GDP of Iceland (Hagstofa)

	Share of GDP in 1998	Share of GDP in 2007	Percentage change
Agriculture	10.3%	6%	-41.75%
Mining & industries	19.8%	15.3%	-22.73%
Construction	8.5%	10.4%	+22.35%
Retail & transportation	22.3%	17.3%	-22.42%
Financial & other specialized service	15.9%	28.1%	+76.73%
Other services	23.3%	23%	-1.29%

Table 4.2 Comparison of GDP structure of 1998 and 2007 (Hagstofa)

A 76.73% increase in the share of GDP put financial and other specialized service the number one output growth from 1998 to 2007. When financial service is singled out, its share of GDP rose from 3.6% in 1998 to 9.1% in 2007, an increase of 152.8%. If insurance and pension funds are excluded from it, leaving banking alone, the GDP share went from 2.6% to 7.5% increased by 188.5% which is by far the highest among all surveyed business (the second highest output growth is 54.47% from real estate service). Agriculture and industries were facing serious shrinkage. Together their share in GDP descended from 30.1% down to 21.3% diminished by 29.24%. The non-tradable sector, however, experienced a slight negative 6.3% growth in relative output. This is largely due to the sharp recession in retail & transportation business which is a kind of intermediate goods and partly connect to the tradable sector. If retail & transportation were taken away the non-tradable sector could achieve a positive 5% growth.

In general the output pattern agrees with the employment pattern. Combining the two together, we are able to see that: financial service, especially banking, was arguably the major booming industry in the country. It had both the fastest employment growth and the fastest output growth since 1998. Proportionally the industry contributed more to income growth than to labour demand as its relative output growth (152.8%) was nearly three times as much as its relative employment growth (54.4%). So we can expect a stronger 'spending effect' than 'resource movement effect' from it.

The non-tradable sector defined in chart 4.5 expanded its employment moderately by 5.3% after the boom. But output growth is ambiguous as it's hard to determine what part of the subject of retail & transportation belongs to it. It is therefore not clear whether the 'spending effect' did transcend the 'resource movement effect' as would be expected.

The rest of the tradable sector, agriculture and industries, are most likely the lagging industries. They suffered from rising wage and reduced their magnitude by 33.0% in relative employment and 29.24% in relative output.

It's quite evident that a 'Dutch disease' triggered by financial sector boom did take place in Iceland during the last few years. It should have led non-tradable goods to appreciate against tradable goods.

The data confirms it that non-tradable goods appreciated. Chart 4.8 shows the time series of the quotient of price index of non-tradable goods and that of the tradable goods. Note that the average indices are not weighted averages but only simple averages of indices from all industries, so the influence of each industry on price level is not correctly reflected in the data. The data ranges from early 1997 to the end of 2008.

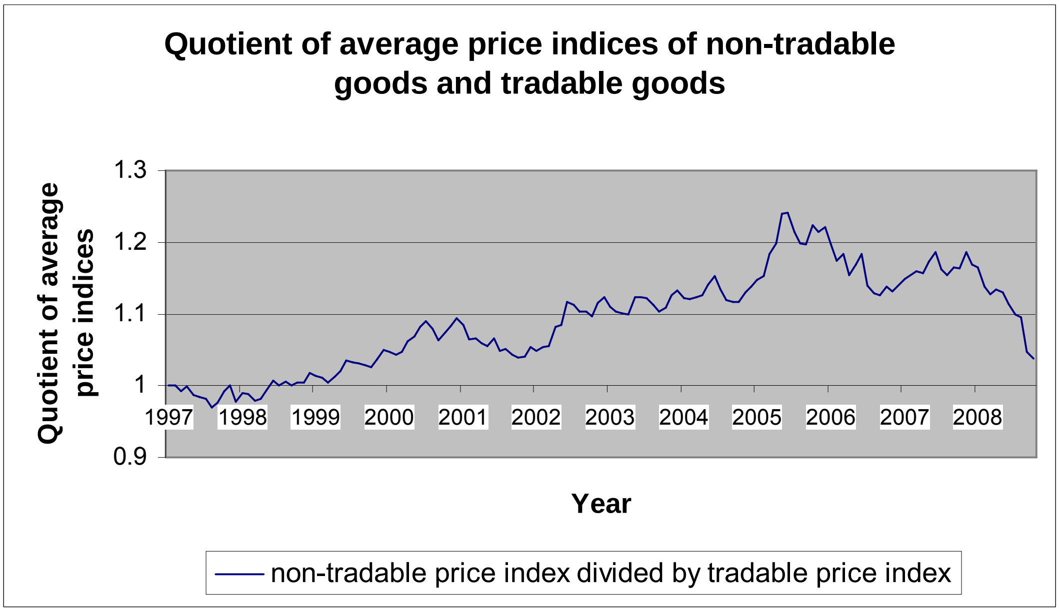


Chart 4.8 Quotient of average price indices of non-tradable goods and tradable goods

Resource: Hagstofa

The relative price broke through its 1997 level late 1998 and ascended thereafter with fluctuations that characterize random walk. The appreciation peaked in mid 2005. Non-tradable goods started to depreciate sharply from the beginning of 2008 when the global financial crisis intensified. The whole process looks like a random walk with positive drift before the end of 2007.

The correlogram of the complete period suggests that there is a AR(1) pattern behind the time series and a Chow test based on AR(1) regression indicates that a structural split is most observable at Feb. 2008 (with a p-value of 0.0034) and next most observable at Jan. 2008 (p-value 0.0178). Detailed statistics see in Appendix I.

To get rid of the index averaging problem we can also take a look at price index quotient of hairdressing and clothing alone from the same time period (chart 4.9).

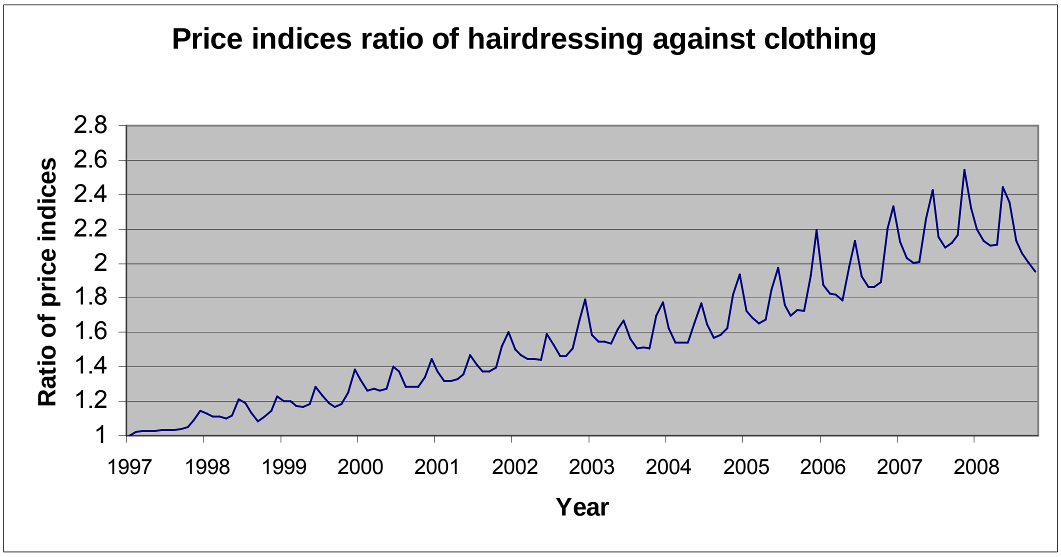


Chart 4.9 Price indices ratio of hairdressing against clothing (Hagstofa)

A clear seasonal fluctuation can be spotted while the trend is steadily up-going until the drop in 2008. It seems that an ascending time trend with a seasonal dummy would probably suit the 1997 to 2007 period. If time trend is applied Chow tests result will be optimized at break time-point Jan. 2008 and the second best is at Dec. 2007. The estimators from the former period (Mar. 1997 to Dec. 2007) also agree that the trend was ascending. All tests are very positive except Durbin-Watson which doesn't matter much in this case. Detailed statistics see Appendix II.

So the prediction of 'Dutch disease' model is confirmed by data from both sides. On one hand price index quotients showed that non-tradable goods had appreciated against tradable goods from 1997 to the end of 2007; on the other hand structural changes of employment and output as well as real wage rise had characterized the economy during the same period. These evidences point out that 'Dutch disease' did plague Iceland and pushed non-tradable goods to appreciate. If non-tradable goods didn't appreciate much against other goods in China, as chart 1 might suggest, the appreciation in Iceland should explain the appreciation of Icelandic non-tradable goods against the Chinese ones, if tradable goods follow PPP. It needs more study to clarify the situation in China.

The recent fall of the Icelandic financial system has proofed that the 'disease' was an unsustainable one. The appreciation of non-tradable goods it spurred was in part a ‘transitory deviation’ from PPP. By analyzing chart 4.8 and 4.9 we already see that correction has started early in 2008.

Krona will stay weak for a while if not become even weaker, tradable prices in Krona will then be well supported. Wage and non-tradable prices in Krona are under pressure due to tightened economic policy and depressed demand. This is a part of the retroversion that is happening: structural unemployment, real wage drop, ratcheting effect, economic structural change, expansion in real industries, shrinkage in non-tradable sector and relative depreciation on non-tradable goods. As far as haircut is concerned, its dollar price level in 2006 was over-inflated and unsustainable and it has already fallen in dollar.

4.3 Trade deficit

Trade deficit can also generate ‘spending effect’ like a boom that doesn’t require factor input. During a period of trade deficit the supply of tradable goods is increased while the supply of non-tradable remains still. The possibility frontier of supply is then lifted above where it would be if trade is in balance by the amount of deficit. It is shown in figure 4.5 that PPF_1 rose to PPF_2 when external trade switched from balance to deficit. Consumption will then become more tradable intensive and non-tradable goods will appreciate against tradable goods as the commodity market balance will be reached somewhere between *d* and *e* on PPF_2 and the absolute slope of the tangent line will be larger than the original one on PPF_1.

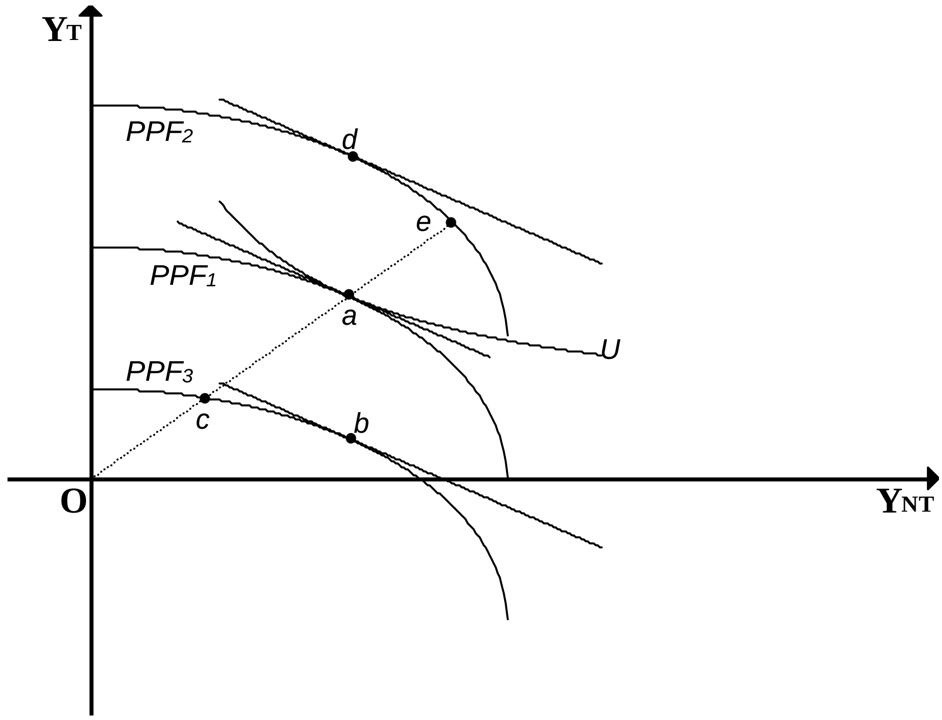


Figure 4.5 The effect of trade surplus and deficit on goods market.

Technically deficit is only a short-term phenomenon and is unsustainable. A country will have to run a balanced trade in the long term and keep an adequate debt position. Therefore non-tradable appreciations caused by trade deficit are 'transitory deviations'. Once the deficit period is over PPF will sink.

If net foreign debt position is moderate by the time deficit ends PPF will only sink to the balance level (PPF_1) with the result that relative non-tradable price returns to the balance level (the line cutting through point *a*). But if net debt gets excessive compare to the economy, the consequence will not only be the end of deficit but also a start of surplus since ultimately foreign debt can only be repaid by trade surplus. During surplus period PPF will sink below the balance level by the amount of surplus, for example to PPF_3. This leads to relative price of non-tradable goods to drop below the original balance price. In the diagram the balance point is now somewhere between *c* and *b* on PPF_3 and the tangent line will have a smaller absolute slope than it original had at *a* on PPF_1.

To help to view the situation in Iceland, chart 4.10 and chart 4.11 are used to show trade balance of Iceland from 1989 to 2007 in absolute amount and as percentages of GDP respectively (Hagstofa). An increase of deficit can be easily spotted since 1998 both in absolute terms and proportionally.

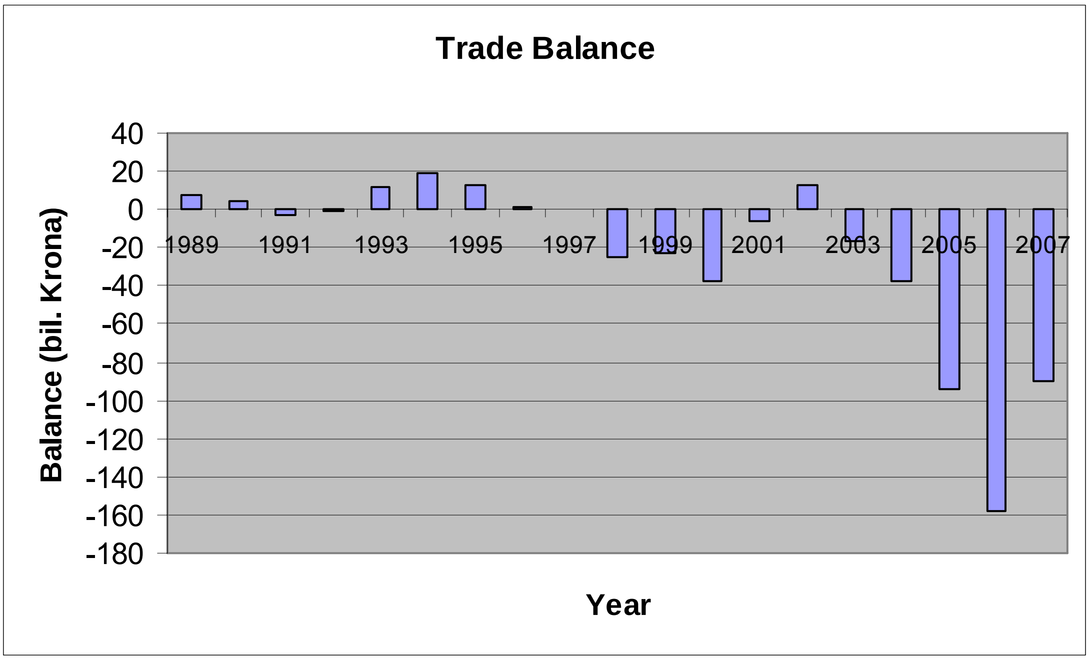


Chart 4.10 Trade balance of Iceland (Hagstofa)

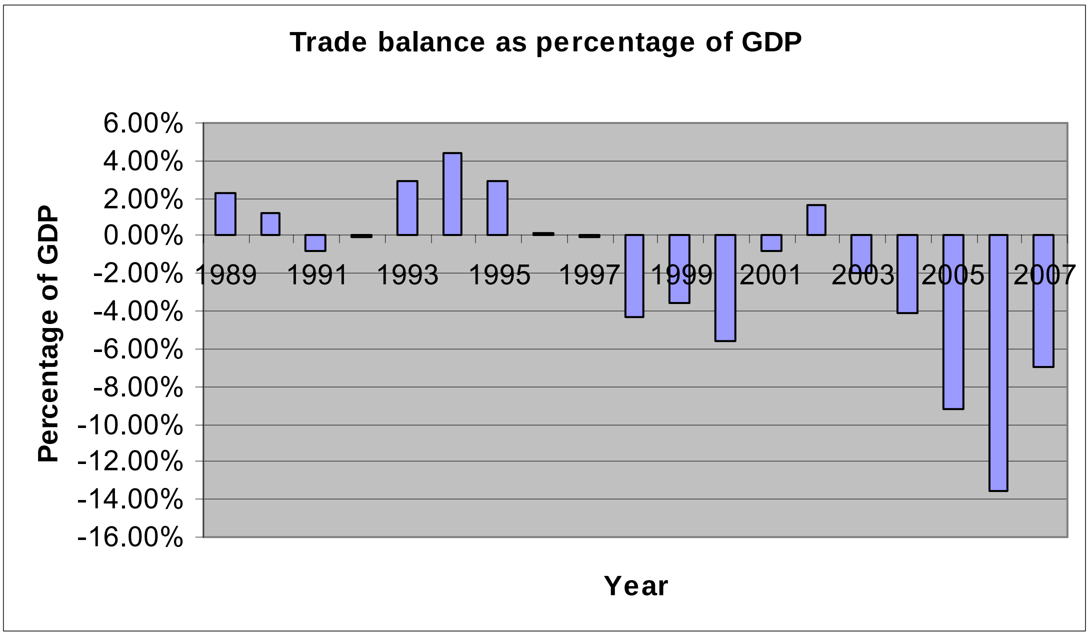


Chart 4.11 Trade balance as percentage of GDP of Iceland (Hagstofa)

The 'spending effect' of the increasing magnitude of trade deficit helped non-tradable goods to appreciate against tradable goods. Non-tradable goods would have become more expensive in dollar if dollar price of tradable goods were fixed during this period.

At the meantime net foreign debt was accumulated. Chart 4.12, 4.13 and 4.14 show year end net foreign claim/debt position of Iceland in absolute amount, as percentage of GDP and FOB value of annual export. The net position was all the time on the debt side and started to increase quickly in all measurements since year 2000.

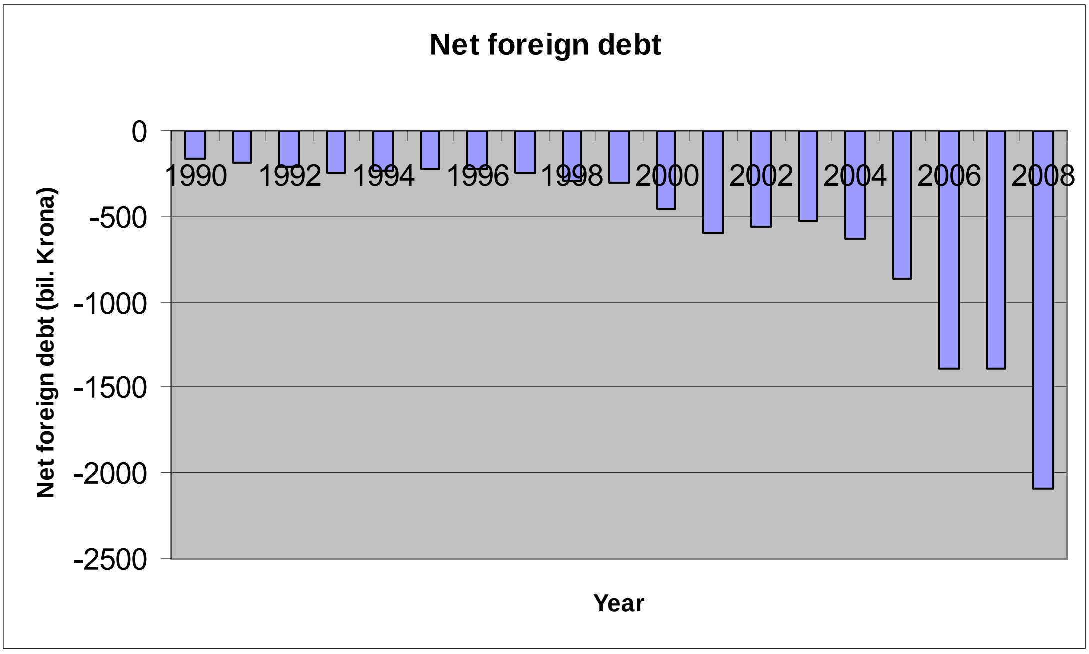


Chart 4.12 Net foreign debt of Iceland (Hagstofa)

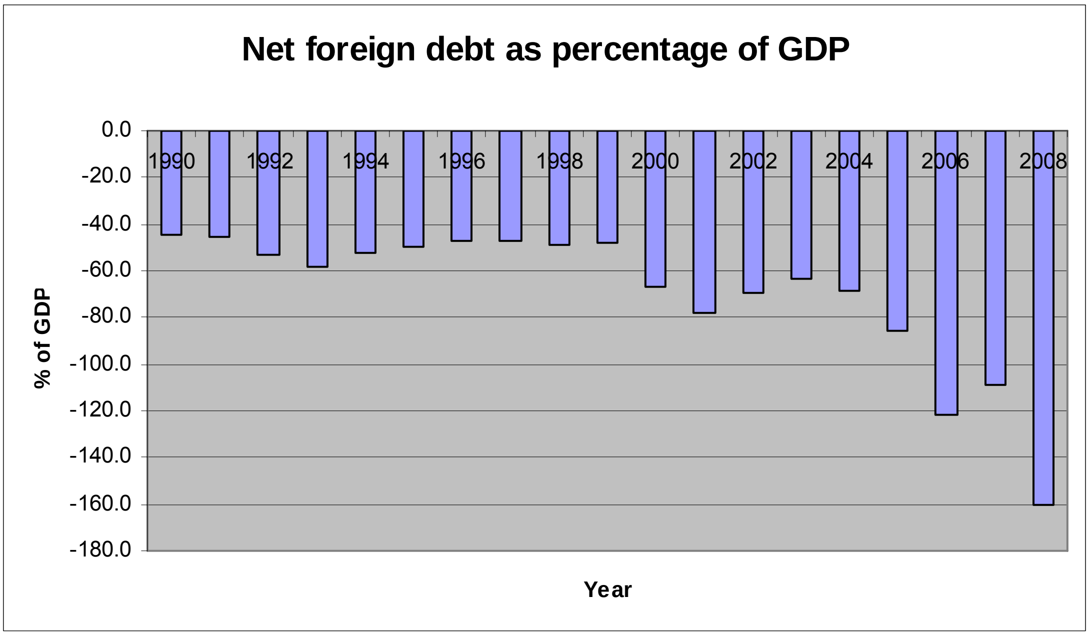


Chart 4.13 Net foreign debt as percentage of GDP of Iceland (Hagstofa)

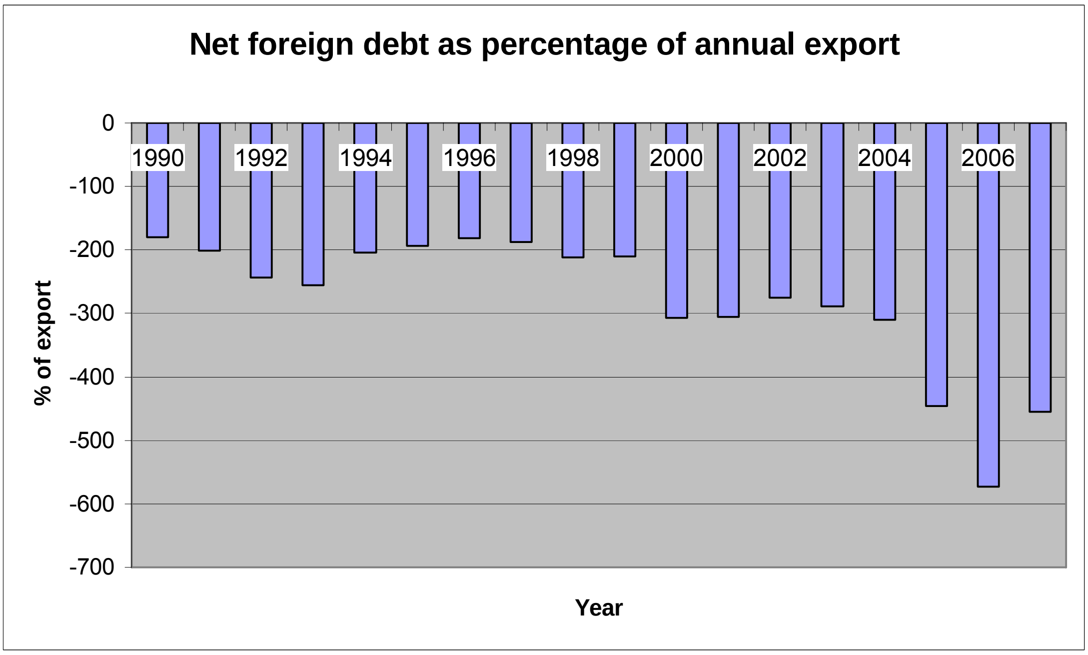


Chart 4.14 Net foreign debt as percentage of annual export of Iceland (Hagstofa)

Net debt/GDP went above 60% in 2000 and rose up to 160% thereafter while 60% is what considered the sustainable debt limit by Maastricht treaty given 5% nominal GDP growth (Grauwe, 2003). Iceland's net debt/export went almost up to 600% in 2006 and has never been lower than 150% which is considered the limit of proper debt by HIPC initiative (Berensman, 2004). Clearly, net debt position has gone excessive. Icelandic economy is facing the task of debt reduction by means of accumulating large amount of trade surplus. It will bring short term balance in Iceland down to somewhere like PPF_3 in figure 4.5 where production will concentrate more on tradable goods and relative price of non-tradable goods will drop.

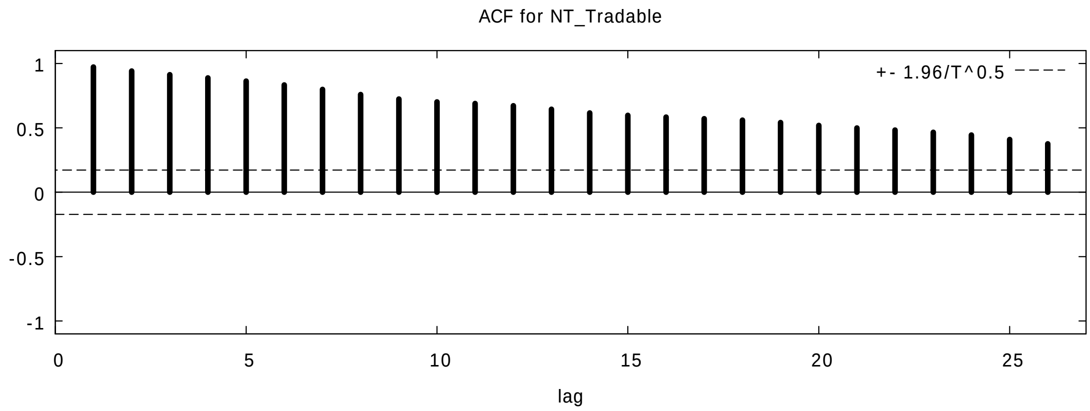
In fact, Iceland has already started to run trade surplus since September 2008. External trade has been on surplus side 3 months in a row. It declares the arrival of a surplus period after the break down of the financial system and the end of over leveraging investment and credit consumption life style. The relative price on non-tradable goods will be kept lower than normal during this period as a result of negative 'spending effect'.

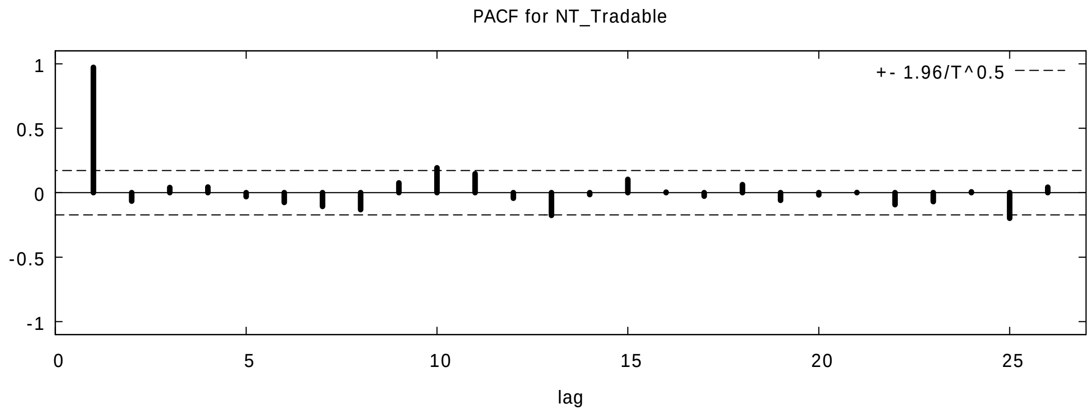
5. Conclusions

Change in productivity in real tradable industries was unlikely to be the cause for enlarging price gap on haircut between Iceland and China. But economic fundamental such as factor endowment was one of the reasons for haircut price to be higher in Iceland than in China. Various facts indicate that the boom started around 1997 and 1998 characterized by financial sector expansion had led to short-lived overheating which in turn contributed to pushing up non-tradable price against tradable and may have caused enlarging price gap on non-tradable goods between the two countries. This should be a very classic demonstration of unsustainable 'Dutch disease'. Increasing trade deficit also helped to magnify the effect of the 'disease' and overwhelming net foreign debt position destined the crash of the economy. As the crisis is already set off, the effect of the 'disease' is being removed and reversed, as a part of which non-tradable products such as haircut are dropping in relative prices.

Appendix I

The correlogram of the complete period has a geometric declining ACFs and rather insignificant PACFs besides the first one. It insinuates that the time series is most likely an AR(1) series.





A Chow test based on AR(1) regression of the time series yielded the following:

Augmented regression for Chow test

OLS estimates using the 141 observations 1997:04-2008:12

Dependent variable: nont

	coefficient	std. error	t-ratio	p-value
const	0.0193719	0.0182545	1.061	0.2905
nont_1	0.983528	0.0167303	58.79	4.55E-099 ***

splitdum -0.0501026 0.121289 -0.4131 0.6802

sd_nont_1 0.0317650 0.107557 0.2953 0.7682

Mean of dependent variable = 1.09225

Standard deviation of dep. var. = 0.0675757

Sum of squared residuals = 0.023554

Standard error of the regression = 0.0131121

Unadjusted R-squared = 0.96316

Adjusted R-squared = 0.96235

F-statistic (3, 137) = 1193.83 (p-value < 0.00001)

Durbin-Watson statistic = 1.92759

First-order autocorrelation coeff. = 0.0353663

Log-likelihood = 413.084

Akaike information criterion (AIC) = -818.167

Schwarz Bayesian criterion (BIC) = -806.372

Hannan-Quinn criterion (HQC) = -813.374

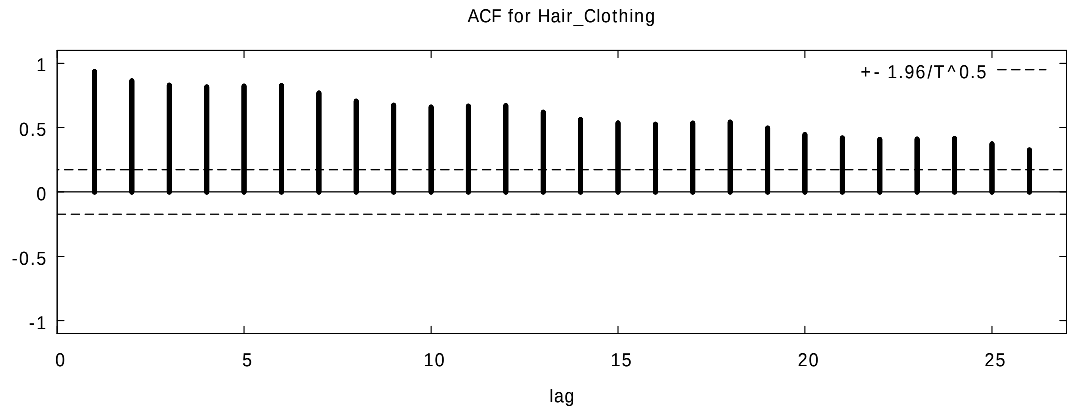
Chow test for structural break at observation 2008:02

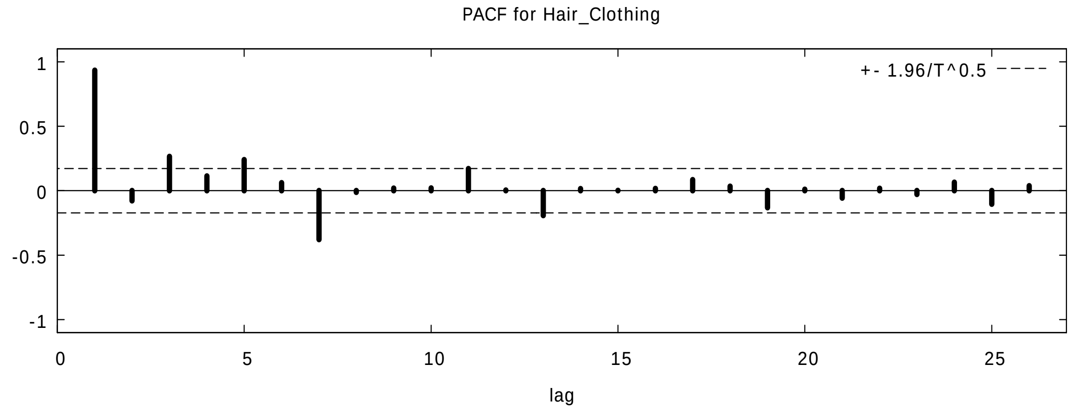
F(2, 137) = 5.93349 with p-value 0.0034

The test indicates that a structural split is most observable at Feb. 2008. Note that the p-value of 0.0034 is the lowest result of all break time-points throughout the whole period. If a mandatory break time is set to be Jan. 2008 the p-value will be 0.0178 which is the second lowest of all.

Appendix II

The correlogram suggests an ARMA process rather than a simple AR for several PACFs clearly breach the critical value and displays a sharp geometric decaying trend.





When time trend is applied to modelling the whole period we'll have the following result from Chow tests:

Augmented regression for Chow test

OLS estimates using the 142 observations 1997:03-2008:12

Dependent variable: harfot

	coefficient	std. error	t-ratio	p-value
const	0.952096	0.0185255	51.39	7.28E-092 ***
time	0.00861648	0.000245408	35.11	1.14E-070 ***

splitdum	5.67251	1.19910	4.731	5.47E-06	***
sd_time	-0.0410597	0.00878420	-4.674	6.94E-06	***

Mean of dependent variable = 1.57391
Standard deviation of dep. var. = 0.379794
Sum of squared residuals = 1.52153
Standard error of the regression = 0.105003
Unadjusted R-squared = 0.92519
Adjusted R-squared = 0.92356
F-statistic (3, 138) = 568.883 (p-value < 0.00001)
Durbin-Watson statistic = 0.993383
First-order autocorrelation coeff. = 0.50281
Log-likelihood = 120.575
Akaike information criterion (AIC) = -233.149
Schwarz Bayesian criterion (BIC) = -221.326
Hannan-Quinn criterion (HQC) = -228.345

Chow test for structural break at observation 2008:01
F(2, 138) = 12.8061 with p-value 0.0000

The test result (p-value 0.0000) is optimized at break time-point Jan. 2008, the second best can be obtained at Dec. 2007. The estimators from the former period (Mar. 1997 to Dec. 2007) indicate that the trend was ascending. Other tests statistics of the period are also very goods except Durbin-Watson test which suggests there's autocorrelation among residuals. This is mostly due to the periodical fluctuation of the sample and the fact that the regression model doesn't include a dummy variable. Such autocorrelation tends to improve the quality of *t*-tests on estimators, but given the extremely small p-value of the *t*-tests, the problem of autocorrelation can be overlooked in the case.

References

Balassa, Bela. “The Purchasing-Power Parity Doctrine: A Reappraisal.” *The Journal of Political Economy* Vol. 72, No. 6 (Dec., 1964), pp. 584-596 <http://www.jstor.org/stable/1829464>

Berensman, Kathrin. “How to ensure debt sustaiability beyond the HIPC-initiative?” (2004), pp. 2 <http://www.un-ngls.org/cso/cso2/001%200304-Hearings-CS-KB-debt.pdf>

Bhagwati, Jagdish N. “Why are Services Cheaper in the Poor Countries?” *The Economic Journal*, Vol. 94, No. 374 (Jun., 1984), pp. 279-286 <http://www.jstor.org/stable/2232350>

Central Bank of Iceland, <http://www.sedlabanki.is/default.aspx?PageID=7>

Corden, W. Max and J. Peter Neary. “Booming Sector and De-Industrialisation in a Small Open Economy” *The Economic Journal*, Vol. 92, No. 368 (Dec., 1982), pp. 825-848 <http://www.jstor.org/stable/2232670>

Dornbusch, Rudiger W. “Purchasing Power Parity.” *NBER Working Paper Series* No. w1591, (March, 1985). <http://ssrn.com/abstract=336331>

Grauwe, Paul De. “The stability and growth pact: a stability and stagnation pact?” (2003), University of Leuven, pp. 3 <http://www.econ.kuleuven.be/ew/academic/intecon/Degrauwe/PDG-papers/The%20Stability%20and%20Growth%20Pact%20CEPS%202003.ppt#277,23,Slide 23>

Hagstofa, <www.hagstofa.is>

Jones, Ronald W. “The Structure of Simple General Equilibrium Models” *The Journal of Political Economy* Vol. 73, No. 6 (Dec., 1965), pp. 557-572 <http://www.jstor.org/stable/1829883>

McKenzie, L. W. “Equality of Factor Prices in World Trade.” *Econometrica*, 1955, *23*, pp. 239-57 < http://www.jstor.org/stable/pdfplus/1910382 >

National Bureau of Statistics of China (NBSC) <http://www.stats.gov.cn/tjsj/ndsj/>

Okun, A. 1981, Prices and Quantities, Brookings.

“Quick facts and figures”, SustainableChoice. (Accessed: Dec, 2008) <http://www.lgsa-plus.net.au/www/html/993-quick-facts.asp>

Rogoff, Kenneth. “The Purchasing Power Parity Puzzle.” *Journal of Economic Literature* Vol. 34, No. 2, (Jun., 1996), pp. 647-668 <http://www.jstor.org/stable/2729217>

Samuelson, Paul A. “Theoretical Notes on Trade Problems.” *The Review of Economics and Statistics* Vol. 46, No. 2 (May, 1964), pp. 145-154 <http://www.jstor.org/stable/1928178>

Savosnick, Kurt Martin. “The Box Diagram and the Production Possibility Curve” *Ekonomisk Tidskrift*, Årg. 60, n:r 3 (Sep., 1958), pp. 183-197 <http://www.jstor.org/stable/3438618>

Stolper, W.F. and P.A. Samuelson. “Protection and Real Wages.” *The Review of Economic Studies*, Vol. 9, No.1 (Nov., 1941), pp. 58-73 <http://www.jstor.org/stable/2967638>

“The Dutch Disease” (November 26, 1977). *The Economist*, pp. 82-83.

The People’s Bank of China,
<http://www.pbc.gov.cn/huobizhengce/huobizhengcegongju/huilvzhengce/renminbihuilvjiaoyishoupanjia.asp>

Toyota, (Accessed: Dec,. 2008)
<http://dealers.toyota.is/cars/new_cars/yaris/pricelist.aspx?rsbid=1B0F9437-AFDE-4E3C-9AD2-9D5C0813638A>

“120 Mathematical Economics” *University of London External Programme*, pp.54-56
<http://www.londonexternal.ac.uk/current_students/programme_resources/lse/lse_pdf/further_units/120_math_econ/ch_04.pdf>

“氧化铝成本结构图”, 佐思投资情报, (Oct,. 2008)
<http://www.okokok.com.cn/Htmls/GenCharts/081029/12800.html>

“中国火力发电洁净煤技术的发展”, 中国新能源网, (Jul,. 2004)
<http://www.newenergy.org.cn/html/0047/200476_900.html>

易车网, (Accessed: Dec,. 2008)
<http://price.bitauto.com/search/car.aspx?carid=10566001000>

“今年成功解决贸易争端 纺织品出口不能只靠低价”, 环球时报, (Nov,. 2005),
<http://xmtex.smexm.gov.cn/2005-11/2005111885626.htm>