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Fiscal Policy and Dutch Disease

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Abstract

In this paper we revisit the Dutch disease paying particular attention to the role of specific factors of production and capital stock dynamics. The main insight is that if the natural resource rich windfall is substantial but not large enough for the country to become a rentier, capital goods must be produced at home and adjustment to natural resource windfall takes time. It takes time to build this home-grown capital. Specific factors are crucial to explain the dynamic responses of the real exchange rate, capital intensities and wages in response to a natural resource windfall. If a country is small and the windfall is large, it may be able to import capital and migrant labour in which case the Dutch disease can be avoided.

JEL-Code: E010, F430, O410, Q300.

Keywords: specific factors, real exchange rate, capital stock dynamics, factor intensity, international trade, Dutch disease, permanent income, fiscal policy rules, overlapping generations.

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1. Introduction

The experiences of resource rich countries have been very heterogeneous. Some have harnessed their resource wealth to boost their economic performance and others have done worse (e.g., van der Ploeg, 2010a). Still, many resource-rich countries have fared badly and this has been coined the Dutch disease. Abstracting from political economy, corruption, conflict and other non-economic explanations, the most popular hypothesis of the Dutch disease has been that a resource bonanza induces appreciation of the real exchange rate, contraction of the traded sector and expansion of the non-traded sectors. Early policy contributions highlight the appreciation of the real exchange rate and the resulting process of de-industrialization induced by the increase in oil exports in Britain (Forsyth and Kay, 1980). The idea behind this Dutch disease is that the extra wealth generated by the sale of natural resources induces appreciation of the real exchange rate and an ensuing contraction of the traded sector (Corden and Neary, 1982; Corden, 1984). For the longer run effects one must allow capital and labour to be mobile across sectors and move beyond the specific factors framework. In an open economy Heckscher-Ohlin framework with competitive labour, capital and product markets, no resource use in production and constant returns to scale in the production of traded and non-traded goods, a natural resource windfall induces a higher (lower) wage-rental ratio if the non-traded sector is more (less) labour-intensive than the traded sector. There is a rise in the relative price of non-traded goods leading to an expansion of the non-traded sector and a contraction of the traded sector. Labour and capital then shift from the traded to the non-traded sectors. More interesting are the effects of a resource boom in a dynamic dependent economy with adjustment costs for investment and costly sectoral reallocation of capital between non-traded and traded sectors (Morshed and Turnovsky, 2004). It is then more costly to transform one form of existing capital into another, since this involves demolition. This way one has factor specificity for each sector in the short run and factor mobility across sectors in the long run. An advantage of this approach is that in the short and medium run the real exchange rate is no longer fully determined by the supply side and does not adjust instantaneously. If a greater fraction of resource revenues is saved, we will argue that the initial appreciation of the real exchange rate will be less and will eventually be reversed.

What happens if the exploitation sector uses labour and capital as factor inputs? Apart from the hitherto discussed *spending* effects of a resource boom, there are also *resource movement* effects (Corden and Neary, 1982). De-industrialization occurs on account of the usual appreciation of the real exchange rate (the *spending* effect), but also due to the labour drawn out of both the non-traded and traded sectors towards the resource sector (the *resource movement* effect). The longer run where both factors of production (labour and capital) are mobile between the traded and non-traded sectors and the resource sector only uses labour can

be analysed with a mini-Heckscher-Ohlin economy for the traded and non-traded sectors. The Rybczinski theorem states that the movement of labour out of the non-resource towards the resource sectors causes output of the capital-intensive non-resource sector to expand. This may lead to the paradoxical result of pro-industrialization if capital-intensive manufacturing constitutes the traded sector, despite some offsetting effects arising from the de-industrialization effects arising from an appreciation of the real exchange rate (Corden and Neary, 1982). If the non-traded sector is more capital intensive, the real exchange rate depreciates if labour is needed to secure the resource windfall; the Rybczinski theorem then says that the non-traded sector expands and the traded sector contracts. This increase in relative supply of non-traded goods fuels depreciation of the real exchange rate. Real exchange depreciation may also result from a boost to natural resource exports if the traded sector is relatively capital intensive and capital is needed for the exploitation of natural resources (Neary and Purvis, 1982). Since less capital is available for the traded sector, less labour is needed and thus more labour is available for the non-traded sector. This may lead to a depreciation of the real exchange rate. This also occurs if the income distribution is shifted to consumers with a low propensity to consume non-traded goods (Corden, 1984).

We reconsider the above theory of the Dutch disease with a simple dynamic, three-sector, specific-factors, international trade model of the Dutch disease. The model supposes that all markets clear instantaneously and that firms operate under perfect competition. To put some structure on our analysis, we make the following simplifying assumptions: the non-traded sector (services) uses only labour and possibly another fixed factor, manufacturing sector (the non-resource traded sector) uses labour and capital, capital is produced by the non-traded sector, and the production of natural resources requires no labour capital or other inputs. The main insight we derive from this model is that if the natural resource windfall is substantial but not large enough for the country to become a rentier, capital goods must be produced at home and adjustment to natural resource windfall takes time. The result is an appreciation of the real exchange as factors are shifted from the non-traded sectors to manufacturing. This sluggish adjustment process is a result of the absorption constraints in the non-traded sector which imply that it takes time to build this home-grown capital. A much more detailed analysis of this can be found in van der Ploeg and Venables (2010). Specific factors are also crucial to explain the dynamic responses of capital intensities and wages in response to a natural resource windfall, which do not occur in the Dutch disease model without specific factors (e.g., Sachs and Warner, 1997). The reason is that with perfect international capital mobility and no specific factors of production, the wage, the relative price of non-traded goods and the capital intensities in the traded and non-traded sectors are pinned down by the world interest rate. If a country is small and the windfall is large, it will be able to import capital and migrant labour in which case the Dutch disease can be avoided.

Another motivation of our paper is that we believe that for many developing countries with a poorly developed manufacturing base the problems with a resource windfall are not so much to do with the temporary loss of learning by doing and the ensuing drop in economic growth resulting from the decline of manufacturing (cf., van Wijnbergen, 1984; Krugman, 1987; Sachs and Warner, 1995), but are much more a result of the non-traded sector having insufficient capacity to meet the boom in demand for home-grown capital (cf., van der Ploeg and Venables, 2010). The temporary rise in the price of non-traded goods simply reflects absorption constraints in many developing economies and will disappear once sufficient home-grown capital has been produced.

The outline of the paper is as follows. Section 2 offers a quick review of the standard theory of the Dutch disease with no capital accumulation but with specific factors. Section 3 extends this theory to allow for learning by doing and endogenous growth, which seems more relevant for developed economies that are rich in natural resources. Section 4 then presents our alternative dynamic story of absorption constraints and Dutch disease, which applies more to developing resource-rich economies. Section 5 then briefly reviews some empirical evidence for the various theories of Dutch disease. Section 6 discusses policy rules for best harnessing foreign exchange windfalls in a model with overlapping generations and no specific factors and section 7 concludes.

2. Dutch disease and de-industrialisation: no capital accumulation

We illustrate the mechanics of the Dutch disease, i.e., that the extra wealth generated by the sale of natural resources on world markets induces appreciation of the real exchange rate and contraction of the traded sector (Corden and Neary, 1982; Corden, 1984), with the Salter-Swan model of a two-sector economy with a resource windfall, abstracting from capital accumulation, international investment and financial assets. Export of resources thus equals net imports of traded goods, that is we have

$$(1)\quad H_T Q E = C_T - H_T \mathrm{F}(L_T),$$

where Q denotes the world price of natural resources, E the volume of exports of natural resources, C_T consumption of traded goods, L_T employment in the traded sector, H_T productivity in the traded and natural resource sectors and $H_T \mathrm{F}(L_T)$ output of the traded sector (with $\mathrm{F}'>0$, $\mathrm{F}''\leq 0$). Non-traded goods market equilibrium requires that

$$(2)\quad C_N = H_N \mathrm{G}(L_N),$$

where C_N denotes consumption of non-traded goods, L_N employment in the non-traded sector, H_N productivity in the non-traded sector and $H_N \mathrm{G}(L_N)$ output of the non-traded sector (with

F′>0, F″≤0). With exogenous labour supply of one unit and labour mobility between traded and non-traded sectors, labour market equilibrium requires that

(3) $L_T + L_N = 1$.

Households maximize utility $U(C_N,C_T)$ subject to the budget constraint

(4) $PC_N + C_T = Y$,

where P is the relative price of non-traded goods in terms of traded goods and national income is defined by

(5) $Y \equiv P H_N G(L_N) + H_T F(L_T) + H_T QE$.

Optimality requires that the efficiency condition $U_N/U_T=P$ must hold. With CES utility, we then have

(6) $C_N = Y/(1+P^{\varepsilon-1})P$,

where ε denotes the elasticity of substitution between traded and non-traded goods. The equilibrium condition for equilibrium in the market for non-traded goods,

(7) $H_N G(L_N) = C_N = Y/(1+P^{\varepsilon-1}) = [PH_N G(L_N)+H_T F(L_T)+H_T QE\ Y]/(P+P^{\varepsilon})$,

yields the following relationship:

(8) $P^{\varepsilon}=H[F((1-L_N))+QE]/G(L_N)$,

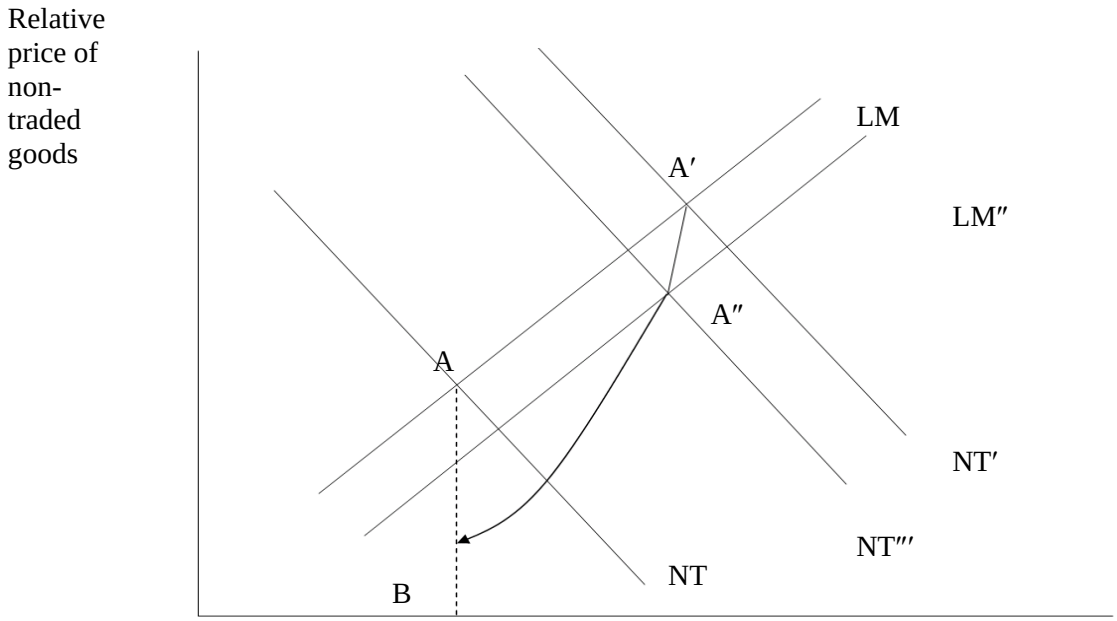
where $H \equiv H_T/H_N$ is the productivity of the traded and resource sectors relative to that of the non-traded sector. This equation corresponds to the NT-locus in fig. 1 and describes those combinations of the real exchange rate P and the share of labour employed in the non-traded sector L_N that ensure clearing of the market for non-traded goods. The NT-locus slopes downwards, since a higher P is associated with relatively lower demand for non-traded goods and thus with fewer workers employed in the non-traded sector. Labour mobility between traded and non-traded sectors requires that labour is paid the same in each sector, so that the value of the marginal product of labour is equalized. This yields the LM-curve:

(9) $P\,G'(L_N) = H\,F'(1-L_N)$,

which gives those combinations of the real exchange rate P and the share of labour employed in the non-traded sector L_N that ensure labour market equilibrium. The LM-curve slopes upward. A higher relative price of non-traded goods P pushes up the value of the marginal

product of employment in the non-traded sector, so employment in the traded sector must decline in order to push up the marginal product of labour in the traded sector.

Figure 1: Natural resource dependence reduces competitiveness



Key: A resource boom shifts A to A′, so a shift from the traded to non-traded sector and real appreciation. With time relative productivity of the traded declines if the elasticity of substitution in demand goods is less than unity. This shifts the equilibrium from A′ to A″ and eventually to B. In the long run there is real depreciation and the allocation of labour is returned to its original level.

Higher natural resource revenue *QE* boosts national income and demand. Hence, the NT-locus shifts upwards, the LM-locus is unaffected and equilibrium in fig. 1 shifts from A to A′. The short-run consequences of higher resource revenues are thus appreciation of the real exchange rate (a higher relative price of non-traded goods *P*), decline of the traded sector and expansion of the non-traded sector. Labour shifts from the exposed to the sheltered sectors. This boosts both consumption and output of non-traded goods. The rise in consumption of traded goods and the contraction in the production of traded goods is made possible by additional imports financed by the increase in resource revenues. National income rises by more than natural resource revenues ($dY=H_T d(QE)+C_N dP > H_T d(QE)$). The natural resource bonanza thus increases welfare.

3. De-industrialisation and Dutch disease: growth and learning by doing

If the traded sector is the engine of growth and benefits most from learning by doing and other positive externalities, non-resource export sectors temporarily hit by worsening

competitiveness are unable to fully recover when resources run out. This may result from learning by doing captured by future productivity of the traded sector increasing with current production of traded goods (van Wijnbergen, 1984) or with cumulative experience (Krugman, 1987). If human capital spill-over effects in production induce endogenous growth in both traded and non-traded sectors, natural resource exports lower employment in the traded sector, hamper learning by doing and stunt economic growth (Sachs and Warner, 1995).

To illustrate how a resource boom affects *relative* productivity growth of the traded and non-traded sector, the adverse effects of the Dutch disease on growth have been illustrated with a dynamic two-sector economy without capital accumulation, absence of current account dynamics and balanced trade (Torvik, 2001). This analysis supposes that both traded and non-traded sectors contribute to learning. A foreign exchange windfall arising from resource exports then leads to appreciation of the real exchange rate in the short run, but real depreciation in the long run. To illustrate these results within the framework presented in section 2, we allow productivity growth in manufacturing and the non-traded sectors to increase with the number employed in those sectors and suppose that learning by doing is more substantial in manufacturing than in the non-traded sector. Suppose also that the elasticity of substitution between traded and non-traded goods in consumption ε is less than unity. A fall in the relative productivity of manufacturing, i.e., $H \equiv H_T/H_N$, induces a depreciation of the real exchange rate (lower P) and, given $\varepsilon < 1$, a smaller non-traded sector (lower L_N). Labour thus shifts from the non-traded sector to manufacturing. After an increase in the natural resource windfall, increase in QE, the economy gradually converges to the lower steady-state value of H, so over time productivity of the traded sector declines relative to that of the non-traded sector. This process is illustrated in fig. 1.

We have already seen in section 2 that higher natural resource exports lead initially to real appreciation and expansion of the non-traded sector (the shift from A to A′ in fig. 1). Over time relative productivity of the traded relative to that of the non-traded sector H declines gradually. This induces gradual depreciations of the real exchange rate and falls in labour use in the non-traded sector, and corresponds to the movement from A′ to A″ and eventually to B in fig. 1. In the end this completely chokes off the initial expansion of the non-traded sector and eliminates the boom of the traded sector through gradual depreciation of the real exchange rate. The new steady-state level of production has also moved in favour of the non-traded sector, not due to reallocation of labour, but due to the relative fall in the productivity of the traded sector.

So although a temporary windfall has no long-run impact on the allocation of labour across manufacturing and the non-traded sector, it does lead to a temporary fall in the real exchange rate and the rate of economic growth and thus to a permanent loss in output. This is

fundamental to the mainstream theory of the Dutch disease. Other theories based on endogenous growth and learning by doing (Sachs and Warner, 1995) also have a temporary drop in the rate of growth, but due to the absence of specific fixed factors have no transient effects on the real exchange rate, the wage or capital intensities as all of these are pinned down by the world interest rate.

4. Dutch disease dynamics and de-industrialisation: absorption constraints

Our objective here is to present an alternative model of de-industrialisation and Dutch disease, which relies on absorption constraints and capital stock dynamics rather than on learning-by-doing externalities. To do this we allow for capital and labour as factors of production and also suppose that there are specific factors to ensure that the natural resource windfall induces realistic dynamics of the real exchange rate and the wage. We also suppose asset dynamics and a perfect international capital market and assume that households are infinitely lived and follow the permanent income hypothesis. Assume therefore a small open dependent economy with perfect access to the international capital market. We suppose that the traded good is the numeraire. To keep matters as simple as possible, we suppose that production in the traded sector only used labour. Normalizing productivity at one we have:

(10) $Y_T = L_T$ and $W = 1$.

The non-traded sector has the following Cobb-Douglas production function:

(11) $Y_N = K^{\alpha} L_N^{1-\alpha}, \quad 0 < \alpha < 1,$

where K indicates the capital produced by the non-traded sector (‘home-grown’ capital). Profit maximization yields the demand for labour in the non-traded sector:

(12) $L_N = K[(1-\alpha)P]^{1/\alpha},$

where P is the relative price of non-traded goods. Labour market equilibrium then gives:

(13) $L_T = 1 - K[(1-\alpha)P]^{1/\alpha}.$

Output of non-traded goods is given by:

(14) $Y_N = K[(1-\alpha)P]^{(1-\alpha)/\alpha}.$

We denote the unit-cost function for producing capital goods by:

(15) $c(P) = P^{\gamma}$

with $0 < \gamma < 1$ the share of non-traded goods in the production of home-grown capital. If the domestically produced traded good (or indeed the perfect substitute produced abroad) is not necessary for the production of home-grown capital, $\gamma = 1$ and $c(P) = P$. This special case highlights the absorption constraints best, since the windfall cannot be used to import capital goods from abroad. They must be fully produced at home.

Profit maximization requires that the marginal product of capital, $r(P)$, must equal the rental change, r^*, plus the depreciation charge, δ, minus the expected capital gains:

$$(16) \qquad r(P) = \alpha[(1-\alpha)P]^{(1-\alpha)/\alpha} + r^* + \delta - \dot{c}(P) / c(P).$$

Preferences are homothetic and $e(P) = P^{\beta}$, $0 < \beta < 1$, denotes the unit-expenditure function, hence consumption is non-traded goods is given by:

$$(17) \qquad C_N = e'(P)U,$$

where U denotes real consumption (or utility). Equilibrium on the market for non-traded goods is given by:

$$(18) \qquad C_N + c'(P)I = Y_N,$$

where $I = \dot{K} + \delta K$ denotes gross investment. The representative consumer maximizes utility, $\int_0^{\infty} \ln(U)\exp(-\rho t)\mathrm{d}t$, subject to the present-value budget constraint of the economy:

$$(19) \qquad \int_0^{\infty} \left[e(P)U + c(P)I\right]\exp(-r^* t)\mathrm{d}t \le F_0 + V_0 + \int_0^{\infty} (Y_T + PY_N)\exp(-r^* t)\mathrm{d}t,$$

where F indicates foreign assets (bonds) and V the present value of natural resource revenues (i.e., natural resource wealth). The present-value budget constraint states that the present value of the stream of current and future consumption and investment spending on traded and non-traded goods cannot exceed initial foreign assets plus initial resource wealth plus the present value of current and future traded and non-traded production. If we set $r^* = \rho$, the optimality condition for the consumer is:

$$(20) \qquad 1/U = \lambda\, e(P),$$

where the marginal utility of wealth λ has to be constant over time. At the time the resource windfall becomes known (upward jump in V_0), λ jumps down and stays at this lower value forever after. A resource windfall thus corresponds to an unanticipated, permanent fall in the marginal utility of wealth λ.

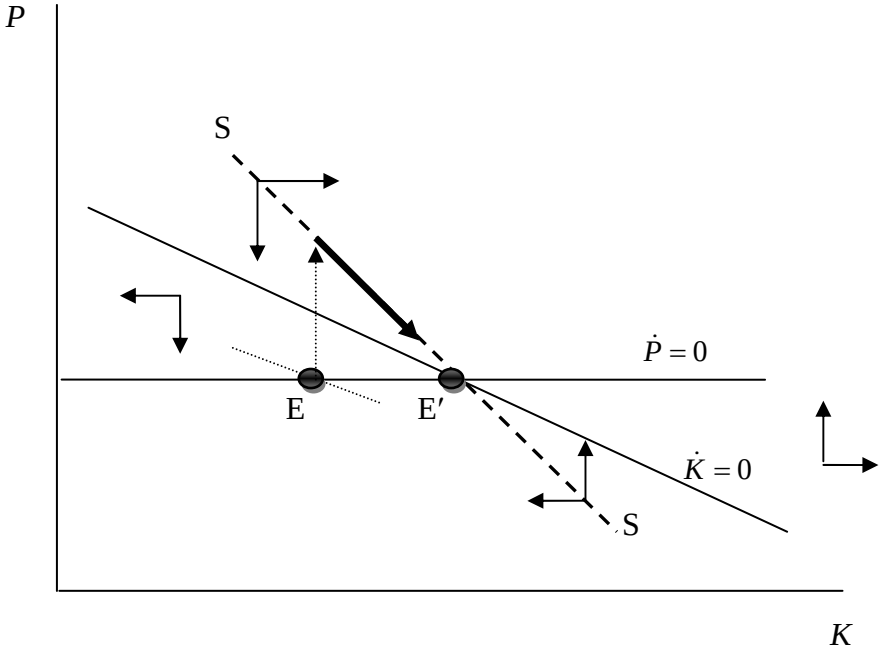
The adjustment path follows from the system of differential equations describing, respectively, equilibrium in the market for non-traded goods and equity arbitrage:

$$(21) \qquad \dot{K} = \left[K\left((1-\alpha)P\right)^{\frac{1-\alpha}{\alpha}} - \frac{\beta}{\lambda P} \right] \frac{P^{1-\gamma}}{\gamma} - \delta K, \quad K(0) = K_0,$$

$$(22) \qquad \dot{P} = \left[r^* + \delta - \alpha\left((1-\alpha)P\right)^{\frac{1-\alpha}{\alpha}} \right] \frac{P}{\gamma}, \quad P(0) \text{ free.}$$

The phase diagram corresponding to this economic system is given in fig. 2.

Figure 2: Absorption constraints and Dutch disease dynamics



The steady-state value of P is independent of λ, but the steady-state value of K increases after downward and permanent jump in λ induced by a windfall of foreign exchange. Note that as the share of traded goods in capital goods vanishes, $\gamma \to 0$, the capital stock adjusts immediately to a natural resource windfall. As a result of the downward jump in λ, there is an immediate and permanent upward jump in K and there is no need for the real exchange rate to appreciate whatsoever. However, much capital in modern economies (think of nurses and teachers as well as infrastructure) must be home-grown and cannot be imported. Consequently, γ is closer to one and absorption constraints will manifest themselves. This may be seen from the saddle-path diagram given in fig. 2.

The optimal response to a windfall is for the real exchange to appreciate on impact signalling labour to shift from the traded to the non-traded sector and shifting demand from non-traded to traded goods. Over time, investment induces a gradual expansion in home-grown capital which permits a gradual reversal of the initial appreciation of the real exchange

rate. The resulting temporary boost to the return on capital in the non-traded sector r(P) is in line with the anticipated capital losses on those capital goods (as over time the relative price of investment goods c(P) will fall and return to its original level). The windfall results in an immediate and permanent increase in the consumption of traded goods, but consumption of non-traded goods increases on impact and subsequently continues to increase towards its new steady-state level.

Home-grown capital also jumps up on impact and then continues to rise to its new steady-state level. Due to the gradual increase in consumption as supply constraints are gradually relaxed, the total stock of assets increases by more than the windfall. Hence, there is initial saving (parking funds abroad) relative to the permanent income hypothesis. Van der Ploeg and Venables (2010) provide a much more general analysis allowing for capital accumulation in the traded sector as well and highlighting the impossibility of shifting capital between the two sectors once it has been installed. One issue that becomes apparent from this more general analysis is that once international migration is allowed and/or capital imported from abroad can be substituted for home-grown capital, adjustment is immediate and the symptoms of the Dutch disease disappear.

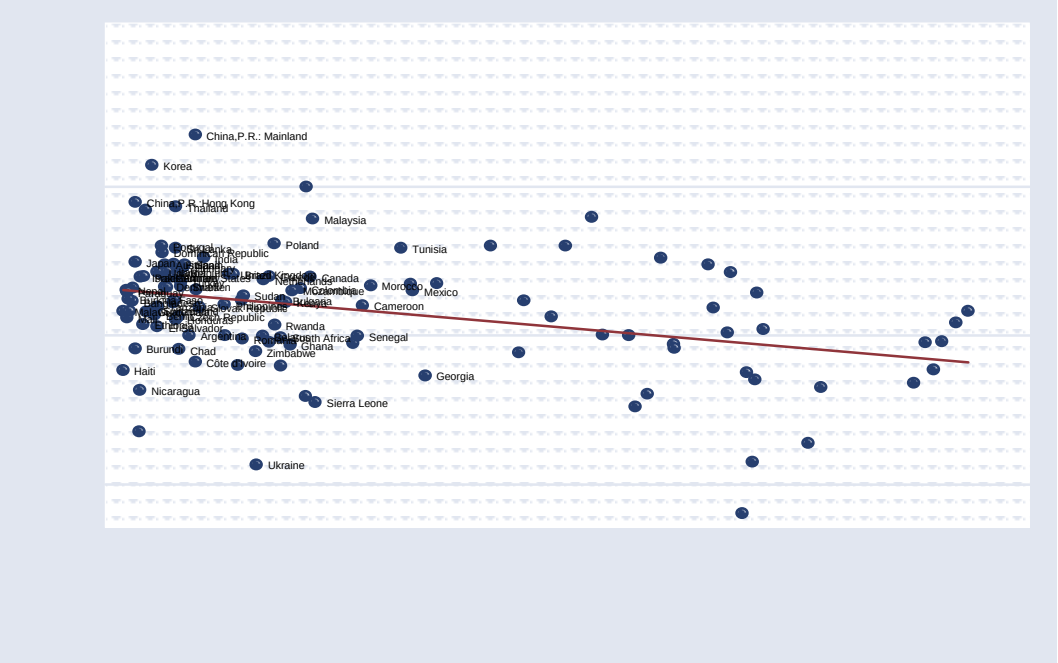
A final comment about the model we have discussed is in order. We have assumed that the natural resource windfall corresponds to a sudden increase in income from abroad. It thus requires no labour or capital inputs to produce a resource-based good that turns the natural wealth of the country into a rent-generating activity. If labour and capital are needed to produce a resource windfall, there may not be Dutch disease effects. Apart from the hitherto discussed *resource spending* effects leading to appreciation of the real exchange rate and contraction of the traded sector, there will be *resource movement* effects resulting from labour being drawn out of the traded and the non-traded sectors into the resource sector as discussed in Corden and Neary (1982). If the traded sector is capital intensive, the Rybczinksi theorem states that these latter effects will lead to an expansion of the traded sector. Hence, if these latter effects are strong enough they may outweigh the contraction of the traded sector resulting from spending effects. Resource windfalls then lead to pro-industrialization.

5. Empirical evidence for Dutch disease effects

Before we discuss how the presence of Dutch disease might affect the optimal way of harnessing windfalls of resource revenue, we first briefly assess whether there is any *direct* empirical support for Dutch disease effects and then whether there is any *indirect* support. Recent empirical evidence for 135 countries for the period 1975-2007 indicates that the response to a resource windfall is to save about 30 percent, decrease non-resource exports by 35-70 percent, and increase non-resource imports by 0-35% (Harding and Venables, 2010). These findings hold in pure cross-sections of countries (averages across one, two, three or

four decades), in pooled panels of countries, and in panel estimations including dynamics and country fixed effects. Another empirical study uses detailed, disaggregated sector data for manufacturing and obtains similar results: a 10.0 percent oil windfall is on average associated with a 3.4% fall in value added across manufacturing, but less so in countries that have restrictions on capital flows and for sectors that are more capital intensive (Ismail, 2010). Using as a counterfactual the Chenery-Syrquin (1975) norm for the size of tradables (manufacturing and agriculture), countries in which the resource sector accounts for more than 30% of GDP have a tradables sector 15 percentage points lower than the norm (Brahmbhatt, et al., 2010). This empirical evidence thus seems to offer *direct* empirical support for the type of Dutch disease effects highlighted in section 2 and section 4. We now assess whether there is *indirect* empirical support for Dutch disease and the resource curse.

Figure 3: Growth and natural resource dependence



Fuels, ores and metals exports in percent of merchandise exports 1970-2002
Source: World Development Indicators, World Bank

Figure 3 indicates a negative correlation between economic growth and natural resource dependence, but this does not say anything about causality. However, early empirical cross-country evidence shows that resource rich countries grow on average about one percentage point less during 1970-89 even after controlling for initial income per capita, investments during the period, openness and rule of law (Sachs and Warner, 1995). The revised cross-country regressions explaining average growth in real GDP per capita during 1970-90 are reported in the first regression of table 1. There is evidence of conditional convergence (in line with the workhorse Solow model of economic growth), since countries with a low (log of the) level of initial real GDP per active member of the population catch up

and grow relatively fast. Countries with a high log ratio of real public and private gross domestic investment to real GDP averaged over 1970-89 appear to grow faster. Countries with a large number of years in which their economy is rated as open and whose citizens accept the rule of law more easily (on a scale from 1 to 6) also grow faster. Even taking account of these traditional growth determinants, there is a strong negative effect of resource dependence (measured by the share of exports of primary products in GNP in 1970) on growth. This is what has become known as the *natural resource curse* and offers support for the theories reviewed in section 3. This pioneering study gives no role for institutions or bureaucratic quality in explaining the curse. The second regression reported in Table 1 uses more countries, more years and an index of institutional quality (on a scale from 0 to 1). Using the starting year 1965 rather than 1970, it confirms that resource rich economies experience slower growth and that institutional quality is not significant at the 5 percent level.

Table 1: Effects of resource dependence and institutional quality on economic growth

Annual growth in real GDP per capita	Sachs and Warner (1997a)	Based on data in Sachs and Warner (1997b)	Mehlum, Moene and Torvik (2005a)
Initial income	-1.76 (8.56)	-1.28 (6.65)	-1.26 (6.70)
Openness	1.33 (3.35)	1.45 (3.36)	1.66 (3.87)
Resource dependence	-10.57 (7.01)	-6.69 (5.43)	-14.34 (4.21)
Rule of law	0.36 (3.54)	-	-
Institutional quality	-	0.6 (0.64)	-1.3 (1.13)
Investments	1.02 (3.45)	0.15 (6.73)	0.16 (7.15)
Interaction term	-	-	15.40 (2.40)
Number of countries	71	87	87
Adjusted R^2	0.72	0.69	0.71

These regressions have become the cornerstone of many discussions of the resource curse, but can be criticized on econometric grounds. For example, the share of resources in GNP (dependence) is potentially endogenous and, if instrumented, it does not significantly affect growth whereas subsoil resource wealth (abundance) does have a significant positive effect on growth (Brunnschweiler and Bulte, 2008). However, natural resource wealth is also endogenous as it is calculated as the present value of natural resource rents. If it is instrumented with the more exogenous measure of economically recoverable reserves, there is no evidence for either a curse or a blessing unless one allows for an indirect effect via volatility (van der Ploeg and Poelhekke, 2010). Another issue is the negative correlation between growth performance and resource dependence, which may merely be picking up cross-country variations in income per capita. Alternatively, if the non-resource traded sector declines and the wage premium for education falls, resource rich economies might invest less in education and thus the growth rate falls. Hence, adding a control for education implies that

the negative coefficient on resource dependence should fall. Similar points apply to intermediate variables such as wars or institutional quality, so one should be careful about drawing inferences about the speed of convergence from the coefficient on initial income. There may also be some omitted variable bias if a third factor say 'underdevelopment' is driving income as then countries with a low income potential are measured as resource rich.

It is important to distinguish between countries with production-friendly institutions and others with rent grabbing-friendly institutions (Mehlum et al., 2006ab). Because it can be shown that there will be more rent seeking following a windfall in countries with bad institutions (e.g., Angola, Nigeria, Sudan and Venezuela, diamond-rich Sierra Leone, Liberia and Congo, and drug states Columbia and Afghanistan) and thus a curse, but not so in countries with strong institutions (e.g., Australia, Canada, US, New Zealand, Iceland and Norway, and also Botswana). Later evidence indeed offers support for the hypothesis that with good institutions the curse can be turned into a blessing (Mehlum et al., 2006ab). The third regression in Table 1 indicates that countries with a high enough index of institutional quality (> 14.34/15.4=0.93) experience no curse. This holds for 15 out of the 87 countries (including the US, Canada, Norway, the Netherlands, New Zealand and Australia). Resource rich countries with bad institutions typically are poor and remain poor. The adverse effect of resource dependence on institutional quality and growth is particularly strong for easily appropriable 'point-source' resources with concentrated production and revenues and massive rents such as oil, diamonds, minerals and plantation crops rather than agriculture (rice, wheat and animals) whose rents are more dispersed throughout the economy, and with easy appropriation of rents through state institutions (Boschini, et. al., 2007).

Table 2: Marginal effects of resources on growth for varying institutional quality

	Primary exports share of GDP	Ores and metals exports as share of GDP	Mineral production as share of GNP	Production of gold, silver and diamonds as share of GDP
Worst institutions	–0.548	–0.946	–1.127	–1.145
Average institutions	–0.378	0.425	0.304	0.279
Average + one s.d. institutions	–0.288	1.152	1.062	1.183
Best institutions	–0.228	1.629	1.560	1.776

Note: Institutional quality is an average of the indexes for bureaucracy, corruption, rule of law, risk of expropriation of private investment and repudiation of contracts by government.
Source: Boschini, et. al. (2007)

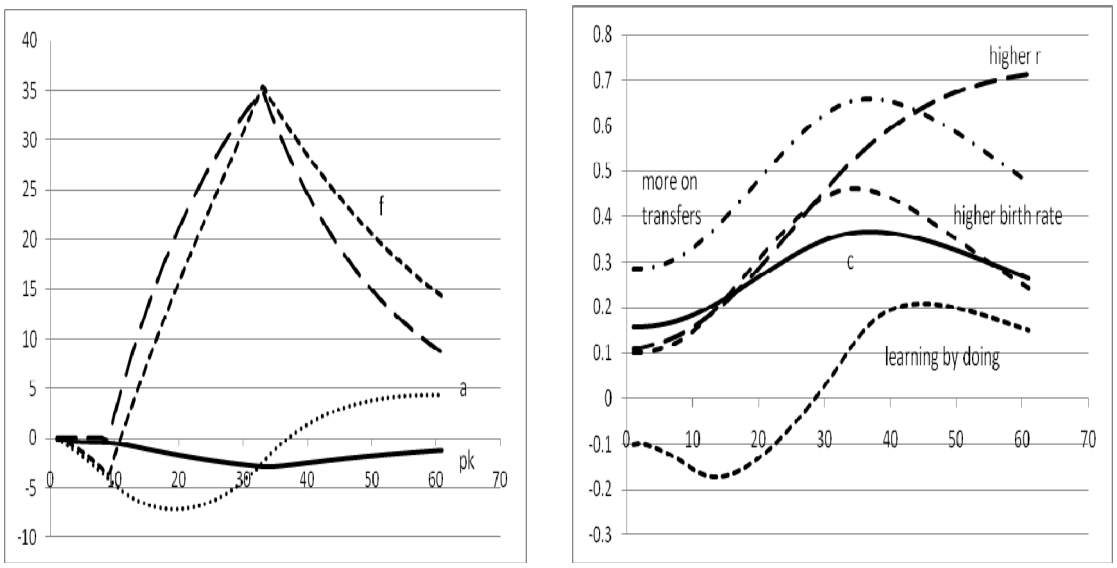
Table 2 calculates the marginal effects of one standard deviation change in various measures of resource dependence that are increasingly technically appropriable on the average yearly growth rate of GDP during 1975-88 for different levels of institutional quality (from cross-country regressions with a sample of 80 industrialised and developed countries, controlling for trade openness, average share of investment in GDP and initial level of income per capita). Going from top to bottom in table 2, we see that better institutions are conducive to growth indicating *institutional* appropriability. Reading table 2 from left to right, the importance of good institutions increases in technical appropriability of resources which confirms *technical* appropriability. The curse is thus not cast in stone.

6. Harnessing natural resource windfalls in developing economies

Having established both analytically and empirically the role of non-traded or home-grown capital in the appearance of absorption constraints and Dutch disease effects, we now turn how absorption constraints and Dutch disease effects might influence the optimal fiscal policy responses to a natural resource windfall.

In policy analysis one often focuses at the optimal way of harnessing a *given* temporary, natural resource windfall (e.g., Collier et al., 2010). The benchmark for this is typically based on the *permanent income hypothesis*, which says that countries should borrow ahead of the windfall, pay back incurred debt and build up sovereign wealth during the windfall and finance the permanent increase in consumption out of the interest on the accumulated sovereign wealth after the windfall has ceased. The IMF has often recommended resource rich countries to put their windfalls in such a sovereign wealth fund (e.g., Davis et al., 2002). The *permanent-income* fiscal rule states that the increase in primary public spending should equal the permanent value of the windfall at the time of discovery and builds up sufficient sovereign wealth to ensure that the interest on the fund at the end of the windfall can sustain the permanent increase in consumption. A more conservative fiscal rule is the *bird-in-hand* rule, which says that the windfall does not serve as collateral for loans, is put in a fund, and a fixed percentage (4% in case of Norway) is drawn from the fund to finance primary public spending. The bird-in-hand rule is prudent in that windfalls are not valued until they are banked, but is less successful in transferring the benefits to future generations than the permanent-income rule.

Figure 3: Macroeconomic Implications of the Bird-In-Hand (4%) Rule



Key: The horizontal axes give units of time. In the left panel *pk*, *a* and *f* indicate the time paths for the equity value of the capital stock, household assets and foreign assets, respectively. The right panel gives the paths for consumption *c* under different assumptions (higher world interest rate, a higher proportion of the windfall spent on transfers, a higher birth rate, and learning by doing in manufacturing).

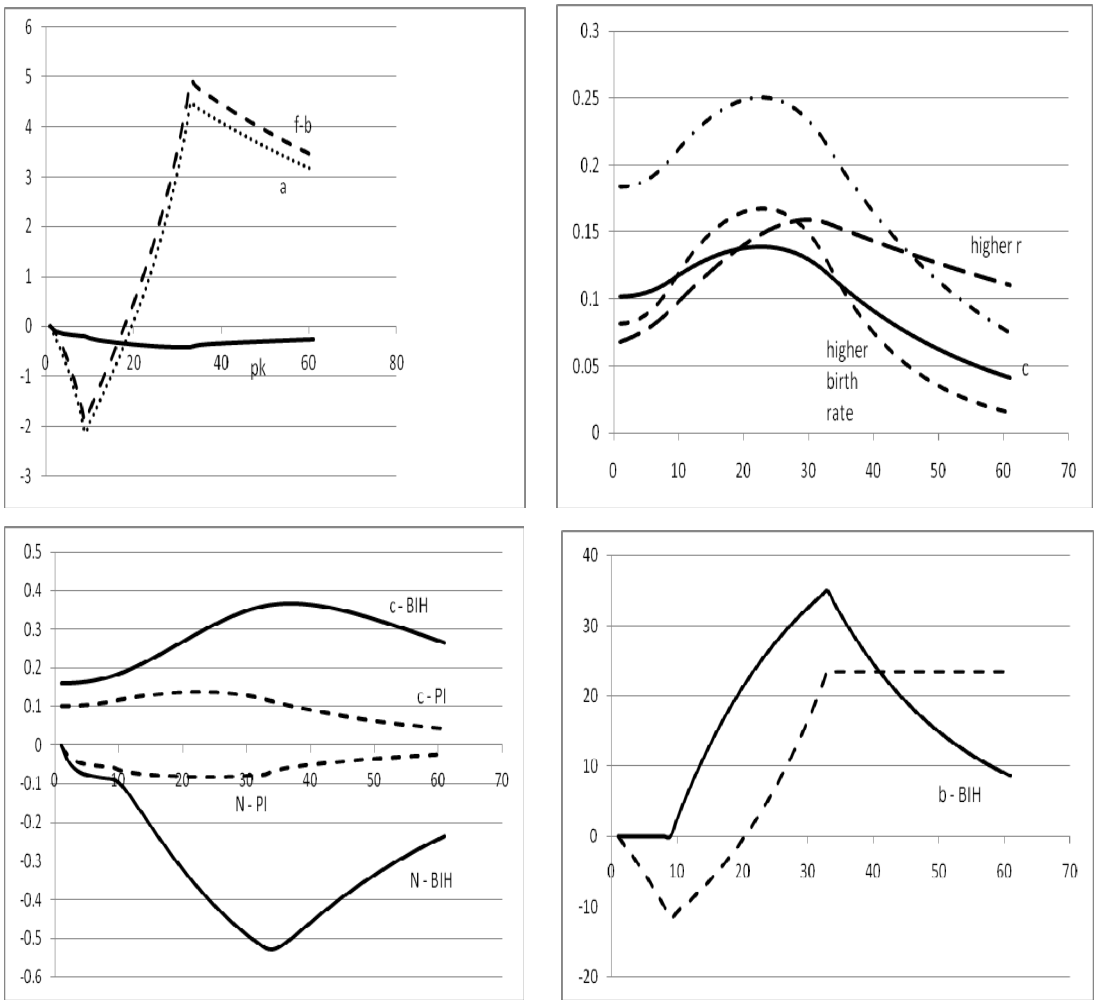
Fig. 3 presents the *bird-in-hand* rule within the context of the theoretical model presented in van der Ploeg (2010b). The main differences with the model presented in section 4 are that it has no specific factors and thus that the real exchange rate is not affect by the windfall of natural resource revenues, but that it does include overlapping generations to give a meaningful role for government debt. We suppose that the windfall lasts from period 10 to 32. As all factor prices are tied down by the world interest rate, capital and employment in manufacturing move in tandem. Ahead of the windfall, capital in manufacturing is run down and labour shifts from manufacturing to the non-traded sector to make possible the increase in consumption of non-tradables. During the windfall capital and employment in manufacturing decline further and after the windfall they gradually rise back to their original steady-state values. These factor movements are entirely achieved via output effects (substitution effects are absent as the real exchange rate does not respond to the windfall). The government does not borrow ahead of the windfall, but builds up assets during the windfall and stops thereafter asserts are gradually winded down (as the 4% rule implies that the fraction of government assets that is being consumed every period exceeds the assumed world return on government assets); see the line of long dashes. Households already borrow ahead of the windfall as can be seen from the time path of foreign assets (indicated by *f*) and household assets (indicated by *a*).

The right panel of fig. 3 shows the sensitivity of the consumption path to four key parameters. First, a higher world interest rate induces an extra incentive to save and postpone

consumption. So there is less borrowing and a smaller upward jump in consumption ahead of the windfall, but eventually the return on accumulated assets permits higher levels of consumption after the windfall has ceased. Second, if a greater proportion of primary public spending is spent on citizen dividends, the whole time path of private consumption is lifted upwards while that of public consumption is shifted downwards. Conversely, if all the windfall revenue is spent on public consumption, private consumption and asset holdings would be unaffected. If furthermore neither the public nor the private sector consumes non-tradables, the capital stock and employment in manufacturing would also not be affected by the windfall which reminds us of our analysis of section 4. In that very special case, the windfall is fully spent abroad with no effects on the domestic economy whatsoever. Third, a higher birth/death rate and thus a bigger departure from Ricardian debt neutrality implies that households discount future transfers more heavily. As a result, consumption jumps up by a smaller amount permitting more household saving and a higher level of future consumption. In the extreme case that there is no debt neutrality, consumption would be completely smoothed. Fourth, with learning-by-doing effects in manufacturing as discussed in section 3 added to the model, the growth rate falls as labour moves from manufacturing to the non-traded sector, and consequently the whole consumption path is shifted downwards. On impact on the news of the discovery consumption now jumps down a little so that employment in the traded sector rises rather than falls ahead of the windfall, but then falls sharply when the windfall revenue pours in. Despite the temporary fall in growth, steady-state consumption is unaffected by learning by doing.

Fig. 4 gives the transient dynamics of an anticipated, temporary bonanza under the permanent-income rule, and the bottom two panels allow us to compare with the bird-in-hand rule. The falls in capital and employment in manufacturing are much smaller under the permanent-income rule. Also, the increase in consumption is much less than under the bird-in-hand rule, but lasts much longer. The government now also borrows ahead of the windfall and accumulates less sovereign wealth than under the bird-in-hand rule, but the fund is not depleted after the windfall to ensure that the boost to primary public spending can be sustained forever. Since with the permanent-income rule the government does some of the consumption smoothing for the private sector, households need to borrow less ahead of the windfall and accumulate fewer assets during the windfall than under the bird-in-hand rule. The sensitivity exercises shown in the top-right panel of fig. 4 give the same qualitative insights as the ones in fig.3.

Figure 4: Macroeconomic Implications of the Permanent-Income Rule



Key: The horizontal axes in each panel give units of time. In the top-left panel *pk*, *a*, *f* and *b* indicate the time paths for the equity value of equity, household assets, foreign assets and government debt, respectively. The top-right panel give the time paths for consumption *c* for the benchmark and for various alternative scenarios (higher world interest rate, a higher fraction of the windfall spent on transfers, and a higher birth rate). The dashed and solid lines in the left-bottom panel give the time paths for consumption and for the permanent-income and the bird-in-hand rules indicated by *c-PI* and *c-BIH*, respectively. Similarly, the right-bottom panel gives the time path of government debt under these two rules.

The above analysis of the bird-in-hand and permanent-income rules can be extended to allow for specific fixed factors in order to have interesting time trajectories of the real exchange rate, wage and factor intensities (van der Ploeg, 2010b). In general, one must take account of many other features of resource-rich developing countries other than absorption constraints. For example, although developing economies often converge on a development path, they often suffer from capital scarcity and high interest rates resulting from premium on high levels of foreign debt, and households do not have access to perfect capital markets. In that case, the permanent income hypothesis is inappropriate. In contrast to transferring much of the increment to future generations (as with the permanent-income and bird-in-hand rules), the optimal time path for incremental consumption should be skewed towards present

generations and saving should be directed towards accumulation of domestic private and public capital and cutting debt rather than accumulating foreign assets (van der Ploeg and Venables, 2011). The windfall then brings forward the development path of the economy. The analysis of van der Ploeg and Venables (2010) and section 4 suggests, however, that there may be absorption constraints so that it might take time before sufficient home-grown capital has been accumulated to meet the extra demand for home investment. In that case, it is optimal to park some of the windfall *temporarily* in a sovereign wealth fund until the domestic economy has alleviated the absorption constraints.

Another issue to consider has to do with the political economy of windfalls. This dictates that incumbents avoid putting resource revenues in a liquid sovereign wealth fund which can be easily raided by political rivals. There is thus a bias to excessive investment in illiquid, partisan projects, especially if the probability of being removed from office is high (Collier et al., 2010).

7. Concluding remarks

Although the hypothesis of learning-by-doing in the traded sector may be relevant for advanced industrialised economies, developing economies are more likely to suffer from absorption constraints in the non-traded sector especially as it is unlikely that capital in the traded sector can easily be unbolted and shunted to the non-traded sector. It may then be optimal to temporarily park some of the windfall in a sovereign wealth fund until the non-traded sector has produced enough home-grown capital (infrastructure, teachers, nurses, etc.) to alleviate absorption bottlenecks and allow a gradual rise in consumption (see also van der Ploeg and Venables, 2010). The economy experiences temporary appreciation of the real exchange rate and other Dutch disease symptoms. However, these are reversed as home-grown capital is accumulated.

Many countries thus find it hard to absorb a substantial and prolonged windfall of foreign exchange, since it takes time for the non-traded sectors to accumulate ‘home-grown’ capital. Whilst these Dutch disease bottlenecks are being resolved, it is optimal to park the windfall revenue abroad until there is enough capacity to sensibly invest in the domestic economy. However, fear of the fund being raided by political rivals can induce a sub-optimal political bias towards too much partisan, illiquid investment.

A realistic analysis of how to optimally harness natural resource windfalls requires one to depart from Ricardian debt neutrality, because otherwise it would not matter whether the government uses bird-in-hand or permanent-income rules. One way of breaking neutrality is to suppose a large fraction of credit-constrained households another way is to have overlapping generations without an operational bequest motives. This then suggests that bird-in-hand rules lead to a lot of extra consumption during and immediately after the windfall, but

in the long run to no extra consumption. A permanent-income rule, in contrast, has much less extra consumption during the windfall but the increase, being financed by interest on the sovereign wealth fund, lasts forever.

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