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The Dutch Disease and Intergenerational Welfare*

Jørgen Juel Andersen[†]

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Abstract

Governments in resource abundant economies face a tradeoff between transferring wealth to present generations and saving for future generations. Employing an overlapping generations framework with endogenous growth, this paper analyzes the intergenerational welfare effects of: (1) a wealth transfer policy where the entire wealth is transferred to the generations alive at present; (2) an income transfer policy where the wealth is saved and the permanent income of the wealth is transferred to all present and future generations, forever. Not surprisingly, present generations are unambiguously better off with the wealth transfer policy. Less trivially, however, the wealth transfer policy can be associated with higher welfare also for future generations. The intuition for this result is that while a wealth transfer depresses growth only in the periods subsequent to the transfer, income transfers constitute a permanent drag on growth. Perhaps counter to the naïve intuition, the policy of saving the wealth and distributing the permanent income to all present and future generations is less beneficial for the future generations if the real return to saving is high.

Keywords: Dutch disease. Growth. Resource wealth. Transfer policy. Intergenerational welfare allocation.

JEL: F43, O41, Q32.

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1 Introduction

The possible adverse economic effects of resource windfalls have gained increasing attention since the empirical contributions of Sachs and Warner (1995, 1997, 2001). Within a large sample of countries, Sachs and Warner document a negative correlation between various measures of resource abundance and growth between 1970 and 1989. Gylfason et al. (1999) provide support for these findings, as do several case studies such as Gelb (1988), Karl (1997) and Auty (2001). One hypothesis for the 'resource curse' is Dutch disease, where the foreign exchange gift indirectly crowds out some productivity enhancing activity.¹ The productivity enhancing activity is usually identified as traded sector production, or manufacturing, and the productivity generating mechanism is some form of learning by doing. The theoretical contributions of Van Wijnbergen (1984), Krugman (1987), Matsuyama (1992), Sachs and Warner (1995) and Torvik (2001) all analyze how resource windfalls may lower growth by crowding out traded sector production.²

The potential negative effects of natural resource wealth on growth due to Dutch disease raise a question that has largely been ignored in the existing literature: What are the consequences for the intergenerational distribution of welfare of different transfer paths of a natural resource wealth? This question calls for a positive answer, but has strong normative implications, and the question is at the heart of the policy debates in most natural resource abundant countries.³ In order to analyze intergenerational welfare, models of overlapping generations are required.⁴ Several contributions address different welfare aspects of the intertemporal and/or the intergenerational allocation of natural resources.⁵ However, none account for the Dutch disease dynamic and the intergenerational distribution of welfare simultaneously. Perhaps most closely related to the present analysis is Sachs and Warner (1995), who analyze the Dutch disease within an overlapping generations framework but disregard the intertemporal government budget constraint and transitional dynamics.

Combining the models of Persson (1985) and Sachs and Warner (1995), this paper analyzes the intergenerational welfare effects of resource wealth when there is learning-by-doing (LBD) in the traded sector, explicitly taking into account the intertemporal government budget constraint.⁶

¹Two main competitors to the Dutch disease hypothesis are the rent-seeking hypothesis (see, e.g., Lane and Tornell, 1996; Torvik, 2002; Mehlum et al., 2005) and the political economy approach (see, e.g., Ross, 1999, 2001; Robinson et al., 2002; Aslaksen et al., 2006; Andersen and Aslaksen, 2008). The rent-seeking hypothesis analyze how productive activities can be crowded out by rent-seeking activities, while the political economy approach focuses on how larger political rents affect the incentives of political players and the outcomes of political processes.

²Neary and van Wijnbergen (1986) provide an early overview of the theoretical and empirical literature on the Dutch disease.

³The normative implications of exhaustible resource abundance is in fact at the heart of a body of literature initiated by Solow (1974), which has been briefly reviewed by Asheim (2005). This literature employs utilitarian Ramsey-type models, like the so-called Dasgupta-Heal-Solow model (as in Dasgupta and Heal, 1979), and works out "rules" for ethical transfer paths, as in, for example, Hartwick (1977, 1978_a, 1978_b).

⁴As suggested by, e.g., Solow (1986).

⁵See, e.g., Mansoorian (1991), Gerlagh and Keyzer (2001), Gerlagh and Van der Zwaan (2002), Agnani et al. (2005), and, in a development context, van der Ploeg and Venables (2009).

⁶Persson (1985) employs a Diamond (1965) OLG model and shows how public debt in small open economies results in a redistribution of welfare from future to present generations. In contrast to the Dutch disease literature, however, the only source of growth in this model is exogenous population growth.

There are generally two ways resource wealth may affect intergenerational welfare allocation. The *direct* way is through the level effect of transfers: a transfer of wealth to the private sector today has a direct negative impact on the amount of wealth available for transfers in the future. The *indirect* way is through endogenous growth effects: high aggregate demand caused by government transfers affects the sectoral composition of the economy, which in turn affects the productivity growth. The transfer path of resource wealth thus has two potentially conflicting effects on the intergenerational allocation of welfare.

The intergenerational welfare effects of different transfer paths clearly have policy implications. In the current analysis, two distinct policy options are characterized and their intergenerational welfare effects are compared. The first policy option is *a wealth transfer policy*. A wealth transfer policy implies transferring the ownership of the resource wealth to the public, i.e., to the generations alive at the time of the windfall. The second policy option is *an income transfer policy*, where the government transfers the permanent income of the resource wealth to all current and future generations. Both policy options are relevant, as they are frequently mentioned both in the literature and in the public resource management debate.⁷

Clearly, a wealth transfer policy is associated with higher welfare for the first period generations (in the short run), compared with the income transfer policy. Moreover, because of its strong adverse effects on traded sector employment, the wealth transfer policy is more damaging for growth in the subsequent period(s). Thus, the wealth transfer policy is associated with welfare reduction for the generations alive in the medium run, compared with the income transfer policy. However, when comparing with the income transfer policy, the wealth transfer policy may improve welfare—in terms of higher GDP and income—for future generations. The reason for this somewhat counterintuitive result is that while the income transfer policy has less severe consequences for growth in the short run, its infinite transfer path constitutes a permanent drag on growth. Using numerical simulations it is shown that the wealth transfer policy can be associated with a higher welfare for the future generations compared with the income transfer policy for a range of realistic parameter values to characterize the economy.

The paper proceeds as follows. Section 2 presents the model. Section 3 defines the static and dynamic equilibria. Section 4 provides the results and a discussion on the growth and the intergenerational welfare effects of the two policy alternatives, and Section 5 concludes.

2 Model

2.1 The supply side

Consider a small open economy of two sectors producing traded (T) and nontraded (N) goods. The labor force is allocated between these two sectors, and η is the fraction of the labor force

⁷The wealth transfer policy is similar to, e.g., the proposition in Sala-i-Martin and Subramanian (2003) regarding the management of Nigeria's natural resource wealth. The income transfer policy is similar to, e.g., the spending rule of the Norwegian Government (see, e.g., Hanneson (2001, ch.7)).

employed in traded sector production, $0 \leq \eta \leq 1$. All endogenous dynamics arise from accumulation of human capital through a LBD mechanism; productivity is assumed to grow proportional to traded sector employment. Following Sachs and Warner (1995) technological progress spills entirely over to the nontraded sector, ensuring balanced growth. The endogenous dynamics of productivity, H , can then be written

$$\frac{H_{t+1} - H_t}{H_t} = \alpha\eta_t. \quad (1)$$

Thus, productivity growth from period t to $t+1$ is equal to the traded sector employment in period t multiplied by a growth factor α , and is a positive externality of traded sector production⁸. As in Romer (1986), each firm is too small to take the LBD externality into account.

Production in both sectors is proportional to both labor and technology,

$$X_{Tt} = H_t\eta_t \quad (2)$$

$$X_{Nt} = H_t(1 - \eta_t). \quad (3)$$

The supply side of the model is thus similar to Sachs and Warner (1995), except that the expressions are simplified by leaving out real capital in the production functions. Not explicitly modelling the real capital dynamics makes the dynamic derivations simpler without losing any important insight. Assuming internationally perfectly mobile capital at a constant (marginal) price, capital adjusts so that the capital-labor ratio is constant, and the result is constant returns-to-scale production with respect to all factors (as in Sachs and Warner, 1995). Since production in both sectors is characterized by constant returns to scale, the relative prices are constant and the real exchange rate is uniquely determined by the supply side. For simplicity all prices, including the real exchange rate, are normalized to unity.⁹ Total production in the economy at time t is the sum of traded sector production, (2), and nontraded sector productions, (3),

$$X_t = X_{Tt} + X_{Nt} = H_t. \quad (4)$$

2.2 The demand side

As in Diamond (1965), individuals live for two periods, and a new generation is born at the beginning of each period. In each time period there is one representative individual for each generation, the young (y) and the old (o). Utility of the representative individual born at the

⁸Assuming that the productivity growth rate is proportional to traded sector employment is a nonessential simplification of the hypothesis that productivity growth is a positive byproduct of employment, known as the *learning by doing* effect. Any increasing function of labor input would produce qualitatively similar results.

⁹Note that a single time period in this model is typically 25-30 years. Assuming balanced growth within each time period implies that the real exchange rate remains constant within each time period. Hence, the model does not address short term real exchange rate fluctuations.

beginning of period t is time separable with Cobb–Douglas utility within each period, and writes

$$U(C_{Tt}^y, C_{Nt}^y, C_{Tt+1}^o, C_{Nt+1}^o) = \ln \left[(C_{Tt}^y)^\gamma (C_{Nt}^y)^{1-\gamma} \right] + \beta \ln \left[(C_{Tt+1}^o)^\gamma (C_{Nt+1}^o)^{1-\gamma} \right]. \quad (5)$$

In equation (5), γ is the weight on traded sector goods, $0 < \gamma < 1$, and β is the individual time preference discount factor.

The individuals work only in the period when they are young, but in addition to labor income the individuals also receive a flow of government transfers, R_t . Although productivity and hence production income is endogenous in the dynamic model, it is considered exogenous by each single consumer—the individuals do not take into account their own contribution to growth, nor do they influence the amount of government transfers. However, all individuals are forward looking in the sense that they have knowledge of the total value of all the transfers they will receive during their lifetimes. The budget constraint every individual faces is thus

$$C_{Tt}^y + C_{Nt}^y + \frac{C_{Tt+1}^o + C_{Nt+1}^o}{1+r} = X_t + \frac{R_t}{2} + \frac{R_{t+1}}{2(1+r)}. \quad (6)$$

The left-hand side of the budget constraint is the present value of lifetime consumption, while the right-hand side is the present value of lifetime disposable income. The government transfers in each period, R_t and R_{t+1} , are assumed to be distributed equally between the two living generations. The world real rate of interest, r , is exogenous to the small economy and constant over time.

Due to Cobb–Douglas utility, a constant fraction of total consumption expenditure is spent on each good within each time period. The fraction of consumption of nontradable goods in each period is equal to $1 - \gamma$, and hence the fraction of tradable goods is given by γ . Further, a homothetic intertemporal utility function in a constant interest rate environment implies that a constant fraction $1 - s$ of lifetime wealth is spent on first period consumption, and, conversely, a fraction s is saved for second period consumption.¹⁰ Maximization of the utility (5) with respect to the budget constraint (6) results in the following static demand functions:

$$C_{Tt}^y = \gamma \frac{1}{1+\beta} \left(X_t + \frac{R_t}{2} + \frac{R_{t+1}}{2(1+r)} \right) \quad (7)$$

$$C_{Nt}^y = (1-\gamma) \frac{1}{1+\beta} \left(X_t + \frac{R_t}{2} + \frac{R_{t+1}}{2(1+r)} \right) \quad (8)$$

$$C_{Tt+1}^o = \gamma(1+r) \frac{\beta}{1+\beta} \left(X_t + \frac{R_t}{2} + \frac{R_{t+1}}{2(1+r)} \right) \quad (9)$$

$$C_{Nt+1}^o = (1-\gamma)(1+r) \frac{\beta}{1+\beta} \left(X_t + \frac{R_t}{2} + \frac{R_{t+1}}{2(1+r)} \right) \quad (10)$$

¹⁰The intertemporal Euler equation is $C_{t+1}^o = (1+r)\beta C_t^y$, and the savings rate is given by $s = \frac{\beta}{1+\beta}$.

The demand functions (7) to (10) of the representative individual are characterized by constant budget shares of total discounted lifetime income which, in turn, are functions of the static preference structure, the world real rate of interest, and the discount rate.

2.3 The government and alternative policies

The government receives a windfall—or, alternatively, discovers a natural resource wealth—of the real value W_1 , at the beginning of period 1. The sole mandate of the government is to distribute this wealth to current and future generations under the restriction that any transfer policy must satisfy the intertemporal budget constraint

$$(1+r)W_1 = \sum_{t=1}^{\infty} \left(\frac{1}{1+r}\right)^{t-1} R_t. \quad (11)$$

In (11) the term $(1+r)W_1$ represents the first period value of the foreign exchange gift, while the right-hand side of the expression is the present value of current and future transfers from the government to the individuals.

Two types of policies that have been proposed in the literature will be discussed and compared below. The first is an income transfer policy similar to the spending rule of the Norwegian Petroleum Fund, as in, e.g., van der Ploeg and Venables (2009).¹¹ Such a spending rule implies that the government transfers the permanent income from foreign exchange wealth, R_{It} , to the public in each period, where

$$R_{It} = rW_1, \forall t. \quad (12)$$

Assuming the transfers are split equally between the two generations, each generation will receive a transfer of $\frac{rW_1}{2}$ in every period.¹²

The second policy alternative that will be discussed is a wealth transfer policy, that is to let individuals—the public—manage the windfall, in line with the proposal of, e.g., Sala-i-Martin and Subramanian (2003). A wealth transfer policy, thus, implies that the entire resource wealth is transferred to the generations alive in the first period, and the individuals decide for themselves how much to spend and how much to save. The amount of the transfers in any period, R_W , is consequently

$$\begin{aligned} R_{W1} &= (1+r)W_1 \\ R_{Wt} &= 0, t \in [2, \rightarrow), \end{aligned} \quad (13)$$

of which each generation alive in period 1 is assumed to receive a transfer of $\frac{(1+r)W_1}{2}$. The

¹¹The Norwegian spending rule says that 4 % of accumulated financial assets may be spent every year. See Hanneson (2001, ch. 7) and Røed Larsen (2003) for more on the spending rule.

¹²The exact allocation of resources between the two generations alive in each time period t is not important for the mechanisms considered, as long as each generation receives a positive fraction of the transfer which is constant over time. The equal split is chosen both because of its appeal due to fairness considerations, and to make the model as simple as possible.

transfers in all future periods equal zero.

3 Mechanisms and static derivations

3.1 Labor market resource allocation—static equilibrium

The total demand for nontradable goods in period t , C_{Nt} , is the sum of demand from the younger (equation (8)) and the older (equation (10)) generations,

$$\begin{aligned} C_{Nt} &= C_{Nt}^y + C_{Nt}^o \\ &= \frac{1-\gamma}{1+\beta} [H_t + (1+r)\beta H_{t-1}] \\ &\quad + \frac{1-\gamma}{1+\beta} \left[\frac{1}{1+r} \frac{R_{t+1}}{2} + (1+\beta) \frac{R_t}{2} + (1+r)\beta \frac{R_{t-1}}{2} \right]. \end{aligned} \quad (14)$$

In equation (14) production income, X , in period t and $t-1$ is substituted by the level of productivity, H , in the same two periods using equation (4).

Demand is clearly boosted by the government transfers, R . Equation (14) states that demand for nontradable goods in time t depends on discounted total lifetime income of the young and savings of the old, which in turn depends on discounted total lifetime income of the old in time $t-1$. Thus, the government transfers affect consumption demand both contemporaneously, and with a one period lag and a one period lead. In addition, consumption demand will depend on the endogenous dynamics of the productivity H_t .

From equations (3) and (14), static equilibrium in the market for nontradable goods implies that

$$\begin{aligned} \eta_t &= \frac{1}{1+\beta} \left[\beta + \gamma - \beta(1-\gamma)(1+r) \frac{H_{t-1}}{H_t} \right] \\ &\quad - \frac{1-\gamma}{1+\beta} \left[\frac{1}{(1+r)} \frac{R_{t+1}}{2} + (1+\beta) \frac{R_t}{2} + (1+r)\beta \frac{R_{t-1}}{2} \right] \frac{1}{H_t}. \end{aligned} \quad (15)$$

Equation (15) states that the traded sector employment—and thus growth—is a function of both productivity and production income for both living generations and of the transfer policy.

There are several things to note from this equilibrium condition. First, in the absence of government transfers the last term in equation (15) disappears. Traded sector employment and growth is then only determined by the endogenous dynamics, represented by the term $\frac{H_{t-1}}{H_t}$. When the older generation in period t is relatively poor (i.e., relatively low $\frac{H_{t-1}}{H_t}$), consumption demand is relatively low in proportion to domestic supply, H_t ($\equiv X_t$). Relatively low aggregate domestic demand implies less crowding out of traded sector production and hence more learning by doing and higher growth. In contrast, if the older generation is relatively wealthy, there will be a stronger crowding out of traded sector production and lower growth.¹³ The ratio $\frac{H_{t-1}}{H_t}$

¹³Note that the Engel elasticities of demand for each generation equals one. Higher income means higher

generally determined by some initial values of productivity, the parameters of the model, and historical government transfer policy. The dynamics are analyzed in more depth later.

Second, note the standard static Dutch disease result; positive government transfers (expansionary fiscal policy), $R_t > 0$, has a negative impact on traded sector employment. This is a standard crowding out effect; expansionary fiscal policy increases private disposable income, which in turn drives up demand for all (normal) goods, leading to a crowding out of traded sector production. As with aggregate demand it is not just the transfers today that directly influence the labor allocation. Forward-looking individuals who were young yesterday ($t - 1$) and received a government transfer when young will save a fixed proportion of this wealth for consumption when old (t). In addition, those who are young today will, being aware that they are going to receive a transfer tomorrow ($t + 1$), choose to consume some proportion of this income today. Consequently, government transfers affect employment contemporaneously, as well as with a one period lead and a one period lag.

Since $\eta_t \in (0, 1)$, equation (15) implies the following restrictions on the relationship between transfers and GDP and growth,¹⁴

$$\frac{1}{2} \left[\frac{1}{1+r} R_{t+1} + (1+\beta) R_t + (1+r) \beta R_{t-1} \right] < H_t \left[\frac{\beta + \gamma}{1 - \gamma} - \beta(1+r) \frac{H_{t-1}}{H_t} \right]. \quad (16)$$

Equation (16) states that for any level of growth the economy can absorb larger transfers when GDP, H_t , is larger. In addition the restriction implies that for any given GDP level, higher growth allows for larger transfers. Finally, the timing of the transfers matter—not just directly, as can be easily seen from equation (16), but also indirectly through the endogenous growth dynamics.

consumption demand for both goods. The fact that higher demand for nontradable goods is crowding out tradable domestic production implies that the elasticity of imports with respect to aggregate income is greater than one. Since the individuals who are young contribute their own supply as their labor income stems from their own contributions to production (in line with Say's law), it is the proportion of the income of the old relative to that of the young that matters for the allocation of employment between the two sectors.

¹⁴The restrictions implicitly impose constraints on the parameter values, given that $R_t > 0$. These matters are more formally addressed in the *Appendix*. Note that an alternative approach than imposing restrictions on the parameter values, or alternatively on R_t , would be to allow for a corner solution for the traded sector employment (ensuring that extreme boosts to aggregate demand do not result in negative levels of traded sector production).

3.2 Productivity dynamics and dynamic equilibrium

Equations (1) and (15), given the restrictions defined in equation (16), define the productivity growth path,¹⁵

$$\begin{aligned} & H_t - \left[\frac{1 + \beta + \alpha(\beta + \gamma)}{1 + \beta} \right] H_{t-1} + \left[\frac{\alpha\beta(1 - \gamma)(1 + r)}{1 + \beta} \right] H_{t-2} \\ &= -\alpha(1 - \gamma) \left[\frac{R_t}{2(1 + r)(1 + \beta)} + \frac{R_{t-1}}{2} + \frac{(1 + r)\beta R_{t-2}}{2(1 + \beta)} \right]. \end{aligned} \quad (17)$$

From equation (17) it is clear that the model possesses dynamic endogenous growth properties, also in the absence of foreign exchange transfers. In a growing economy the development of productivity, GDP and income will be converging towards a steady state growth rate defined by¹⁶

$$\begin{aligned} \eta_* &= \frac{-[1 + \beta - \alpha(\beta + \gamma)]}{2\alpha(1 + \beta)} \\ &+ \frac{\sqrt{[1 + \beta - \alpha(\beta + \gamma)]^2 + 4\alpha(1 + \beta)[\gamma + \beta - \beta(1 - \gamma)(1 + r)]}}{2\alpha(1 + \beta)}. \end{aligned} \quad (18)$$

As equation (18) shows, government transfers do not affect the steady state growth rate. The reason is that in a growing economy the ratio of the transfers to GDP approaches zero as time approaches infinity. Steady state growth and labor allocation are therefore only determined by the deep parameters of the economy; the individual time preference factor, β , the strength of the learning-by-doing mechanism, α , the preferences for tradables (vs. nontradables), γ , and the world rate of interest, r .

4 Transfer policies: growth and welfare

4.1 Benchmark: No (net) government transfers

As a benchmark, consider first the growth path and welfare distribution of an economy in which there are no (net) government transfers, $R_t = 0$, *all t*. Assuming that the economy is in its steady state, productivity, production and welfare for each generation grow at a the same constant rate, $\alpha\eta^*$, where η^* is defined by equation (18). The reason why this special case may serve as a useful

¹⁵In the analyses that follow it is assumed that the Period 1 government transfers are unexpected (a windfall is, per se, unexpected). This implies that Period 1 productivity is predetermined, and is defined by $H_1 = \left[\frac{1 + \beta + \alpha(\beta + \gamma)}{1 + \beta} \right] H_0 - \left[\frac{\alpha\beta(1 - \gamma)(1 + r)}{1 + \beta} \right] H_{-1}$. Moreover, since the Period 1 transfer is unexpected for the generation that is old in Period 1, forcing them to consume the entire transfer in this period, the solution for the Period 2 productivity deviates from the general dynamic solution. The Period 2 productivity is $H_2 = \left[\frac{1 + \beta + \alpha(\beta + \gamma)}{1 + \beta} \right] H_1 - \left[\frac{\alpha\beta(1 - \gamma)(1 + r)}{1 + \beta} \right] H_0 - \alpha \frac{1 - \gamma}{1 + \beta} \left[\frac{R_2}{2(1 + r)} + \frac{(2 + \beta - \gamma)R_1}{2} \right]$.

¹⁶Note that growth is, by equation (1), proportional to the employment share of the traded sector. See the *Appendix A1–A4* for the derivation of η_* and for the general and specific solution to equation (17).

benchmark is that this is the overall productivity maximizing solution. Note, however, that with positive net government transfers, productivity maximization is not equivalent either to income or to welfare maximization.

4.2 An income transfer policy

Implementing an income transfer policy, as defined in eq. (12), will have effects on both growth and welfare distribution across generations, compared to the benchmark. The model identifies two separate effects; one direct income effect and one indirect, dynamic growth effect. First, an income transfer policy secures every generation the same positive level-shift in life-time income equal to $\frac{rW_1(2+r)}{2(1+r)}$.¹⁷ Second, there is a dynamic effect through the mechanism of LBD and endogenous productivity growth. This second indirect effect is unambiguously negative with respect to income for all future generations (see the right-hand side in eq. (17)).¹⁸

Inference regarding the net welfare effects of an income transfer policy requires aggregation of the direct and indirect income effects. A comparison with the benchmark policy of no government transfers provides three important corollaries.

First, both generations alive in the period of implementation ($t = 1$) experience an unambiguous welfare gain compared with the benchmark of no transfers. Moreover, the generation young in Period 1 is the overall “winner” as it receives government transfers throughout its lifetime. The lifetime net gain of an income transfer policy for the generation young in Period 1 is equal to the discounted value of the income transfer, $\frac{rW_1(2+r)}{2(1+r)}$.

Second, in the long run, $t \rightarrow \infty$, the indirect growth effect will eventually outweigh the level effect of the government transfers. Although the growth *rate* eventually will converge to its steady state rate, the productivity *level* will diverge from the benchmark level because of the negative growth shifts during the relatively long period of transition.¹⁹ Thus, after some point in time—dependent on the characteristics of the economy—individuals are worse off with the income transfers than they would have been with the benchmark of no transfers.

Third, from the first and the second corollaries it is clear that there exists a turning point in time, within the interval $t \in (1, \infty)$, where the net welfare effect of an income transfer policy relative to the benchmark goes from positive to negative. Around this turning point, the gross lifetime gain of government transfers, $\frac{rW_1(2+r)}{2(1+r)}$, is neutralized by the gross loss in production due to the negative dynamic effects of the government transfers. Thus, compared to the benchmark case, an income transfer policy is welfare improving for earlier generations and welfare deteriorating for future generations. The speed of transition depends on the parameter values and

¹⁷The only exception is the old generation in period 1, which only receives the transfer in this period.

¹⁸A priori, the generation young in Period 1 may suffer from the adverse growth effects by a wealth transfer policy. However, processes of learning by doing are often quite slow, and the full implementation of new technology (skills, techniques, etc.) is likely to happen with a lag. In the model, a demand shock in one period does not affect productivity until the next period.

¹⁹Given equation (16), the growth rate will be converging towards the steady state growth rate (not overshooting it) after an initial shock. Thus, after a negative shock, the growth rate will gradually adjust *from below* towards the steady state equilibrium. The adjustment will be faster in the first periods than in the subsequent periods.

on the size of the foreign exchange wealth. It is straightforward to show that there are feasible parameter combinations that reduce welfare as early as for the generation young in Period 2.²⁰

4.3 A wealth transfer policy

A wealth transfer policy involves transferring the entire foreign exchange wealth, including interests, $R_1 = (1+r)W_1$, to the two generations alive in the first policy period, $t = 1$. After Period 1, there will be no more government transfers, hence $R_t = 0, \forall t \in [2, \infty)$. The same two distinct effects as before may be identified; the positive direct income effect and the negative growth effect.

The first corollary of a wealth transfer policy is that the two generations alive in period 1, $t = 1$, both evidently experience a net welfare gain, as they both receive a transfer of $\frac{(1+r)W_1}{2}$ in period 1 without having any of their predetermined income reduced. The welfare gain is potentially largest for the younger generation, since they are free to choose their own consumption path. The older generation will consume the entire transfer in Period 1. Finally, note that both generations alive in Period 1 are unambiguously better off with a wealth transfer policy than with any of the other two alternatives. For the older generation it is straightforward to confirm that $\frac{R_W}{2} > \frac{R_I}{2} > 0$. For the young generation the difference in transfers between privatization and a permanent income rule equals $\frac{W_1}{2(1+r)} > 0$.

The second corollary is that subsequent generations—that is all generations born in $t \in [2, \infty)$ —experience an unambiguous negative welfare effect of the wealth transfer policy relative to the benchmark case. These generations only inherit the negative indirect dynamic productivity effects, and receive no government transfers to compensate for income loss due to lower productivity. Although the growth rate will gradually converge towards the steady state level, the transition period of lower growth will permanently shift the growth path downwards.

4.4 Income transfers versus a wealth transfer

In terms of welfare for future generations (i.e. for those born after the medium term which, as demonstrated above, can end as early as the beginning of period 3), both the income transfer policy and the wealth transfer policy are worse than the benchmark case with no transfers. However, given that the national wealth will be consumed sooner or later, a more interesting question is: what are the comparative welfare effects of transferring the entire wealth to the present generations, compared with transferring the permanent income to all generations forever? As noted above, a wealth transfer policy unambiguously implies the highest welfare for the generations alive in Period 1, compared to an income transfer policy. However, because

²⁰Comparing the welfare of the generation young in Period 2 in the benchmark case with the income transfer policy case shows that for certain parameter combinations, $r > \frac{2(1+\beta)-\alpha(1-\gamma)(3+\beta-\gamma)}{1+\beta-\alpha(1-\gamma)(2+\beta-\gamma)}$ if $[1+\beta-\alpha(1-\gamma)(2+\beta-\gamma)] > 0$ and $r < \frac{2(1+\beta)-\alpha(1-\gamma)(3+\beta-\gamma)}{1+\beta-\alpha(1-\gamma)(2+\beta-\gamma)}$ if $[1+\beta-\alpha(1-\gamma)(2+\beta-\gamma)] < 0$, the income transfer policy case is associated with lower welfare than the benchmark case as early as for the generation young in Period 2.

H_2 (*wealth transfer policy*) $<$ H_2 (*income transfer policy*), the wealth transfer policy is more damaging for the first growth period.²¹ Hence, the generation born in period 2—the period subsequent to the windfall period—is unambiguously worse off with the wealth transfer policy.

Going beyond period 2, which policy is more favorable for the welfare of future generations generally depends on the specific characteristics (i.e., parameter values) of the economy. Employing the arbitrarily chosen but empirically plausible parameter values $\alpha = 1$, $\gamma = 0.4$ and $\beta = 0.3$, and assuming an initial foreign exchange wealth of 5% of GDP, Chart 1 shows that income, net of government transfers, is higher with a wealth transfer policy than with an income transfer policy as early as for the generation young in Period 3. In this simulation the annual world interest rate is set at 0.05, assuming a period length of 25 years. The long-run, steady state traded sector share of GDP implied by this specific parameter constellation is 12.5%, which appears a reasonable number for the average natural resource producing country.²² For later generations, $t \in [4, \rightarrow)$, the difference in production income between a wealth transfer- and an income transfer policy is increasingly diverging. The net *welfare* effects lag behind the productivity effect as these also depend on the income effects of the wealth, and the turning point in comparative welfare is somewhere between the generations that are young in the periods 4 and 5 (see Chart 2). Thus, given the economic characteristics defined by the parameter values above, the generations that are young in periods 2, 3 and 4 are the only generations that are worse off with respect to total income in a wealth transfer policy regime compared with an income transfer policy regime.

4.5 Parameter sensitivity and the world real interest rate

As noted above, the relative performance of the two policy alternatives with respect to the welfare of future generations generally depends on the economy specific characteristics.²³ A key parameter of the model is the world real interest rate, as this, for any given level of learning by doing and any given preference structure, determines the real return to saving relative. Hence, the world real interest rate determines the households' intertemporal consumption paths as well as the rate of return on private and public savings. Perhaps counterintuitively, then, a higher world interest rate would not weaken, but strengthen our main result that a wealth transfer policy is better for the welfare of future generations (in the baseline simulation, all generations born at the beginning of Period 4 and later) than an income transfer policy. The intuition for this result is that even if a positive shift in the world interest rate clearly has a positive level effect for the income transfers—by raising the real value for future generations of the transfers they will receive—the negative, long run growth effects from a larger crowding out of future traded sector

²¹The formal condition for this to hold is $r > -\frac{2+\beta-\gamma}{1+\beta-\gamma}$. As the right-hand side of the inequality is negative, this condition will always be fulfilled.

²²Data from the World Bank WDI database (<http://publications.worldbank.org/WDI/>) indicate that the share of manufacturing in Norway, the U.K, Brazil and Nigeria is 10% (2007), 14% (2004), 18% (2007), and 3% (2006), respectively.

²³See the *Appendix*, Section A5, for a detailed discussion of how the properties of the model depend on the parameter values.

production dominates the positive level effect. Performing a sensitivity analysis with regard to the real rate of interest (holding the other parameter values constant) shows that this result is indeed robust; only lower annual real interest rates than approximately 0.01 makes an income transfer policy preferable for future generations. In this case, the two generations alive in Period 1 are the only ones to benefit from a wealth transfer policy.

5 Concluding remarks

This paper extends the literature on the Dutch disease in two ways. First, the full dynamics (transitional and steady state) of Dutch disease with learning by doing externalities in a simple overlapping generations framework is characterized. Second, the explicit growth and welfare effects of two relevant policy options are analyzed and compared. The first is a wealth transfer policy, where the government transfers the entire sum of a natural resource wealth to the generations alive at the time of the windfall. The second is an income transfer policy, where the government transfers the permanent-income of the wealth to the generations alive in each period forever.

The results from the analysis suggest that the concern for the welfare of future generations cannot consistently be used as an argument for saving rather than spending a resource wealth. Depending on the characteristics of the economy, and given a sufficiently high world real interest rate, transferring the entire resource wealth to current generations may increase the welfare of future generations, compared with the income transfer policy.

Three caveats associated with the current analysis should, however, be noted. First, the results critically rests on the (standard) assumption that the traded sector is a more important driver of growth than the nontraded sector. Reversing this assumption would also reverse the comparative results. Second, the analysis does not consider optimality.²⁴ Third, the analysis ignores the potential political-economic effects of natural resource wealth and natural resource management. Needless to say, there may certainly be weighty political economic arguments against pursuing a wealth transfer policy, in particular in countries which are characterized by weak or malfunctioning political- and democratic institutions. However, there is indeed also great uncertainty attached to what may be the long-term political-economic consequences of the build up of huge public savings funds. The analysis of the political economy of intergenerational conflict in the presence of vast natural resources is therefore an important topic for future research.

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²⁴Matsen and Torvik (2005) analyze optimality of the transfer path in a model without overlapping generations (which may be considered a special case of the current model when $\beta = 0$), and demonstrate that some Dutch disease is always optimal. This study does not, however, analyze the intergenerational distribution of welfare.

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Appendix

A1 The general solution of eq. (17)

Eq. (17),

$$H_{t+2} - \left(\frac{1 + \beta + \alpha(\beta + \gamma)}{1 + \beta} \right) H_{t+1} + \left[\frac{\alpha\beta(1 - \gamma)(1 + r)}{1 + \beta} \right] H_t = 0, \quad (19)$$

is a linear second order inhomogeneous difference equation in the constant coefficients a and b , where $a = \frac{1 + \beta + \alpha(\beta + \gamma)}{1 + \beta}$ and $b = \frac{\alpha\beta(1 - \gamma)(1 + r)}{1 + \beta}$, $b \neq 0$, and with the particular solution of eq. (17), u_t^* . Substituting $H_t = m^t$ in eq. (19) gives $m^t(m^2 + am + b) = 0$. For m to fit into eq. (19), m must satisfy the characteristic equation

$$m^2 + am + b = 0. \quad (20)$$

The roots of eq. (20) are

$$m_1 = \frac{1 + \beta + \alpha(\beta + \gamma)}{1 + \beta} + \sqrt{\frac{1}{4} \left[\frac{1 + \beta + \alpha(\beta + \gamma)}{1 + \beta} \right]^2 - \frac{\alpha\beta(1 - \gamma)(1 + r)}{1 + \beta}}, \quad (21)$$

$$m_2 = \frac{1 + \beta + \alpha(\beta + \gamma)}{1 + \beta} - \sqrt{\frac{1}{4} \left[\frac{1 + \beta + \alpha(\beta + \gamma)}{1 + \beta} \right]^2 - \frac{\alpha\beta(1 - \gamma)(1 + r)}{1 + \beta}}. \quad (22)$$

Consequently, the general solutions of eq. (19), where C_1 and C_2 are arbitrary constants, are:

6.0.1 If eq. (20) has a pair of real roots:

$$H_t = C_1 m_1^t + C_2 m_2^t \quad (23)$$

6.0.2 If eq. (20) has a double real root:

$$H_t = (C_1 + C_2 t) m^t \quad (24)$$

The case of complex roots does not make economic sense and is therefore ignored throughout the analysis.

A2 Stability analysis 1

This section analyzes the stability of the general solutions above. In the present context, “instability” is a situation where the levels of interest (production, productivity, wealth, and consequently welfare) are ever-increasing, rather than converging towards some steady state levels. Eq. (19) is globally and asymptotically stable if, and only if, $|a| < 1 + b$ and $b < 1$. These conditions are equivalent with the moduli of each root in the characteristic equation being less than one. The

first stability condition,

$$\gamma < \frac{\beta r}{1 + (1+r)\beta}, \quad (25)$$

requires a relatively high traded sector weight in the demand for the difference equation to be unstable. The second stability condition,

$$\gamma > \frac{\alpha\beta(1+r) - (1+\beta)}{\alpha\beta(1+r)}, \quad (26)$$

shows that the solution is unstable for a sufficiently low interest rate for any given values of the discount factor of future consumption and weight on traded sector consumption. Hence, a sufficiently low r implies that the development of the levels of interest is diverging. Both of the conditions in ineq. (25) and in ineq. (26) are enveloped by the constraint given by ineq. (16).

A3 Stability analysis 2

As shown in A2, certain combinations of parameter values imply that the growth path is diverging. However, the diverging evolution of the productivity level will eventually approach a steady state growth rate which is sensitive to the parameter values. The steady state fraction of the labor force employed in the traded sector is easily derived from (1) and (15),

$$\begin{aligned} \eta_{t+1} = & \frac{1}{1+\beta} \left\{ \beta + \gamma - (1-\gamma) \left[\frac{1}{(1+r)} \frac{R_{t+1}}{2} + (1+\beta) \frac{R_t}{2} + (1+r)\beta \frac{R_{t-1}}{2} \right] \frac{1}{H_t} \right\} \\ & - \frac{\beta}{1+\beta} (1-\gamma)(1+r) \frac{1}{1+\alpha\eta_t} \end{aligned} \quad (27)$$

In a growing economy the foreign exchange gift term will approach zero as time approaches infinity, as $\lim_{t \rightarrow \infty} \frac{1}{H_t} = 0$. Inserting for η_* , the steady state traded sector employment, and rearranging gives eq. (18)

$$\begin{aligned} \eta_* = & \frac{-[1 + \beta - \alpha(\beta + \gamma)]}{2\alpha(1 + \beta)} \\ & + \frac{\sqrt{[1 + \beta - \alpha(\beta + \gamma)]^2 + 4\alpha(1 + \beta)[\gamma + \beta - \beta(1 - \gamma)(1 + r)]}}{2\alpha(1 + \beta)}. \end{aligned}$$

Only positive values of employment make economic sense, therefore the negative solution of eq. (18) is disregarded. The constraint of ineq. (16) ensures a positive steady state growth rate. The stability of eq. (27) requires that $0 < f'(\eta_t) < 1$, where $f(\eta_t) = \eta_{t+1}$. This condition is enveloped by ineq. (16). A more intuitive analysis of stability is to employ (27) and analyze

local stability around steady state through the stability condition

$$\begin{aligned} 0 < f'(\eta_t) &= \frac{\alpha\beta(1-\gamma)(1+r)}{(1+\beta)(1+\alpha\eta_*)^2} = \frac{\frac{\beta}{(1+\beta)}(1-\gamma)(1+r)H_t}{(1+\alpha\eta_*)H_t} \frac{\alpha}{(1+\alpha\eta_*)} \\ &= \frac{C_{Nt+1}^\alpha}{X_{t+1}} \frac{\alpha}{(1+\alpha\eta_*)} < 1. \end{aligned}$$

By definition the expression is strictly positive, except from the special case where $\alpha = 0$, which implies no growth and hence no dynamics. By assumption $\frac{C_{Nt+1}^\alpha}{X_{t+1}} \leq 1$. One sufficient condition for convergence of the steady state growth rate is thus $\frac{\alpha}{(1+\alpha\eta_*)} < 1$, or equivalently $\alpha < \frac{1}{1-\eta_*}$, subject to the constraints given by ineq. (25) and ineq. (26). As for the benchmark case it may be shown that the steady state equilibrium is stable for any value of $\alpha \in [0, \rightarrow)$.²⁵ However, subject to ineq. (16) the conditions above will always be fulfilled.

A4 The specific solution of (17)

The specific solution of eq. (19) (in the case of real roots) can be derived from eq. (23). Inserting for the initial conditions H_0 and H_1 gives two independent equations in C_1 and C_2 . Solving for C_1 and C_2 gives

$$C_1 = -\frac{H_0m_2 - H_1}{m_1 - m_2}, \quad (28)$$

$$C_2 = \frac{H_0m_1 - H_1}{m_1 - m_2}. \quad (29)$$

Inserting from equations (28) and (29) into eq. (23) provides the specific solution of the difference equation in productivity (19) in the case of real roots,

$$H_t = \frac{(H_1 - H_0m_2)m_1^t + (H_0m_1 - H_1)m_2^t}{m_1 - m_2}. \quad (30)$$

In eq. (30) the productivity level is a function of time only, given the parameter values and the initial conditions.

Inserting the benchmark parameter values in eq. (30) gives

$$H_t = 1.40 \left[(H_1 - 0.41H_0)(1.13)^t + (1.13H_0 - H_1)(0.41)^t \right]. \quad (31)$$

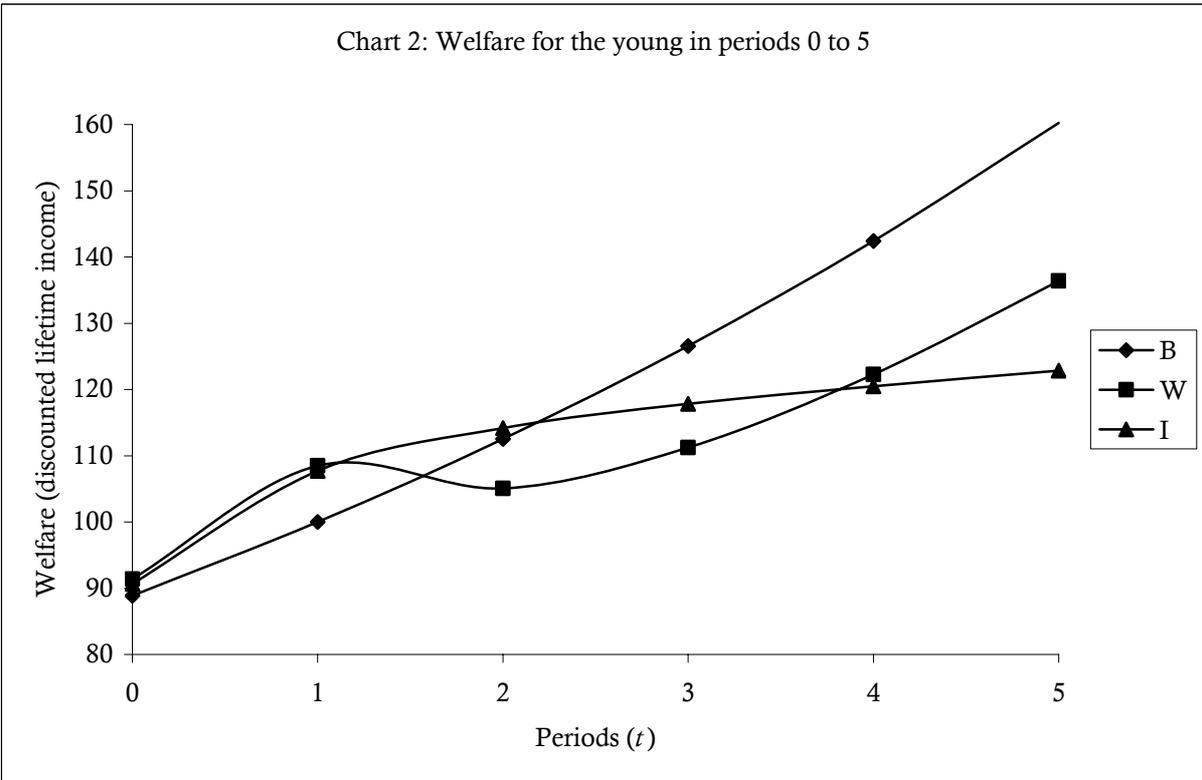
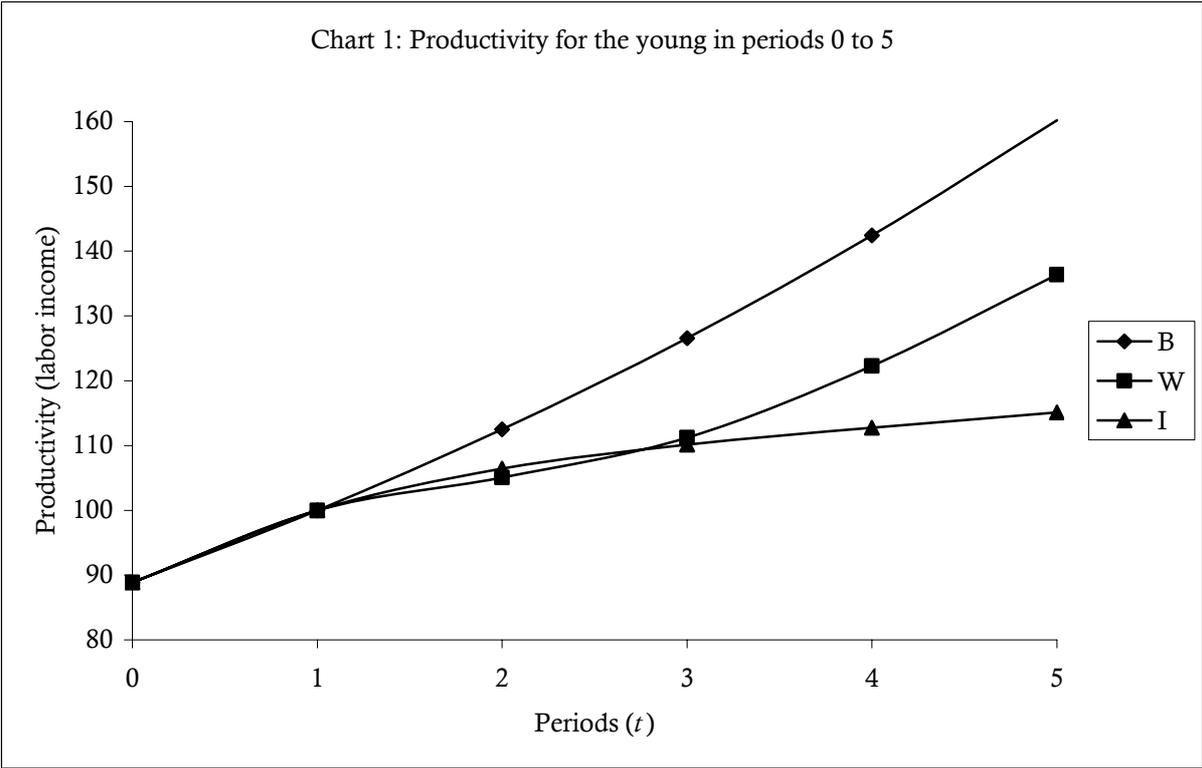
This specific solution for the productivity level is diverging, but the growth rate is converging towards approximately 0.13 in the benchmark case. Moreover, note that the specific solution is a function of time only, subject to some initial ‘‘point of departure’’, H_0 and H_1 .

²⁵See the Appendix, Numerical analysis of the radicand.

A5 Numerical analysis of the radicand

Whether the roots of the characteristic equation of equations (19), (21) and (22), are real, double real or complex depends on whether the radicand, $Ra(\alpha, \beta, \gamma, r) = \frac{1}{4} \left[\frac{1+\beta+\alpha(\beta+\gamma)}{1+\beta} \right]^2 - \frac{\alpha\beta(1-\gamma)(1+r)}{1+\beta}$, is positive, equals zero or is negative. Employing the benchmark values $\alpha = 1$, $r = 2.39$, $\beta = 0.30$ and $\gamma = 0.4$ provides a point of departure for the numerical parameter analysis.²⁶ This vector of parameter values implies a positive radicand and hence real roots in the characteristic equation. Marginal increases in r and β decrease the value of the radicand, while an increase in γ has the opposite effect. Under the benchmark conditions, $\gamma \approx 0.30$ is a point of inflection; a lower weight on traded goods consumption than this threshold leads to complex roots. Similarly, $\beta \approx 0.44$ and $r \approx 3.32$ are points of inflection. As for the effect of the strength of the learning-by-doing mechanism, α , this will in general enhance the effects of the other parameters, i.e., *weaker learning by doing* effects *lowers* the point of inflection for γ , while it *raises* the inflection points for both β and r . Stronger learning-by-doing effects will conversely have the opposite effects on the inflection points of the parameters.

²⁶The values of r and β represents annual real interest and discount rates of approximately five percent each.



Note: The simulations are based on the parameter- and initial state values: $\alpha=1$, $\gamma=0.4$, $\beta=0.3$, $r=2.4$, $H_1=100$ and $W_1=5$. The parameters β and r reflect annual real interest- and discount rates of 5 percent over a period of 25 years. In all simulations the economy starts out in a steady state equilibrium. B, W and I refer to the benchmark case (B), the wealth transfer policy (W) and the income transfer policy (I), respectively.