THE DISTRIBUTIONAL IMPACT OF A RESOURCE BOOM

James H. Cassing

University of Pittsburgh, Pittsburgh, PA 15260, USA

Peter G. Warr*

Australian National University, Canberra, A.C.T. 2600, Australia

Received September 1982, revised version received July 1984

Sizeable export growth led by a booming natural resource extraction sector has recently been experienced in a number of countries. This form of growth holds potentially important implications for the distribution of income, and in this paper a simple general equilibrium trade model is presented which is aimed at exposing the effects of a 'resource boom' on factor owners' real incomes. The analysis highlights the critical role played by the real exchange rate and also explores the consequences of a resource boom in the presence of real international capital flows and 'endogenous protection' wherein one group of factor owners uses commercial policy to maintain the group members' real incomes.

1. Introduction

Several countries have recently experienced substantial export growth led by a booming natural resource extraction sector. For example, in Great Britain, Mexico, Norway and Holland there have been dramatic increases in the proven reserves of oil and natural gas, while in Australia and Canada the resource boom has been based more broadly on a wide range of mineral exports. In all of these countries, however, the structural adjustment required in order to exploit the new-found wealth is creating economic tension. As a result of the discovery of a new or larger export sector, other domestic industries have lost international competitiveness. In some sectors profits are squeezed and investment is falling.

Earlier studies of this so-called 'Dutch disease' have focused attention on

*This paper was written while Cassing was at Australian National University and has benefited from the helpful comments of two anonymous referees, P.J. Lloyd, Ben Smith, and, in particular, W.M. Corden. A longer version of this paper, which contains more detailed mathematical derivations, is available in Cassing and Warr (1982).
the economy-wide output effects of a resource boom.\footnote{See, for example, McKinnon (1976), Snape (1977), Corden (1981), and, for an Australian empirical study, Gregory (1976). Corden and Neary (1982) focus on de-industrialization and in addition provide some discussion of income distributional issues, representing the 'resource boom' as Hicks-neutral technical change within the export sector.} In particular, the main issue has been one of 'de-industrialization' as the non-booming sectors — especially, importables — are forced to contract. Despite the inherent interest of this issue, however, it is not industry sizes but rather changes in the real incomes of factor owners that determine the distribution of gains and losses from a resource boom. And there is an alternative to the passive acceptance of restructured factor rewards and the adjustment which is thus encouraged. Adversely affected groups might appeal to the political process for policies aimed at ameliorating their losses. The dynamics of this political appeal are not well understood, but historically such appeals have both met with success and given rise to relatively inefficient income protection measures such as trade barriers. A full analysis of the income distributional impact of natural resource development should thus include an account both of the initial impact on factor rewards of a 'minerals boom' and of the secondary impact of any successful ploys aimed at offsetting the initial changes.

In this paper we offer an investigation of the sorts of issues involved. Our focus is on the effects of sector specific resource-based growth on the functional distribution of income. In section 2 we present a simple general equilibrium model robust enough to expose the sources of income redistribution implicit in new natural resource development. Section 3 focuses on the role played by the non-traded goods sector and the pivotal importance of the price of non-traded goods in determining the distribution effects of a resource boom. In section 4 we consider the additional complication of real international capital flows. Finally, in section 5 we investigate the repercussions of attempts to protect certain factor owners' real incomes through commercial policy.

2. A simple model of income distribution

Initially we will assume the absence of a non-traded goods sector or a quota protected sector and suppose that there are three internationally traded goods — $G_1$ (good 1), $G_2$, and $G_3$. Let $G_1$ be the export good and $G_2$ and $G_3$ be importables. This highlights the basic supply side structure of the model. In subsequent sections, we successively introduce non-traded goods, internationally mobile capital, and commercial policy considerations. Denote by $C_i$, $X_i$ and $P_i$ the consumption, production, and price of $G_i$. We will assume that there are three perfectly inelastically supplied, internationally immobile, productive inputs — capital ($K$), labor ($L$), and mineral-laden land ($T$) — with the factor rewards $r$, $w$, and $t$, respectively. We denote by $a_{ij}$ the
amount of factor $i$ in a unit of good $j$. As usual, we will assume that production functions are linear homogeneous and that competition prevails in all markets.

Less typically, we will assume that while all three industries utilize perfectly mobile capital and labor, only industry 1 employs mineral-laden land. Thus, there is an asymmetry in the employment of industry specific factors. This asymmetry assumption is new, realistic, and represents a plausible compromise between the more traditional Heckscher–Ohlin and Ricardo–Viner trade models. The power of the assumption resides in an enriched supply side for the three commodity variable proportions model. Relative factor intensities — especially capital–labor ratios — are still natural and critically important. Yet, there is no indeterminacy in production as with the two-factor–three-commodity model wherein the existence of flats in the production possibilities surface necessitates access to demand side information in order to solve for industry activity levels. Also, we can safely perform comparative statics experiments without some ancillary condition which prevents an importable industry from jumping to zero output.

Given world prices, equilibrium in this model is described by eqs. (1)–(8):

\begin{align*}
a_T T_1 t + a_L L_1 w + a_K K_1 r &= P_1, \quad (1) \\
a_L L_2 w + a_K K_2 r &= P_2, \quad (2) \\
a_L L_3 w + a_K K_3 r &= P_3, \quad (3) \\
X_1 &= X_1(T, L_1, K_1), \quad (4) \\
a_L L_2 X_2 + a_L L_3 X_3 &= L - L_1, \quad (5) \\
a_K K_2 X_2 + a_K K_3 X_3 &= K - K_1, \quad (6) \\
P_1 \frac{\partial X_1}{\partial L_1} &= w, \quad (7) \\
P_1 \frac{\partial X_1}{\partial K_1} &= r. \quad (8)
\end{align*}

\textsuperscript{2}Well-known presentations of these models include Jones (1956, 1965, 1971).

\textsuperscript{3}See, for example, Samuelson (1970) and Melvin (1968). The traditional specification of a 'smoothly bowed' transformation surface has intuitive appeal and is a consequence of the assumed equal number of factors and commodities. Recently, considerable research has focused upon a variety of underlying input–output structures and the implications of the alternative specifications. See, for example, Jones and Scheinkman (1976), Chang (1979), and Ethier (1983) for relevant discussions of dimensionality. Of particular interest for this paper is the recent series of models in Corden and Neary (1982).
Eqs. (1)–(3) are just the usual competitive conditions that revenues are exhausted by factor payments. In particular, notice that eqs. (2) and (3) determine the mobile factor rewards. Therefore, owners of mineral-laden land represent the residual claimants in sector 1. Although not the focus of this paper, in many countries the taxation of these rents has become an important policy issue. Eqs. (4)–(6) represent the full employment conditions. Finally, eqs. (7) and (8) state that factor rewards equal value marginal products in industry 1 and determine the allocation of the mobile factors to $G_1$ production. The solution to the system is straightforward. Eqs. (2) and (3) determine $w$ and $r$. Then, eqs. (7) and (8) fix the levels of $L_1$ and $K_1$. Given $T$, this fixes $X_1$ in eq. (4) and $X_2$ and $X_3$ in eqs. (5) and (6). Finally, $\tau$ is determined as the residual in (1). The system combines the Ricardo-Viner model with the Heckscher-Ohlin model in the following sense. Eqs. (2)–(3) and (5)–(6) taken together are just the familiar $2 \times 2$ variable proportions structure. But the supply of labor and capital available depends upon the output of $G_1$. This, in turn, is determined as in the Ricardo-Viner model in that labor and capital are drawn into the $G_1$ industry until, given the fixed supply of $T$, marginal value products are driven down to factor rewards determined in the $G_2$ and $G_3$ sectors. Notice that in the absence of quotas or non-traded goods, the $G_1$ industry confronts infinitely elastic supplies of the mobile factors.

2.1. The equations of change

In order to investigate the properties of this model — we still assume the absence of quotas or non-traded goods — we differentiate logarithmically to get the equations of change. We use $\cdot \cdot \cdot$ to denote proportional changes — for example, $\dot{X}_i \equiv \frac{dX_i}{X_i}$:

$$\dot{X}_1 = \frac{L}{L-L_1} \left( \dot{T} + \frac{L_1}{L-L_1} \left( T + A \dot{w} + B \dot{r} + C \dot{r} \right) \right),$$ (15)
\[ \dot{R}' = \frac{K}{K-K_1} \dot{R} - \frac{K_1}{K-K_1} (\dot{T} + D\dot{w} + E\dot{r} + F\dot{t}), \]  

(16)

where

\[ K' \equiv K - K_1, \quad \lambda_{ki} \equiv \frac{K_i}{K}, \quad \theta_{ki} \equiv \frac{rK_i}{P_i X_i}, \quad L' \equiv L - L_1, \]

\[ \lambda_{li} \equiv \frac{L_i}{L'}, \quad \theta_{li} \equiv \frac{wL_i}{P_i X_i}, \quad \theta_{ti} \equiv \frac{tT}{P_i X_i}, \quad \beta_L = \lambda_{l2} \theta_{k2} \sigma_2 + \lambda_{l3} \theta_{k3} \sigma_3, \]

\[ \beta_K = \lambda_{k2} \theta_{l2} \sigma_2 + \lambda_{k3} \theta_{l3} \sigma_3, \quad A \equiv (\theta_{l1} \sigma_{LL} - \theta_{l1} \sigma_{LT}), \]

\[ B \equiv (\theta_{k1} \sigma_{KL} - \theta_{k1} \sigma_{KT}), \quad C \equiv (\theta_{t1} \sigma_{TL} - \theta_{t1} \sigma_{TT}), \]

\[ D \equiv (\theta_{l1} \sigma_{LK} - \theta_{l1} \sigma_{LT}), \quad F \equiv (\theta_{t1} \sigma_{TK} - \theta_{t1} \sigma_{TT}). \]

The derivation of these equations is summarized in the appendix. As usual, each \( \theta_{ij} \) denotes the \( i \)th factor distributive share in the \( j \)th industry. The coefficients \( \lambda_{ij} \) and \( \lambda_{kj} \) refer to the proportion of labor and capital in the \( G_2 - G_3 \) sector employed in industry \( j \). Each \( \sigma_{ij} \) denotes the elasticity of substitution in industry \( j \) and each \( \sigma_{i,j} \) denotes the Hicks–Allen partial elasticity of substitution between factors \( i \) and \( j \) in industry 1.

The coefficients attached to factor reward changes seem complicated, but there are really no surprises. In the \( G_2 - G_3 \) sector, \( \beta_L \) and \( \beta_K \) are necessarily positive. In the \( G_1 \) industry, \( A \) through \( F \) are a priori indeterminate because with three inputs the partial elasticities of substitution have no definite sign. However, we know that \( \sigma_{rT} < 0 \) and that of \( \sigma_{LK}, \sigma_{KT}, \) and \( \sigma_{LT} \), at most one is negative. This is enough structure to yield most qualitative results of interest.

### 2.2. An export boom in the absence of non-traded goods

An expansion in the \( G_1 \) industry can be induced either by an increase in \( T \) (a 'mineral discovery') or by a relative increase in \( P_1 \) (a world price rise for minerals). In order to abstract from the exogenous terms of trade effects of a mineral price rise, we will focus on a mineral discovery.\(^4\) As a first approximation, we treat the natural resource as though it is not exhaustible. In subsequent sections, our discussion focuses upon changes in the functional

\(^4\)In the longer version of this paper [Cassing and Warr (1982)] we offer a sketch of the analysis when the export price rises exogenously.
distribution of income induced by the resource boom through changes in the
real exchange rate (i.e. relative price of non-traded goods). In order to
highlight the critical role of the non-traded goods price, we will briefly
consider a world wherein all goods are tradeable and so all output prices are
fixed exogenously.

In this version of the model, a mineral discovery is distributionally neutral
in the sense that factor prices remain unchanged — eqs. (9)–(11). This implies
that the benefits from the boom are received in full by the owners of the
newly-discovered mineral-laden land. The real incomes of the owners of labor,
capital, and existing mineral-laden land are unaffected by the boom. From
eq. (12), output of $G_1$ increases proportionately to the mineral base increase.
That is, $\hat{x}_1 = \hat{t}$. Since production functions are linear homogeneous, $\hat{K}_1 = \hat{L}_1 = \hat{t}$. That is, mobile factors are extracted from the rest of the economy in the
proportions $K_1/L_1$. The output effects are then straightforward applications
of Rybczynski (1955). Writing $k_i$ for $K_i/L_i$ and $k_i'$ for $K_i'/L_i'$, then if $k_1 = k'_1$, both $X_2$ and $X_3$ will contract in the same proportions. That is, $\hat{x}_2 = \hat{x}_3 = -\hat{t}$.

In this case, the mineral discovery would be activity neutral in the sense
that neither of the contracting sectors bears a disproportionate share of the
necessary contraction. In general, the more capital intensive (labor intensive)
of the two industries must contract more if $k_1 > k'_1$ ($k_1 < k'_1$). Of course, if $k_1$ is
not between $k_2$ and $k_3$, where $k_i$ denotes $K_i/L_i$, then one industry — the
other extreme factor intensity industry — will expand and one will contract.
Thus, if $G_1$ is most capital intensive — as conventional wisdom has it —
then the burden of adjustment will fall disproportionately on the relatively
less labor intensive industries in other sectors.

3. Non-traded goods

The existence of a non-traded goods sector introduces two important
complications into the model. First, since a resource boom generally
increases national income, the demand for non-traded goods will rise on this
account and so these industries may not share in the contraction necessary
somewhere in the economy in order to allow expansion in the minerals
sector. Of course, any expansion in the non-traded goods sector requires that
some other industries expand by less or contract by more than otherwise.
Second, since domestic demand must equal domestic supply in the non-
traded goods sector, output prices can no longer be taken as exogenously
given. But, of course, factor rewards are related to output prices and so
income distributional changes will be transmitted through changes in the
non-traded goods price.

In order to clarify the role of non-traded goods, we assume now that $G_3$ is
not traded internationally. This means that $P_3$ is endogenously determined and we close the system with the domestic market clearing equation:

$$X_3 = C_3(P_1, P_2, P_3, Y),$$

(17)

where domestic consumption depends upon prices and national income:

$$Y = wL + rK + tT = P_1X_1 + P_2X_2 + P_3X_3.$$ 

(18)

Differentiating logarithmically yields the additional equation of change:

$$\dot{C}_3 = \varepsilon_{31} \dot{P}_1 + \varepsilon_{32} \dot{P}_2 + \varepsilon_{33} \dot{P}_3 + \eta_3 \dot{Y},$$

(19)

where $\varepsilon_{3i}$ denotes the $i$th price elasticity of demand for $G_3$ and $\eta_3$ denotes the income elasticity of demand for $G_3$. We retain the small country assumption of fixed external prices for $G_1$ and $G_2$.

3.1. The non-traded goods price

In order to investigate the effect of a resource boom on the price of non-traded goods, we focus on the market equilibrium condition. The net change in the output and the consumption of non-traded goods is the sum of two effects. First, there is a change in production and consumption due to the exogenous increase in $T$. Second, there is an additional impact induced by the endogenous change in $P_3$ necessary to bring production and consumption of the non-traded good into equality. This adjustment may involve a rise or a fall in the price of the non-traded good, but the condition determining the direction of this price adjustment proves to be relatively simple and of fundamental importance. Since this condition [ultimately numbered (27)] is the key to the income distributional consequences of a resource boom, we present the derivation in detail. Essentially the analysis isolates the resource boom induced shifts in the general equilibrium demand and supply functions for non-traded goods.

The resource boom induced change in the consumption of good 3 is given by:

$$\dot{C}_3 = \zeta_{33} \dot{P}_3 + \eta_3 \dot{Y},$$

(20)

Corden and Neary (1982) present one model wherein each of three sectors uses an industry specific factor. Even in the absence of a non-traded goods sector a resource boom would induce income redistribution in such a model. Their subsequent analysis upon introduction of a non-traded good is slightly less complicated because the only mobile factor employed in $G_1$ production is labor.
where $\zeta_{33}$ denotes the income compensated price elasticity of demand for good 3. At constant prices the change in national income (valued at output prices) due to the resource boom would equal the value of the additional resource supply valued at factor prices. Thus, we have:

$$\dot{Y} = \theta_T \dot{T}, \quad (21)$$

where $\theta_T \equiv T/Y$ denotes the return to mineral-laden land as a proportion of national income. Substituting (21) into (20) yields the expression:

$$\dot{C}_3 = \zeta_{33} \dot{P}_3 + \eta_3 \theta_T \dot{T}. \quad (22)$$

Now, substituting into the non-traded goods market equilibrium condition $\dot{C}_3 = \dot{X}_3$, we have, together with the price eqs. (9)-(11), four equations with the endogenous variables $\dot{w}$, $\dot{r}$, $\dot{f}$, and $\dot{P}_3$ in terms of the exogenous variable $\dot{T}$. This system now reduces neatly in the following way. Solving for the factor price changes in terms of $\dot{P}_3$ from eqs. (9)-(11) and substituting into the solution for the output effect from eqs. (13)-(16) yields:

$$\dot{X}_3 = Q \dot{P}_3 + R \dot{T}, \quad (23)$$

where

$$Q \equiv \left[ F_w \theta_K^2 - F_r \theta_L^2 + F_r(\theta_K^1 \theta_L^2 - \theta_K^2 \theta_L^1)/\theta_T \right]/(\theta_K^2 - \theta_K^3),$$

with each $F_j$ term arising from the solution of eqs. (13)-(16). Using eqs. (22) and (23), the market clearing equation for the non-traded good can now be written as:

$$Q \dot{P}_3 + R \dot{T} = \zeta_{33} \dot{P}_3 + \eta_3 \theta_T \dot{T}, \quad (24)$$

where

$$R \equiv (L_1 K_2 - L_2 K_1)/(L_2 K_3 - L_3 K_1)$$

whence

$$\dot{P}_3 = \dot{T}(\eta_3 \theta_T - R)/(Q - \zeta_{33}). \quad (25)$$

Assuming stability of the system ensures that the denominator of (25) is positive, since it equals the elasticity of excess demand for non-traded goods with respect to $P_3$. It follows that the direction of adjustment of the non-traded good's price is determined by the numerator of eq. (25). That is,

$$\text{sign}(\dot{P}_3/\dot{T}) = \text{sign}(\eta_3 \theta_T - R). \quad (26)$$
J.H. Cassing and P.G. Wart, Impact of a resource boom

Substituting for $R$ as defined in (24), and assuming that $\hat{T} > 0$, yields the condition we seek:

$$\hat{P}_3 \equiv 0 \quad \text{as} \quad \frac{L_1 (k_2 - k_1)}{L_3 (k_3 - k_2)} \equiv \eta_3 \theta_T.$$  

(27)

Intuitively, the term $\eta_3 \theta_T$ gives the income-induced expansion in the consumption of $G_3$ at constant prices from a given proportionate growth in $T$. This effect, assumed positive, is stronger the larger is the income elasticity of demand for non-traded goods and the greater is mineral-laden land’s contribution to the national income. The term $R$ captures a Rybczynski effect and represents the adjustment of $G_3$ output at constant prices induced by the exogenous sector specific increase in the resource base. This effect depends upon the relative capital intensities in production and on the relative sizes of the $G_1$ and $G_3$ sectors, as indicated by their employment levels.

Now suppose that $R < 0$ so that $X_3$ declines at constant commodity prices on account of the expansion of the export sector. Then, since $G_3$ rises at constant prices, there is a positive excess demand in the non-traded goods sector and $P_3$ must increase in order to clear this market. If, instead, $R > 0$, then $X_3$ increases at constant prices. In this case, $P_3$ may rise or fall as the increase in $X_3$ falls short of or exceeds the increase in $C_3$.

As a special case, note that $\hat{P}_3 = 0$ when the production and consumption effects are equal. Since factor prices are related to output prices, and since the right-hand side of eq. (27) is positive, it follows that a necessary condition for constant factor prices (distributional neutrality of a resource boom) is that the importable goods sector holds an intermediate factor intensity (that is, $k_1 < k_2 < k_3$ or $k_3 < k_2 < k_1$). Intuitively, this is so because the ‘extreme’ factor intensity industries’ outputs must move in the same direction before any price changes. Since $G_1$ output expands, $\hat{X}_3 > 0$ without a price change is only possible if $G_3$ is not the intermediate intensity commodity. Generally, however, there is no guarantee that factor incomes will be insulated from the resource boom.

3.2. Factor rewards

In order to calculate possible changes in factor rewards, we first relate factor price changes to output price changes and then relate output price changes to relative capital intensities. Using eqs. (9)–(11) we can solve for the effects of output price changes on factor rewards:

$$f = \frac{1}{\theta T_1} \hat{P}_1 - \frac{\theta_{K1} \theta_{L3} - \theta_{K3} \theta_{L1}}{\theta_{T1} (\theta_{K2} - \theta_{K3})} \hat{P}_2 + \frac{\theta_{K1} \theta_{L2} - \theta_{K2} \theta_{L1}}{\theta_{T1} (\theta_{K2} - \theta_{K3})} \hat{P}_3,$$  

(28)
\[ \hat{r} = \frac{\theta_{L3}}{\theta_{K2} - \theta_{K3}} \hat{P}_2 - \frac{\theta_{L2}}{\theta_{K2} - \theta_{K3}} \hat{P}_3, \]  
(29)

\[ \hat{w} = -\frac{\theta_{K3}}{\theta_{K2} - \theta_{K3}} \hat{P}_2 + \frac{\theta_{K2}}{\theta_{K2} - \theta_{K3}} \hat{P}_3, \]  
(30)

where \( \theta_{ki} \geq \theta_{kj} \) as \( k_i \equiv k_j, i,j=2,3 (i \neq j) \).

In order to interpret these equations, ignore for the moment the endogeneity of \( \hat{P}_3 \). Then the intersectorally mobile factors' rewards respond to price changes exactly along Stolper–Samuelson (1941) lines. For example, if \( \hat{P}_2 > 0 \) and \( k_2 > k_3 \), then \( \hat{r} > \hat{P}_2 > 0 > \hat{w} \). A rise in \( P_1 \) has no effect on \( w \) and \( r \) nominally, although, of course, \( w/P_1 \) and \( r/P_1 \) obviously will fall. Any rise in \( P_1 \) accrues entirely to holders of the industry specific factor in the \( G_1 \) industry and induces a real income gain for owners of \( T \). That is, \( t/P_1 = 1/\theta_{T1} > 1 \). The effect of an increase in \( P_2 \) or \( P_3 \) on \( t \) depends upon relative capital intensities. For example, if \( P_3 \) rises and \( k_3 < k_2 \), \( w \) will rise and \( r \) will fall. If \( G_1 \) uses labor relatively intensively — \( k_2 > k_1 \) — then the residual claimant's reward, \( t \), must fall. However, if \( k_1 > k_2 \), then \( t \) will rise with the increase in \( P_3 \).

We are now in a position to relate relative factor intensities to the distributional consequences of a resource boom. Condition (27) relates capital intensity information to changes in \( P_3 \) induced by the resource supply increase. Eqs. (28)–(30) then relate the change in \( P_3 \) to changes in factor rewards. Table 1 shows the six possibilities. Two-thirds of the possible capital intensity assumptions, cases C to F, yield unambiguous results. In these cases the importable holds an extreme factor intensity which, as we have seen, guarantees that the non-traded good's price rises. Consequently, the changes in the real rewards of labor and capital reduce to a simple Stolper–Samuelson exercise using eqs. (29) and (30). In case C, for example, \( k_2 < k_3 \) and so the real wage rate falls and the real rental rate rises.

In all of the unambiguous cases the real return to mineral-laden land falls. Thus, the condition that the importable holds an extreme factor intensity in

<table>
<thead>
<tr>
<th>Case</th>
<th>Capital intensities</th>
<th>((\hat{X}<em>3)</em>{P_3=0})</th>
<th>(\hat{P}_3)</th>
<th>(\hat{w})</th>
<th>(\hat{r})</th>
<th>(t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>(k_3&lt;k_2&lt;k_1)</td>
<td>+</td>
<td>(\hat{P}_3)</td>
<td>+</td>
<td>(\hat{P}_3)</td>
<td>+</td>
</tr>
<tr>
<td>B</td>
<td>(k_1&lt;k_2&lt;k_3)</td>
<td>+</td>
<td>(\hat{P}_3)</td>
<td>-</td>
<td>(\hat{P}_3)</td>
<td>+</td>
</tr>
<tr>
<td>C</td>
<td>(k_2&lt;k_3&lt;k_1)</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>D</td>
<td>(k_2&lt;k_1&lt;k_3)</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>E</td>
<td>(k_3&lt;k_1&lt;k_2)</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>F</td>
<td>(k_1&lt;k_3&lt;k_2)</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*\(\hat{P}_3(-\hat{P}_3)\) denotes that the factor reward change takes on the same (opposite) sign as the non-traded good's price change.
production is sufficient to ensure a decline in the natural resource's real reward. In the two cases where importables are the intermediate capital intensity commodity, the induced changes in real factor rewards are not determinate without more quantitative information. The source of the ambiguity resides in the fact that the Rybczynski effect of the resource boom operates in the direction of $X_3$ increasing and so $P_3$ may rise or fall depending on whether or not $\hat{C}_3$ exceeds $\hat{X}_3$ at constant prices. However, once we know the sign of $\hat{P}_3$, which can be determined from condition (27), the ambiguity with respect to factor rewards is resolved. Thus, for example, in case A if $\hat{P}_3 > 0$, then the real wage rate rises and the real rental rate falls.

3.3. Resource owners' real incomes

The real reward to old owners of the mineral resource unambiguously declines due to the resource boom if importables are not the intermediate capital intensity commodity. In table 1 these are cases C through F. The gain from the new mineral wealth accrues to the new mineral owners and to one of the mobile factors. When the importable holds the intermediate factor intensity — cases A and B — the real return to mineral-laden land is ambiguous on two counts. First, the change in the nominal factor reward $t$ moves with the change in the price of non-traded goods, but this price change depends upon the strength of the Rybczynski and expenditure effects in condition (27). Second, if in cases A and B, $\hat{P}_3 > 0$ and so $t > 0$, then the real income of mineral-laden land owners may still fall since $t/\hat{P}_3 > 1$ is not guaranteed. In particular, from eq. (28) it is easy to show with numerical examples that $t/\hat{P}_3$ may be greater or smaller than unity. If the coefficient of $P_3$ in (28) is less than unity, and if a $T$ owner's expenditure share on the non-traded good is sufficiently large, then the nominal rise in $t$ will not induce a real income gain.

Formally, the change in real income of $T$ owners is given by:

$$\dot{y}_T = t - \mu_1 \hat{P}_1 - \mu_2 \hat{P}_2 - \mu_3 \hat{P}_3,$$

where $\mu_i$ denotes $T$ owners' expenditure share on $G_i$. Since $\hat{P}_1 = \hat{P}_2 = 0$, we have:

$$\dot{y}_T = (t/\hat{P}_3 - \mu_3)\hat{P}_3.$$

Then, substituting from eq. (28), we can write the condition for a real income

\[\text{We assume that an individual's nominal income derives exclusively from the ownership of only one factor. Thus, } \dot{y}_T \text{ does not depend upon } \dot{w} \text{ or } \dot{f}.\]
gain or loss from a rise in $P_3$ as:

$$\dot{y}_T \equiv 0 \quad \text{as} \quad \frac{(\theta_{K1} \theta_{L2} - \theta_{K2} \theta_{L1})}{\theta_{T1}(\theta_{K2} - \theta_{K3})} \equiv \mu_3. \quad (33)$$

Of course, if $\tilde{P}_3 < 0$, then $\ell < 0$. Nonetheless, $T$ owners' real incomes may rise if $t$ falls proportionately by less than $P_3$ falls and if $\mu_3$ is sufficiently large. It follows that if $\tilde{P}_3 < 0$ the right-hand inequalities in condition (33) are reversed.

4. International capital mobility

Resource booms are frequently accompanied by international factor movements, and in some cases these movements have been quite large. In Australia, for example, the current boom has coincided with a sizeable (real) capital inflow. In the Middle East there have been large migrations of both skilled and unskilled labor. In order to investigate this complication we shall suppose that 'capital' is an internationally mobile factor which moves so as to equate its real rate of return $r$ to the international rate. We retain the assumptions that goods 1 and 2 are traded internationally at fixed prices, that good 3 is non-traded, and that 'labor' is immobile internationally.

The price equations (1)-(3) now take $P_1$, $P_2$, and $r$ as exogenous and serve to determine $w$, $t$, and $P_3$ endogenously. We note in passing that this model admits comfortably the possibility of international factor mobility with all three industries at positive activity levels. Thus, capital mobility does not drive one sector to zero output as in Mundell (1957). Differentiating logarithmically and solving yields the analog of eqs. (28)-(30):

$$t = \frac{1}{\theta_{T1}} \tilde{P}_1 - \frac{\theta_{L1}}{\theta_{T1} \theta_{L2}} \tilde{P}_2 \frac{(\theta_{K1} \theta_{L2} - \theta_{K2} \theta_{L1})}{\theta_{T1} \theta_{L2}} \hat{r}, \quad (34)$$

$$\hat{w} = \frac{1}{\theta_{L2}} \tilde{P}_2 - \frac{\theta_{K2}}{\theta_{L2}} \hat{r}, \quad (35)$$

$$\tilde{P}_3 = \frac{\theta_{L3}}{\theta_{L2}} \tilde{P}_2 + \frac{(\theta_{K2} \theta_{L3} - \theta_{K3} \theta_{L2})}{\theta_{L2}} \hat{r}. \quad (36)$$

Eqs. (34)-(36) confirm that the international mobility of one factor serves to insulate real factor rewards from the resource boom. That is to say, regardless of an increase in mineral-laden land ($\tilde{T} > 0$) if $\tilde{P}_1 = \tilde{P}_2 = \hat{r} = 0$, then equilibrium requires $t = \hat{w} = \tilde{P}_3 = 0$. Thus, the resource boom imparts no price effects and the only gainers from the boom are the owners of the newly discovered resource.
Intuitively, international capital mobility provides a quantity adjustment alternative to the price adjustment otherwise inherent in the resource boom. In the absence of international factor flows, any induced disequilibrium in the non-traded goods market requires that the non-traded good's price change, and therefore that factor prices change. However, capital mobility ensures that any incipient rental differential internationally induces a capital flow until the original price pattern is established. Whether this insulation of factor rewards is achieved by a capital inflow or a capital outflow obviously hinges on whether the returns to capital would otherwise have risen or fallen in the absence of capital mobility.

New capital flows and changes in industry activity levels due to the resource boom can be calculated from eqs. (13)-(16) and the non-traded goods market equilibrium condition (17). Since factor prices do not change, it follows from the discussion in section 2 that \( \dot{K}_1 = \dot{L}_1 = \dot{T} \). Consequently, from eqs. (15) and (16), we have:

\[
\dot{L}' = \dot{T}(L'/L'),
\]

\[
\dot{K}' = \dot{T}(K'/K') + \dot{K}(K/K').
\]

And, from eq. (19), we know that \( \dot{C}_3 = \gamma_3 \ddot{Y} \).

Now we must be careful to specify the income effect correctly in the presence of foreign factor ownership.\(^7\) The effect of capital mobility on the demand for good 3 now depends on whether or not the returns to capital moving internationally are spent domestically. If the returns to capital flowing into (out of) the country are repatriated abroad (to the home country) in full, then \( \ddot{Y} = \theta_\gamma \dot{T} \). On the other hand, full non-repatriation implies that the demand for the non-traded good is affected by the magnitude of these returns and so \( \ddot{Y} = \theta_\gamma \dot{T} + \theta_k \dot{R} \). More generally we can write:

\[
\ddot{Y} = \theta_\gamma \dot{T} + \theta_k \dot{R} \gamma,
\]

where \( \gamma \) is the proportion of mobile capital's return which is not repatriated.

Substituting from eqs. (37) and (38) into eqs. (13) and (14) and using \( \dot{X}_3 = \dot{C}_3 = \eta_3(\theta_\gamma \dot{T} + \gamma \theta_k \dot{R}) \) we have two equations to determine \( \dot{X}_2 \) and \( \dot{K} \).

Solving,

\[
\dot{X}_2 = -\frac{1}{H} \left[ K(L_1 + L_3 \eta_3 \theta_\gamma) + \gamma_\gamma (L_1 L_3 - L_3 K_1) \right] \dot{T}
\]

\(^7\)For an analysis of the role of foreign ownership in standard trade theory, see Brecher and Bhagwati (1981).
and

\[ R = \frac{1}{H} \left[ L_2 K - L_1 K_2 + \eta_3 \theta_T (L_2 K_3 - L_3 K_2) \right] \hat{T}, \tag{41} \]

where

\[ H = L_2 K + \gamma_K (L_3 K_2 - L_2 K_3), \quad \gamma_K = \eta_3 \theta_K \gamma. \]

The term \( \gamma_K \) represents the proportional increase in \( C_3 \) due to the expenditure on non-traded goods of non-repatriated returns to foreign owned capital. From (40) it is clear that the possibility that the import competing industry 2 will not decline in response to a resource boom requires that the earnings from capital moving internationally are not fully repatriated. Full repatriation (\( \gamma = 0 \)) implies \( \gamma_K = 0 \) and eq. (40) then reduces to

\[ X_2 = \hat{T}(L_1 + L_3 \eta_3 \theta_T)/L_2. \tag{42} \]

Industry 2 thus declines when \( \hat{T} > 0 \) provided that good 3 is not inferior in consumption. This is a much stronger result than occurs in the absence of international factor mobility wherein we cannot dismiss the possibility that importable good production increases. Furthermore, the decline in \( X_2 \) occurs even if the production of good 3 does not rise — that is, \( \eta_3 = 0 \), so that \( C_3 = X_3 = 0 \). Intuitively, the expansion of the export industry 1 at constant factor prices draws labor from the non-booming sectors at the rate \( \hat{L}_1 = \hat{T} \). If \( X_3 = 0 \), this labor comes entirely from industry 2 and with fixed factor prices, this industry must decline.

The impact of the resource boom on net international capital flows is given by eq. (41). A capital inflow might reasonably be expected and this is guaranteed if the booming export sector is most capital intensive and if any impact through the non-traded goods market is not strong. For example, if \( \hat{C}_3 = \hat{X}_3 = 0 \), then eq. (41) reduces to \( \hat{R} = \hat{T}(k_1 - k_2)L_1/K \), which implies a capital inflow for \( \hat{T} > 0 \) so long as \( k_1 > k_2 \).

However, it is of interest to note that in general a resource boom may be accompanied by a capital outflow even though the booming sector is the most capital intensive. From (41), if \( k_1 > k_2 > k_3 \), as conventional wisdom suggests, then the sign of \( \hat{R} \) is ambiguous. If the income effect of the boom on the demand for good 3 — \( \eta_3 \theta_T \) — is large, then the numerator of (41) may be negative. In this case, the expansion of industries 1 and 3 absorbs labor from industry 2. But if industry 3 is large and its capital intensity sufficiently low relative to industry 2, then the capital released from industry 2 may exceed that required by the expansion elsewhere.

Finally, while international capital mobility insulates factor owners from any real income effects of a resource boom, it follows from the analysis in
previous sections that some factor owners gain and others lose from such insulation. For example, from table 1, if \( k_2 < k_3 < k_1 \), then the real wage would have fallen in the absence of capital mobility. And, in general, any capital inflow is a response to an incipiently higher real rental rate and lower wage rate. Labor cannot be harmed by a capital inflow under any capital intensity assumptions.

### 5. Endogenous protection

The central distributional result of the analysis thus far is that, so far as the mobile factors 'capital' and 'labor' are concerned, either the return to both of these factors is unaffected by the resource boom (the result when all goods are traded or when two goods are traded and one factor is internationally mobile) or that one factor gains and the other loses. Both cannot gain. Since the boom increases aggregate income, redistributive mechanisms such as factor taxes and subsidies can clearly be imagined which could in principle ensure that no factor is ultimately harmed by the boom. In practice, however, relatively inefficient redistributive measures such as trade taxes, quantitative restrictions, and voluntary export restraint on the part of trading partners have been advocated and in many cases implemented in an effort to moderate or to remove the losses accruing to factors initially harmed by the boom. In public discussion, a deterioration in the real income of, say, labor is commonly attributed to the increased imports which accompany the boom, rather than the general equilibrium price effects of the resource boom itself.

This raises the question of what such interventions imply for the factor which initially benefited from the boom. In itself, a trade intervention which benefits one factor harms the other. So, could the effort to protect the factor which initially loses from the boom cause the other factor (which initially benefits) to suffer a net loss? We shall thus consider the case where protection is adjusted so that the real income of the factor which would otherwise have been harmed by the resource boom remains constant. In order to make the discussion more concrete we shall focus our exposition on the set of cases wherein industry 2 is the most labor intensive. With \( P_2 \) held constant, \( P_3 \) unambiguously rises in response to the boom and capital benefits while labor is harmed. Nevertheless, our qualitative results in no way require this particular configuration of capital intensities.

Writing \( \dot{y}_i \) for the change in the real income of factor \( i \), for labor we have

\[
\dot{y}_L = \dot{w} - \sum_{i=1}^{3} \Phi_i \dot{P}_i
\]

\(^8\)Of course, growth can immiserize even a small country in the presence of distortions, as in Bhagwati (1968). For a related discussion of protection in a natural-resource-rich economy, see Burgess (1980).
where \( \Phi_i \) denotes the share of labor's expenditure which is devoted to \( G_i \). Naturally, these shares are non-negative and must sum to unity. Now let the resource boom proceed as before, except that we simultaneously adjust the domestic price of \( G_2 \) sufficiently to keep the real return to labor constant. That is, \( \bar{P}_2 \) is set that for a given value of \( \bar{T} \) (assumed small), \( \bar{y}_L = 0 \). The implication is that the political process is behind the changes in \( P_2 \) and we might suppose, for example, that the price of importables is manipulated through tariff policy. In the Stolper–Samuelson spirit we shall ignore changes in tariff revenue on the assumption that the initial tariff is 'small'. With labor so protected, the question is: What happens to \( \bar{y}_K \)?

Eqs. (9)–(11), the market clearing equation for good 3, and eq. (43) now give a five-equation system with the endogenous variables \( \bar{f}, \bar{w}, \bar{r}, \bar{P}_2 \), and \( \bar{P}_3 \) in terms of the exogenous variable \( \bar{T} \). Solving this system for \( \bar{f}, \bar{P}_2 \), and \( \bar{P}_3 \) it is readily shown that \( \bar{f}/\bar{P}_2 > 1 \) and \( \bar{r}/\bar{P}_3 > 1 \).

The behavior of the non-traded good's price, \( P_3 \), is again the key to the system. The condition for \( P_3 \) to rise in this system is identical to condition (27). Also, we note that the endogenous adjustment in \( P_2 \) must move with \( P_3 \). If \( P_3 \) rises (as it must if industry 2 is the most labor intensive) then \( r \) must rise in terms of all goods. Thus, \( \bar{y}_K > 0 \). Capital owners cannot be harmed by the combination of a resources boom \textit{and} endogenous protection sufficient to maintain the real income of labor.\(^9\) Of course, the interests of capital and labor still conflict; capital owners would be still better off if the resources boom was not accompanied by this endogenous protection. This result is unchanged if labor is the factor gaining from the boom and capital the protected factor. The prices of \( G_2 \) and \( G_3 \) must move in the same direction, but whether \( P_2 \) rises or falls relative to \( P_3 \) depends on factor intensities in industries 2 and 3. In the case we have focused upon, where \( k_2 < k_3 \), \( P_3 \) changes proportionately more than does \( P_2 \).

On the other hand, if \( P_3 \) falls in response to the boom, then these conclusions are reversed. The attempt to protect the factor losing from the boom in this case causes the factor which initially gained to suffer a net loss. As we have seen, the non-traded good's price can fall only when \( k_2 \) is intermediate, so suppose \( k_1 > k_2 > k_3 \) and suppose that from condition (27) we find that \( P_3 \) falls. Then in the absence of any change in protection labor again loses from the boom and capital gains. Labor's real position can now be improved by reducing \( P_2 \), such as by expanding import quotas, cutting tariffs, or introducing import subsidies. But if this is pursued to the point where labor's real position before the boom has been restored, capital's gain will have been turned into a net loss. The general proposition is that when one factor's real position is held constant by means of adjustments to

\(^9\)For a formal proof of the results and a further analysis of the effects of protection which adjusts endogenously, see Cassing and Warr (1982).
protection, the other factor’s real income moves in the same direction as the non-traded good’s price.

For old owners of the specific factor in the booming export sector, the proposition is reversed. That is, when one of the mobile factors’ real position is held constant through protection policy, the real incomes of old owners of mineral-laden land move in the opposite direction from the non-traded good’s price. Solving as before, we find that $t/P_3 < 0$. Since $P_3$ and $P_2$ move together — and $\hat{P}_1 = 0$ — a rise (fall) in $P_3$ unambiguously harms (helps) old mineral-laden land owners. The result is not unexpected since an increase in $P_2$ and $P_3$ must draw resources into the $G_2$ and $G_3$ sectors and so lower the return to the specific factor in the $G_1$ industry.

6. Summary and conclusions

This paper attempts to focus in a tractable way on some of the income distributional consequences of a resource boom. The approach is first to build a simple general equilibrium model in which changes in factor owners’ real incomes are well defined and then to isolate the sources of income gains and losses induced by sector specific factor growth. The analysis does not show what will happen as a result of a resource boom. It does, however, focus on the economic forces at work and illustrates what is reasonably possible. In addition to the usual conclusion of such variable proportions models that relative factor intensities matter, three lessons emerge.

First, the non-traded goods sector plays a critical role in the distributional consequences of a resource boom. Since factor rewards depend on output prices, unless the resource boom affects the prices of non-traded relative to traded goods factor prices will be unaffected by the boom. But the resource boom generally disrupts equilibrium in the non-traded goods market, inducing a change in the price of non-traded goods and this change in the real exchange rate in turn alters factor prices and so factor owners’ real incomes. For a given change in the price of the non-traded good these factor price changes may be deduced from factor intensities in the various industries.

Second, international factor mobility tends to insulate domestic factor owners from real income changes induced by a resource boom. This occurs because incipient factor reward differentials induce factor flows which work against actual changes in factor payments. In the model, international mobility of capital serves to preserve the pre-boom structure of commodity prices and factor returns. However, the output effects of the boom are altered and a capital outflow is not an unrealistic possibility.

Finally, we have introduced the notion of endogenous protection whereby the importable price is taken to be adjusted (through the political process) so as to maintain the real reward of some group adversely affected by the
resource boom. This protection erodes and sometimes reverses the gains which would otherwise accrue to some other factor owners. The distribu-
tional consequences, however, are not the same as would result from merely leaving the new resource unexploited.

Appendix: Derivation of the equations of change

Eqs. (9)–(11) and (13)–(14) are standard results. [See, for example, Jones (1965) or Batra (1973).] Eq. (12) follows from the linear homogeneity of the $G_1$ production function. Write

$$\frac{T}{X_1} = a_{T_1}(w, r, t). \quad (A.1)$$

The total (logarithmic) differential of eq. (A.1) is given by

$$\frac{dT}{X_1} = \theta_{L_1} \sigma_{LT} \hat{w} + \theta_{K_1} \sigma_{KT} \hat{r} + \theta_{T_1} \sigma_{TT} \hat{t}. \quad (A.2)$$

[See, especially, Kemp (1969, ch. 7), Allen (1938) and Batra and Casas (1976).] Rearrangement of eq. (A.2) yields eq. (12).

Finally write,

$$\frac{L_1}{X_1} = a_{L_1}(w, r, t). \quad (A.3)$$

As above, the total (logarithmic) differential of eq. (A.3) is given by

$$\frac{dL_1}{X_1} = \theta_{L_1} \sigma_{LL} \hat{w} + \theta_{K_1} \sigma_{KL} \hat{r} + \theta_{T_1} \sigma_{TL} \hat{t}. \quad (A.4)$$

Define $L' = L - L_1$. Then the proportional change in $L'$ is given by

$$\frac{L'}{L - L_1} = \frac{L}{L - L_1} \frac{L_1}{L - L_1} \frac{L_1}{L - L_1}.$$ 

Substitute for $X_1$ from eq. (12) into eq. (A.4) and substitute for $L_1$ from eq. (A.4) into eq. (A.5). This yields eq. (15). Eq. (16) is derived analogously using

$$\frac{R_1}{X_1} = \theta_{L_1} \sigma_{LR} \hat{w} + \theta_{K_1} \sigma_{KR} \hat{r} + \theta_{T_1} \sigma_{TR} \hat{t}. \quad (A.6)$$

References


Chang, W.W., 1979, Some theorems of trade and general equilibrium with many goods and factors, Econometrica 47, 709–726.


