A Dependent Economy Model with Productive Linkages and the Pattern of Specialization in Resource Abundant Countries*

Leandro Antonio Serino•
Universidad Nacional de General Sarmiento

Resumen

El presente trabajo incorpora eslabonamientos productivos al modelo de economía dependiente. El modelo muestra que un choque externo positivo en los sectores asociados a los recursos naturales, como el experimentado por los países Sudamericanos en años recientes, podría favorecer la diversificación de la estructura productiva y de las exportaciones, un resultado que contrasta con las predicciones de los modelos tradicionales. Ello puede suceder cuando los impulsos externos promueven la expansión de los eslabonamientos productivos que proveen servicios de infraestructura y otros servicios especializados esenciales para la producción de bienes industriales y servicios exportables. La diversificación puede verse favorecida de manera directa cuando el sector asociado a los recursos naturales es un sector moderno e integrado productivamente, o indirectamente, mediante políticas que canalicen parte del impulso externo hacia la expansión de los eslabonamientos productivos.

Abstract

This paper presents a dependent economy model extended to consider the role of productive linkages. The model shows that a positive natural resource shock, as the one experienced by South American countries in recent years, can encourage productive and export diversification, in contrast to the predictions of conventional models. This can occur when the shock promotes the expansion of productive linkages, which provide infrastructure and other specialised services that are essential to compete in modern manufacturing production. Diversification may occur directly in countries with natural resource intensive industries with productive linkages, or indirectly through policies to promote investment in infrastructure in the context of positive resource shocks.

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• *lserino@ungs.edu.ar / leaserino@gmail.com*

1. Structural Change: A Necessary but Elusive Condition for Economic Development in Resource Abundant Countries

Trade and financial liberalization in the 1990s gave place to a policy-induced de-industrialization process in South American countries, especially Argentina, and the others in the southern cone (Palma, 2005). There are different reasons making process a worrisome one and productive and export diversification a desirable development outcome in South America. First, natural resource exporters tend to grow less than their resource-poor counterparts, especially when they are not able to diversify and develop additional competitive advantages (Serino, 2008). Second, there are differences in returns to scale and the skill and technological intensities of the sectors producing natural resource and industrial products (Cimoli and Correa, 2005; Kaldor 1981; Katz, 2000; Thirlwall 1995, 2002).[1] The third one is related to the necessity of additional sources of foreign exchange to overcome external bottlenecks, which have been a fundamental constraint to sustained growth in Argentina.

Renewed concern regarding Argentina's and South America's pattern of trade specialization arises as demand for natural resource products has increased in response to the expansion of China and India and primary commodity prices skyrocketed in recent years. According to the dependent economy and related multi-sectoral models, the analytical tools commonly employed to study the impact of shocks in small open economies, a positive shock, such as that referred to above, will reduce the competitiveness of the non-traditional tradable sectors, strengthening South America's natural resource-based pattern of trade specialization.

As shown in this paper, this is not the only possible adjustment to a positive natural resource shock; the shock may also contribute to productive and export diversification. Drawing on Ros (2000, 2001), this paper develops a multi-sectoral model to discuss the possibility of positive indirect interaction between the natural resources and other tradable sectors.

The model moves beyond conventional approaches and takes into account the heterogeneity characterizing the non-tradable sectors in most economies. It distinguishes between two non-tradable sectors: the consumer-oriented and the producer-oriented ones. The first provides consumer services (e.g. restaurants, entertainment, etc.); the second provides non-tradable intermediate inputs which, following Hirschman, I refer to as productive linkages. The strength of the productive linkages in the entire economy depends critically on the quality and extension of non-tradable production of the financial, physical and technological infrastructures. These infrastructures are critical in determining the competitiveness of an economy, and are especially relevant to modern industrial sectors.

Also, productive linkages are a potential source of positive externalities. The expansion of the non-tradable sector that generally follows a positive natural resource shock, may benefit the non-traditional tradable sectors, or set in motion forces that counteract the price adjustments predicted by dependent economy models when (non-tradable) productive linkages expand with a shock and allow other sectors to take advantage of them.

The availability of productive linkages is not a sufficient condition for productive and export diversification in natural resources exporting countries. Yet, in successful staple economies, such as Australia and Canada, impulses from the traditional exporting sector spread through the rest of the economy via a variety of linkages (Fogarty, 1985; Watkins, 1963),[2] and most competitive industries in the Scandinavian countries are linked to the productive linkages in their natural resource exporting sectors (Ramos, 1998; de Ferranti, et al., 2002).

The paper discusses the impact of natural resource shocks on the pattern of trade specialization.

1. Cross-country empirical studies emphasize other disadvantages associated with natural resource abundance. These are: Prebisch-Singer terms of trade hypothesis; price and macroeconomic volatility and income distribution and political economy conflicts.

2. According to Fogarty, all successful staple economies are characterized by the presence of: technological and scientific infrastructures, usually provided by government; a developed marketing system; government finance and modern banking services; significant physical infrastructure (transportation, ports, grain-elevators, etc.).

It shows that the consequences of a positive shock depend on how natural resource revenues are used, and especially whether they finance consumer or producer services. Taking into account the role of productive linkages adds a dimension generally absent in dependent economy models and suggests that a positive natural resource shock does not necessarily constrain the competitiveness of other tradable sectors, as suggested also by Eswaran and Kotwal (2002) and Torvik (2001). The analysis in this paper has some economic policy implications. It suggest that encouraging the natural resources sector to develop linkages would be beneficial for the entire economy, and also that policies that directly or indirectly promote investment in infrastructure in the context of a positive resource shock will be similarly beneficial.

Section 2 presents a dependent economy model extended with productive linkages. The section starts with a conceptual discussion and then turns to the presentation of the model. After this the section analyses the impact of a positive natural resource shock and discusses the conditions for this shock to reinforce or contribute to modify the pattern of specialization of resource abundant countries. Section 3 concludes.

2. A Linkage Dependent Economy Model

2.1. Some conceptual issues

Paraphrasing Hirschman's general notion of linkages "as the attempt to discover how one thing leads to another (Hirschman, 1981)", this paper examines how alternative uses of the revenues from natural resources encourages different patterns of trade specialization. In particular, the paper explores the possibilities and conditions for a positive resource shock to facilitate productive and export diversification. The analysis focuses on Argentina and other South American countries; hence, diversification is conceived of as the development of a competitive manufacturing sector that helps to reduce a country's dependence on natural resource exports.[3]

According to Mayer (1997), manufacturing competitiveness and exports depend on natural resource endowments, macroeconomic and sectoral policies, size and patterns of world trade and the importance of the physical, technological and financial infrastructure. The analysis in this paper focuses on two out of five of these determinants. The first is the direct and negative relationship between the natural resource and the manufacturing sectors commonly emphasized in dependent economy models. The second is the positive and indirect contribution of resource abundance or a positive resource shock to the competitiveness of the other tradable sectors, indirectly by improving the different types of infrastructure (and productive linkages of the economy).

The model presented in this paper is similar to the multi-sectoral analytical models employed to study the impact of shocks in small open economies, starting with the dependent economy model (Salter, 1959; Dornbusch, 1980). It is also in line with models developed during the 1980s and 1990s to describe adjustments in relative prices and the economic structure that followed commodity booms and other events that increased inflows of foreign exchange.[4] (See e.g. Corden and Neary, 1982; Corden, 1984; Edwards, 1989; Murshed, 1999). One such event was the process of de-industrialization experienced in the Netherlands in the 1970s following the discovery of gas fields in the North Sea, a process that was described by *The Economist* as the 'Dutch disease'.

Following Ros (2000, 2001), this papers incorporates productive linkages to a dependent economy-type model. Productive linkages principally concern the provision of (non-tradable) intermediate inputs like physical, financial and technological infrastructure and other specialized inputs. As Mayer (1997) and the literature recognize, productive linkages are an important (price and non-price) competitiveness determinant and provide inputs that are used intensively in modern industries (see e.g. Chudnovsky and Porta, 1990; Rodriguez-Clare, 1996).

3. Throughout this paper I use the terms manufacturing sector and industrial sector to refer to the non-natural resource tradable sector.
4. There are static and dynamic dependent economy-type models. Static models focus on how relative price adjustments modify the structure of an economy, emphasizing how certain positive shocks can lead to unemployment and trade deficits. Dynamic models emphasize the growth retarding consequences of a positive resource shock.

The provision and expansion of productive linkages are critical if economies are to change their pattern of trade specialization. They are a source of positive external effects through the provision of services characterized by the presence of economies of scale, e.g. transportation, communication, and services that are very specialized and can promote economies of specialization, like agricultural and engineering services. In the model, positive external effects are developed as pecuniary externalities.[5] This means that the development and expansion of productive linkages can be translated to lower input prices, which increase the profitability of the tradable sectors using them.

The model in this paper is also related to the multiple-equilibrium family of studies that followed the seminal paper by Murphy, Shleifer, and Vishny (1989). Murphy et al. (1989) formalize a core proposition of pioneers of development economics: that modern production techniques (characteristic of advanced countries) are a source of pecuniary externality. As externalities create coordination failures, they can prevent developing countries from upgrading from traditional to modern activities, leading to what is known as a development trap. A 'Big Push', to coordinate economic decisions, is necessary to escape from the trap. This impulse may come from massive public investment and/or large expansions in private consumption that make modern production techniques profitable (Rosenstein-Rodan, 1943, Murphy et al., 1989, Sachs and Warner, 1999),[6] or from any increase in aggregate demand that contributes to establishing and expanding productive linkages (Rodriguez-Clare, 1996).[7] The third channel that is applicable to open economies is emphasized in this paper.

The analysis in Ros (2001) studies the general case in which economic development is conceived of as a change in the pattern of specialization from labour-intensive to capital and technological intensive industries, sponsored by the expansion of productive linkages. With a focus on the experience of Latin American countries, this paper analyses the (possibilities of a) transition from natural resources to modern industrial production and exports.[8] Of particular interest is the case where the expansion of productive linkages, which sets up the conditions for economic development, follows from a positive natural resource shock.[9]

The implications of a positive shock for economic development depend on how natural resource income is used, and especially whether it (mainly) increases consumption or contributes to expanding productive linkages, two of the possible uses of resource revenues.[10] Moreover, expansion of the productive linkages following a natural resources shock will be determined by the initial characteristics of the natural resource sector. If the natural resources sector is modern and makes intensive use of financial and research and development services, for instance, then the expansion of productive linkages and ensuing positive externalities for other sectors, will be more likely.[11] Also, the development of productive linkages will depend on economic policies designed to use natural resource income to invest in infrastructure or to encourage an integrated natural resource sector.

The model developed in this paper has links with dynamic dependent economy models. However, it is more innovative (see e.g. Sachs and Warner, 1995 and other work referred to in Serino, 2008) in that expansion of the non-tradable sector following a positive

5. *Scitovsky (1954) identifies two external effects: technological and pecuniary externalities. Following Scitovsky, a technological externality can be defined as occurring "whenever the output (x1) of a firm depends not only on the factors of production (l1, c1,…) utilized by this firm but also on the output (x2) and factor utilization (l2, c2,…) of another firm or group of firms" while pecuniary externalities arise "whenever the profits of one producer are affected by the actions of other producers" (Scitovsky, 1954: 144-5). To the extent that we are assuming that external effects are translated into price changes, the analytical model is developed along the lines of pecuniary externalities.*

6. *Sachs and Warner (1999) set up a "big push" model in which a positive resource shock expands the size of the domestic market and boosts economic development. Such a process is compatible with the big push type industrialization experienced by some of the regions of recent settlement during the 1870-1930 period.*

7. *According to Rodriguez-Clare (1996) sustainable development depends on the presence and adequacy of productive linkages.*

8. *It is highly unlikely that resource abundant countries develop labour-intensive industries because they "tend to emphasize more capital-intensive industries due to the relative high price of labour in comparison to their degree of industrialization" (Syrquin; 1989, p.218)*

9. *Indeed, the analytical framework captures an idea presented in a model developed by Gutiérrez de Piñeres (1999), whereby when the primary sector requires significant investment in infrastructure and knowledge, the sector becomes an important source of externalities and facilitates the development of other exporting sectors. However, rather than considering externalities within the primary sector only, as Gutiérrez de Piñeres (1999) does, the model investigates how the natural resource sector can contribute further to the emergence of a dynamic manufacturing sector.*

10. *This means that in this paper I do not take account of consumption of tradable goods or other savings-investment decisions. For a discussion of savings-investment uses of natural resource revenues, see work on trade shocks by Collier and Gunning (1999).*

11. *For a detailed and instructive discussion on the role and characteristics of linkages in primary exporting countries see Hirschman (1981).*

resource shock, expands the productive linkages and may improve rather than jeopardize economic competitiveness. Only Torvik (2001) and Eswaran and Kotwal (2002) explore this type of adjustment. According to Torvik (2001), dynamic economies of scale arise in both the tradable and non-tradable sectors; as knowledge spillovers are assumed to go in both directions, a resource gift that drives the non-tradable sector may turn out to be beneficial in the long-run. Similar to the model proposed in this paper, Eswaran and Kotwal's staple-growth model sustains that the non-tradable sector produces both consumption and producer services. They emphasize that as income grows, demand for producer services rises and manufacturing sector costs fall, thereby promoting diversification in resource abundant countries, as it seems to have been the case in Australia, Canada and Scandinavian countries. A related paper by Galiani, Heymann, Dabús y Tohmé (2007) explains human capital accumulation in Argentina. However, in the paper human capital is accumulated to produce high quality services consumed by the elite and does not generate growth enhancing complementarities.

2.2. The model

The model distinguishes between tradable and non-tradable goods and sectors. The tradable sector is disaggregated according to the existence of natural resource endowments. The tradable sector therefore includes an internationally competitive natural resource sector (*R*) and a potentially competitive manufacturing sector (*M*). Sector *R* is defined as a '*large*' sector producing both unprocessed and industrialized natural resource products.

Sector *M* (henceforth the manufacturing or industrial sector), therefore, includes only non-natural resources industries, which implies that diversification (as it is understood in this paper) cannot take place through the development of natural resource-based industries (*NRBI*), although this is a valid alternative for Latin American countries, but not necessarily easy to achieve (Roemer, 1979). In fact, the assumption of a 'large' sector *R* is made to illustrate that *NRBI*, which certainly have more productive linkages than primary production, can contribute to developing other competitive industries.

For simplicity, the model assumes that output in sector *R* is exogenous, as shown in equation (2.1).[12] This simplifying assumption is often made in dependent economy models[13] and brings two important advantages. First, it makes the model suitable to analyse the effects of a resource shock, and also adjustment to other foreign exchange shocks associated with debt, aid or other capital inflows. Second, the assumption of an exogenous natural resource sector facilitates discussion on the uses of resource income as being determined by technology or economic policies, while keeping the model analytically tractable.[14] As in Murshed (1999) and Sachs (1999), the model further assumes that natural resource production is entirely for export.[15]

Non-resource manufacturing goods are produced with Cobb-Douglas constant returns to scale technology that combines capital and non-tradable intermediate inputs (*I*) (see eq. (2.2) below). These domestically produced inputs represent backward linkages in sector *M* which provide the infrastructural or specialized inputs mentioned in Section 2.1.[16] To emphasize the capital and linkage intensity characteristic of the sector, labour is excluded in eq. (2.2). However, this is not to imply that manufacturing does not use labour, but rather that the sector makes an indirect use of it through productive linkages.

$$\overline{R} \tag{2.1}$$

$$M = K_M{}^{\beta} I^{1-\beta} \tag{2.2}$$

To study the role of productive linkages the non-tradable side of the economy distinguishes two types of products and sectors: consumer-oriented and producer-oriented. The latter encompasses the physical,

12. *The assumption of an exogenous resource sector excludes analysis of capital adjustments between sector R and other sectors using capital as a factor of production. See Corden and Neary (1982) for a complete discussion of these adjustments.*
13. *Murshed (1999) and Torvik (2002) are examples of dependent economy models assuming an exogenous supply for the natural resource sector.*
14. *Adding the supply side of the natural resource sector and a government sector, will complicate analysis of the model.*
15. *The implications of a natural resource sector producing for the domestic and export markets are discussed in Serino (2007).*
16. *Although the model is built around the idea of backward linkages this does not mean that other productive linkages are irrelevant.*

technological and financial infrastructures and specialized services employed as inputs in the manufacturing sector. These inputs are produced in sector *I* using a technology describing increasing returns to scale. Examples of these inputs are producer services such as consultancy, various types of financial products and research and extension departments, where increasing returns result from economies of specialization, and the infrastructures associated with communication and transportation, where increasing returns are derived from scale economies. Sector *I*'s production function is described in equation (2.3), which is simpler than the specification in Ros (2001). As shown in equation (2.4), sector *S* produces consumer goods and services –and other non-tradable inputs– using a technology with constant returns to scale.

$$I = L_I^{1+m} \text{ , where } \mu>0 \qquad (2.3)$$

$$S = L_S \qquad (2.4)$$

Producers in sector *I* determine prices by a mark-up over variable costs. Prices in this sector equal $p_I=(1+\pi)\cdot\omega$, where π stands for a fixed mark-up and $\omega=w\ (L_I/I)$ represents sectoral unit labour costs.[17] The price of non-tradable inputs (p_I) relative to the price of manufacturing products equals

$$\frac{p_I}{p_M} = (1+\pi)\frac{w\cdot L_I}{p_M\cdot I} \qquad (2.5)$$

In a monopolistic competition context –or with adequate regulation[18]– increasing returns mean that intermediate input prices fall with the size of sector *I*, improving the profitability of the sectors using these inputs. They also imply that sector *I* is a source of productive complementarities which has implications for the pattern of specialization and the dynamics of the system.

As discussed in Ros (2000), if sector *I* is small, the non-tradable inputs will be expensive and the sectors using them will not be profitable –in our model, the manufacturing sector– because this can only be developed in association with sector *I*. If, on the other hand, producer linkages are relative large input prices (productivity) may turn out to be low (high) enough and render the manufacturing sector competitive. Moreover, once the manufacturing sector breaks even, its interaction with sector *I* will be self-reinforcing. This pecuniary externality can be particularly important in resource abundant countries that are seeking to modify their pattern of specialization, as it provides a channel for the resource sector, if modern and industrialized, to indirectly encourage diversification.

To explore this proposition formally, demand for intermediate inputs is linked to the manufacturing sector and to natural resources income.

$$ED_I = I_M^d + I_R^d - I = 0 \qquad (2.6)$$

In equation (2.6) I_M^d is demand for intermediates from sector *M* and equals $I_M^d = [p_M/p_I\ (1-\beta)]^{1/\beta}\ K_M$. The term I_R^d is exogenous and equals $I_R^d = t\ (R/P_I)$, where parameter *t* represents the percentage of the revenue from natural resources spent on non-tradable intermediate inputs. Working with an exogenous resource sector implies that I_R^d can be technology or policy determined.[19] It is possible, therefore, to assume that parameter *t* represents different policies and mechanisms for channelling of natural resource revenues to the increasing returns sector, like credit or tax policies to encourage investment in technological infrastructure, or direct public investment in physical infrastructure. Although it is possible to consider other saving-investment decisions,[20] it is assumed that resource income is used only to demand non-tradables: intermediate inputs (*tR*) or consumption goods and services (*(1-t)R*). Combining (2.5) and (2.6) leads to the following expression of output in sector *I*.[21]

$$I = \left[\frac{(1-\beta)\,p_M I}{(1+\pi)wL_I}\right]^{\frac{1}{\beta}} K_M + \frac{t}{(1+\pi)}\frac{RI}{wL_I} \qquad (2.7)$$

17. *This specification is simpler than the one employed in Ros (2001), where mark-up is defined over marginal costs rather than over average labour costs.*
18. *This is to ensure that providers of intermediate inputs do not appropriate a fraction of the natural resource rents, as happened, according to Di Tella (1985), between 1870 and 1930 in the regions of recent settlement.*
19. *One likely specification of sector R's supply function compatible with the idea that NRBI and positive resource shocks may promote diversification is* $R = T_R^{\lambda} I^{1-\lambda}$, *where* $\lambda>\beta$. *The function suggests that sector R has productive linkages and the inequality states that these are smaller than those in the manufacturing sector. It also suggests that in resource abundant countries the manufacturing sector is more dependent on dynamic advantages to be competitive.*
20. *In his study of natural resources-based industrialization in Malaysia, Thoburn (1973) defines linkages as an investment decision, in line with Hirschman's understanding of linkages.*
21. *An alternative expression of I is given by* $I = [(1-\beta)\ p_M/p_k]^{1/\beta}\ K_M + t(R/p_I)$. *This and equation (2.7) are used in this paper.*

As shown in equation (2.7), productive linkages are an increasing function of the capital stock from sector *M*, the magnitude of resource income, and the extent to which natural resource revenues are used to demand non-tradable intermediates, denoted by *t*. Output in sector *I* is negatively related to price (w/p_M in eq. (2.7)) .

The impact of resource shocks on the pattern of specialization is analysed in terms of the dynamics of the labour market and capital accumulation, as in Ros (2000; 2001). This requires that we substitute labour demand[22] in $L=L_S+L_I$, to obtain the following linearized expression of equilibrium market wages.

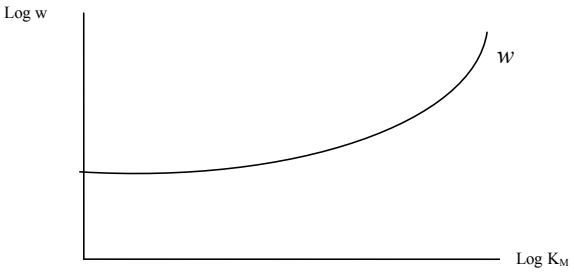
$$\ln w = \ln qR + \frac{1}{\beta(1+\mu)}\ln\left[\frac{p_M}{p_I}(1-\beta)\right] + \frac{1}{1+\mu}\ln K_M + \frac{1}{1+\mu}\ln\frac{tR}{p_I} - \ln L \quad (2.8)$$

Equation (2.8) shows that unless there is an unlimited supply of labour resource abundance creates upward pressure on market wages, as predicted by the standard Dutch disease models. This positive association is caused by two different effects. First, higher wages are associated with *(1-t)R*: the so-called *spending effect* capturing the extra expenditure on non-tradable consumer goods and services which higher resource income promotes. Second, the resource sector increases wages via *tR*, an effect that is similar (though not exactly equal) to the *resource effect* identified in Dutch disease type models. Increases in the size of sector *R* expand labour demand –indirectly through sector *I*– and this requires an increase in market wages to restore equilibrium in the labour market. Finally, market wages are positively related to the size of sector *I* and the capital stock.

Figure 1 plots equation (2.8) in the (*Log w; Log* K_M) space. Assuming the presence of excess capacity in the short-run[23] or that, due to the lower productivity of sector S compared to sector *I*, the non-tradable sector producing consumer goods can provide an initially elastic supply of labour,[24] the market wage schedule (*w curve*) has a relatively flat initial segment. This means that the initial expansion of sector *I* can be achieved at low labour costs. Yet, increases in capital stock and labour demand in sector *I* make the *w curve* steeper.[25] Alternatively, positive changes in the size of the resource and intermediate sectors shift the *w curve* upwards.

Figure 1

Capital accumulation and market wages



Note: Adapted from Ros (2000).

To complete the analytical model, I need to account for the dynamics of capital accumulation. Capital accumulation is assumed to equal the depreciation rate (δ) and to be financed by savings from profits,[26] as shown in equation (2.9). Because the purpose of the model is to emphasize the role of productive linkages, the analysis does not allow for capital accumulation to be financed by resource revenues.

$$\frac{I}{K} = s_M \cdot r_M = \delta \quad (2.9)$$

The profit rate r_M is obtained from profit maximization of equation (2) and equals $r_M = \beta(I/K_M)^{1-\beta}$. Replacing *I* in r_M, plugging the new expression of the profit rate into equation (2.9), and rearranging the terms gives an alternative wage curve (w^*): the long-term wage curve, which is compatible with capital accumulation.

22. To obtain expressions for labour demand I follow the procedure in Ros (2000). For simplicity I assume that demand for non-tradable consumer goods and services (S) comes from natural resources income only, and labour demand from sector S equals $L_S = (1-t)R/w$. *From equation (2.3) we know that labour demand in sector I equals* $L_I = I^{(1/(1+\mu))}$. *Substituting I into this expression, labour demand can be expressed as* $LI = \{[(1-\beta)\, p_M/p_I]^{1/\beta} K_M + t(R/p_I)\}^{1/(1+\mu)}$, *which is then included in the excess labour market equilibrium identity.*

23. The assumption of excess capacity in the short-run is theoretically consistent with the mark-up specification of sector I. It is also compatible with the labour market characteristics of many Latin American countries during the 1999s - and especially Argentina.

24. A possibility is to assume that sector S comprises the informal sector of the economy, as in Ros and Skott (1998).

25. It is possible to obtain a similar curve without the assumption of short-run excess capacity or hidden unemployment. As in Ros (2001), the curve will be relatively flat when sector M is small as is the case for the backward linkages sector I.

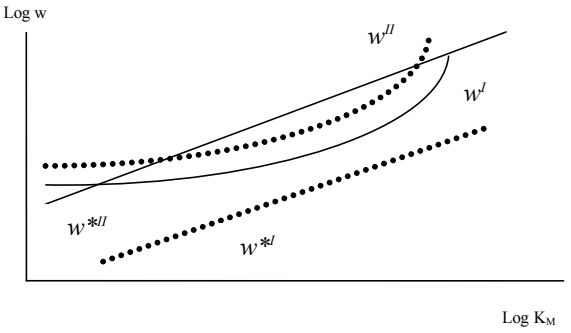
26. This means assuming a stationary labour force and no exogenous technical change, as well as the common assumption that workers do not save.

$$\ln w^* = \frac{\frac{(1-\beta)}{\beta}\ln\left[\frac{(1-\beta)}{(1+\pi)}\frac{p_M I}{L_I}\right] + (1-\beta)\ln\left[\frac{tRI}{(1+\pi)L_I K_M}\right] - \ln\left(\frac{\delta}{s_M \beta}\right)}{\left[\frac{1-\beta^2}{\beta}\right]} \quad (2.10)$$

According to (2.10), long-term equilibrium wages are positively associated to the size of the natural resource sector and the percentage of the natural resource revenues used to satisfy demand for intermediate inputs (*t*). Long-term wages are also positively related to the size of the intermediate sector and the capital stock.[27] Defining equilibrium as a situation where market wages (*w curve*) equal long-term wages (*w* curve*), the model can be used to explore the effect of changes in the size and uses of resource revenues.

Figure 2

Natural resource shocks and the pattern of specialization in a context of multiple-equilibriums



Note: Adapted from Ros (2000). K_M stands for the minimum capital stock required to develop a competitive manufacturing sector.

2.3.Positive natural resource shocks: a curse or a blessing?

Discussion of the implications of a positive resource shock for the pattern of specialization is depicted in Figure 2, which combines the market wage schedule (w curve associated to (2.8)) and the long-term wage schedule (w* curve derived in (2.10)). A remarkable feature of the figure is that multiple-equilibriums are a possibility in this stylized economy. In the bad equilibrium, resource abundant countries specialize according to their static competitive advantage, but in the good equilibrium, they are capable of developing internationally competitive manufacturing sector.

Multiple-equilibriums arise from the combination of an initially elastic labour supply and increasing returns in sector *I*. For low levels of the capital stock the elastic labour supply makes the market wage curve (*w*) flatter than the long-term wage schedule (*w**) –as production in sector *I* can be expanded at low labour costs. But the market wage schedule becomes steeper than long-term wages for high levels of the capital stock because a large manufacturing increases labour demand (through backward linkages with sector *I*) creating upward pressure on market wages.

Analytically, multiple-equilibriums require $(1-\beta)/\beta$ (the slope of the long-term wage curve *(w*)*) to be smaller than $1/(1+\mu)$, the slope of the market wage curve *(w)*, when labour supply becomes inelastic; these conditions hold for $\mu <= 0.2$ and $\beta > 0.5$. The former is a plausible condition since externality parameters larger than 0.25 are highly unlikely (de Melo and Robinson, 1992). Although the latter condition is compatible with developing countries, especially those in Latin American, where capital represents a large share of total income, the condition follows from the assumption about how capital accumulation is financed in the model. Allowing for capital accumulation to be financed from the income from natural resource reduces the value of β and thus increases the likelihood of multiple-equilibriums.[28]

Figure 2 also shows that the two curves may not intersect. This would be the case when the market wage schedule (*w*) is above the long-term equilibrium wages (*w**). This outcome corresponds to very low values of *t*, and describes an economy with a natural resources sector with no or very small productive linkages,[29] and no indirect interaction between sectors *R* and *M*. In this hypothetical case of low productive linkages in sector *R*, income from the primary sector mostly finances con-

27. Long-term wages and capital stock in the manufacturing sector are positively related because through I capital stock enters twice in the numerator offsetting the negative effect arising from its presence in the denominator. Some tedious algebra makes it is possible to obtain the slope of the w curve in the log w, log K space, which equals* $(1-\beta)/\beta$.

28. Allowing for capital accumulation to be financed from natural resource rents makes the slope of the w curve equal to* $(1-2\beta)/\beta$. *In this case, the condition for multiple-equilibriums is equal to* $\beta >= 0.35$; *values that are also consistent with figures for the capital shares in developed countries.*

29. According to Ros (2000), no intersection is also possible in resource abundant countries with small labour forces. Because the analysis focuses on middle-income countries, the case is not discussed in the text.

sumption, leading to higher market wages due to the Dutch disease spending effect. In the context of a small sector *I* –explained in part by the lack of backward linkages in the resource sector– high market wages constrain the development of sector *M*. Hence

> *there is a unique stable equilibrium without a manufacturing sector where the economy specialises in the production of primary-commodities (Ros 2000: 232).*

Moreover, for low values of *t* all positive changes in sector *R* make productive and export diversification less likely. In Figure 2, this is the case when the market wage schedule w^I stays above w^{*I}.

Alternatively, for larger values of *t* it is more likely that the two curves will intersect. Although sector *R* pushes market wages upwards via the Dutch disease *resource effect*, a natural resource sector with productive linkages also pushes the long-term wage curve (w^*) upwards.[30] If the productive linkages in sector *R* are sufficiently large, they will offset the *resource effect* and the development of the manufacturing sector starts to become a possibility. The upward movement of the long-term wage curve is due not only to the direct effect associated with a larger *R* or ***t***, as can be determined from equation (2.10)). It is also due to the indirect (external) effect that the expansion of sector *R* has on the price of non-tradable inputs (p_i): intermediate inputs demand from sector *R* increases the size of the productive linkages (sector *I*). According to equation (2.5), this translates into lower input prices increasing the profitability of the manufacturing sector, which now may emerge. In Figure 2, this outcome of positive externalities between tradable sectors corresponds to a long-term curve w^{*II} intersecting twice with the market equilibrium schedule w^I.

The low intersection in Figure 2 shows the minimum conditions (capital stock) for a profitable manufacturing sector. Complementarities among the tradable sectors and productive linkages make this an unstable equilibrium. If $K_M<\underline{K}_M$, sectors *M* and *I* are small, implying high intermediate inputs costs, which make the manufacturing sector unprofitable, and the economy fails to diversify. If, on the other hand, $K_M>\underline{K}_M$ the capital stock will be large enough to reduce production costs in sector *I* and allow the manufacturing sector to break even, leading to a sustained expansion in the capital stock. In other words, as the economy enters the region of multiple equilibriums it is able subsequently to move to dynamic equilibrium –high intersection– characterized by high capital stock and wages, and competitive economic diversification.

The analytical discussion concludes by examining the relation between the minimum conditions for a profitable manufacturing sector and changes in the size of sector *R*, and the uses of natural resource income. In terms of Figure 2, this involves considering changes in the *w* and w^* curves. According to the model, changes in sector *R* engender opposite adjustments in the curves. On the one hand, a positive resource shock creates Dutch disease effects shifting the market wages curve upwards, increasing the minimum capital stock necessary for the emergence of a competitive manufacturing sector. Indeed, it is also possible that a large spending effect, as for instance implied by a large value of *(1-t)*, will move the economy to equilibrium without a manufacturing sector.[31] On the other, expansion of sector *R* shifts the w^* *curve* upwards, making diversification more likely; an outcome that may also be the result of increases in the size of the productive linkages in sector *R*, as captured by parameter *t*.

3. Concluding Remarks

This paper has presented a dependent economy model extended to consider the role of productive linkages. The so-called linkage dependent economy model suggests that: *resource abundant countries can overcome a development trap and that a positive resource shock can encourage productive and export diversification, modifying South America's pattern of trade specialization.*

This conclusion emerges from an analysis of the contribution of the natural resource sector to the expansion of productive linkages, which provide infrastructure and other specialized services that are es-

30. *The same will apply if government channels resource revenues to enlarge productive linkages, through public investment in infrastructure.*
31. *This occurs when the two curves no longer intersect and market wages (w) are above long-term wages (w*).*

sential to compete in modern manufacturing production. As discussed, if natural resource income mainly finances consumption, a positive resource shock will basically engender Dutch disease type adjustments, making diversification unlikely. On the contrary, if resource revenues directly or indirectly promote the expansion of productive linkages, a resource shock can bring the economy to the *good equilibrium* of successful structural change and export diversification.

The good equilibrium will thus depend on the characteristics of the natural resource sector and economic policies. Diversification may follow directly in countries with natural resource intensive industries with productive linkages, such as Australia, Canada, the USA and the Scandinavian countries. On the other hand, it may require particular policies to promote investment in technology and infrastructure in the natural resources sector, as suggested by Akiyama and Yabuki (1996), Barbier (2004) and Ramos (1998), or economy-wide investment. As noted by Palma (2000) in relation to Chile, avoiding Dutch disease effects and encouraging productive and export diversification may require that the natural resource sector is taxed and the revenue is spent on competitiveness-enhancing projects.

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