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Resource boom, productivity growth and real exchange rate dynamics — A dynamic general equilibrium analysis of South Africa

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Abstract

This paper studies the impact of a natural resource boom on structural change and real exchange rate dynamics, taking into account the indirect effect that operates through relative sectoral productivity changes. The paper's contribution to the Dutch disease literature is threefold. First, I extend the simple learning by doing productivity specification to include trade barriers and technology gap dynamics, consistent with the modern treatment of productivity growth. Second, I present a dynamic general equilibrium analysis that incorporates imperfect substitution between domestic and foreign goods. Third, I apply the model to South Africa and analyze the macroeconomic impact of increases in gold prices during the 1970s. Political pressure for rapid domestic spending following a surge in resource rents tends to generate myopic government behavior with immediate expansion of government consumption. The model specification captures this fiscal response to higher resource income. Numerical simulations show how the resource boom can help explain the paths of structural change and real exchange rates observed in South Africa. Because of productivity effects, gradual real depreciation follows an initial appreciation of the real exchange rate.
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1. Introduction

Existing Dutch disease analyses typically relate productivity improvements to learning by doing. Van Wijnbergen (1984) investigates the impact of a resource boom in a two-period model, and shows that productivity effects generate real depreciation following an initial appreciation of the real exchange rate. Torvik (2001) finds similar results in a more general setting. In this paper, I present a dynamic general equilibrium analysis of an increase in resource income. The paper's contribution to the literature is threefold. First, the productivity specification is consistent with modern

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treatments in which productivity growth is related to trade barriers and technology gap dynamics. Incorporating technology transfer as a source of productivity growth strengthens the productivity effect of a resource boom, and generates additional implications for real exchange rate dynamics and structural change. Second, imperfect substitution between domestic and foreign goods endogenizes the tradable price and affects the real exchange rate path. Third, I apply the model to South Africa and analyze the macroeconomic impact of the increases in gold prices during the 1970s.

Numerical simulations show how the resource boom in the 1970s contributes to the structural change and the real exchange rate path observed in South Africa in subsequent decades. Higher public consumption following the boom leads to real exchange rate appreciation and expansion of nontradables at the cost of the industrial sector. Relative industrial productivity growth declines and the change in relative productivity has feedback effects on the economic structure and real exchange rate dynamics. A gradual real depreciation follows the initial appreciation of the real exchange rate, which is broadly consistent with the South African experience following the gold price boom. The productivity effect also tends to hold back the deindustrialization process.

The rest of the paper is organized as follows: Section 2 reviews the literature; Section 3 describes the South African experience from 1963 to 2003; Section 4 presents a dynamic general equilibrium model that incorporates endogenous productivity dynamics; Section 5 investigates the impact of the 1970s resource boom on the real exchange rate and structural change in South Africa; Section 6 presents a sensitivity analysis with respect to the elasticity of substitution between domestic and foreign goods; and Section 7 concludes the paper.

2. The literature on resource booms, productivity and the real exchange rate

The impact of a resource boom on structural change and the real exchange rate depends on how the additional income is allocated over time. Matsen and Torvik (2005) discuss the optimal spending path and highlight the importance of adopting a fiscal rule to manage resource wealth. Røed Larsen (2005) shows that Norway has avoided the resource curse for 25 years because of effective institutions and the well-designed public management of resource wealth. However, Gelb (1988) explains that higher resource income generates political pressure to increase government spending, and may generate Dutch disease effects. Because this mechanism is relevant to South Africa (documented in Section 3), the dynamic general equilibrium model is specified to incorporate an expansion of government consumption financed by the resource income.

Froot and Rogoff (1995) and Rogoff (1996) survey the long-run determinants of the real exchange rate. Commodity prices, sectoral productivity differentials, government spending, interest rate differentials, and net foreign assets are typically found to affect the path of the real exchange rate. Chen and Rogoff (2003) and Cashin et al. (2004) identify a significant long-run relationship between commodity prices and the real exchange rate. MacDonald and Ricci (2002) find that relative sectoral productivity affects the real exchange rate both directly through tradable prices and indirectly through wages. According to MacDonald and Ricci (2003), the South African real exchange rate path is primarily driven by developments in commodity prices,[1] but is also affected by relative productivity, government spending, relative real interest rates and the degree of openness. Aron et al. (2000) obtain similar findings.

Economy-wide modeling of productivity growth in developing countries often starts with the catching-up advantage of backwardness known as the Veblen–Gerschenkron effect. Nelson and Phelps (1966) first formalized the mechanism, and Parente and Prescott (1994, 2005) offer a modern restatement by introducing the concept of barriers to technology adoption. Nelson and Phelps (1966) concentrate on human capital as a barrier, while Parente and Prescott (1994) incorporate investment barriers. Here, I focus on the broader role of international barriers, as investigated in the literature on productivity spillovers (e.g., Klenow and Rodriguez-Clare, 2005).

A broad empirical literature addresses the sources of productivity growth and documents the importance of international spillovers through trade. Coe et al. (1997) conclude that a developing country can boost its productivity by importing a larger variety of intermediate products and capital equipment that embody foreign knowledge. Several studies indicate the importance for productivity growth in South Africa of both openness and domestic factors. Jonsson and Subramanian (2001) advocate the productivity-enhancing effect of an open economy; Harding and Rattsø (2005) address the endogeneity problem of openness and document the importance of trade barriers to South African

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[1] Gold accounts for more than 60% of the South African commodity price.