Capital Intensity and Welfare: National and International Determinants

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Ministry of Economic Development
Occasional Paper 07/03

June 2007
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Date: June 2007

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Acknowledgements
This paper was prepared for the Ministry of Economic Development, New Zealand. I thank Richard Fabling for preparing the graphs and for his extremely helpful comments during the preparation of the paper. I also thank Roger Procter, Geoff Lewis and participants at a New Zealand Treasury seminar for their helpful comments.

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Abstract

Why do some countries and regions have higher capital intensity than others? This question is at the heart of economic development analysis since capital intensity, per capita incomes and welfare are closely linked. We develop a two sector general equilibrium model relevant to small open economies that import capital goods and produce export goods priced in world markets. This model is used to derive a taxonomy of factors that lead to differing capital intensities across countries. Aggregate capital intensity is a function of multi-factor productivity (MFP) in the traded goods sector (but not in the non-traded sector), the capital share parameter for each sector, the cost of capital and the terms of trade. Total output and consumer utility are affected by the same variables and also by MFP in the non-traded sector.

JEL Classification: E13, E22, O11

Keywords: capital intensity, per capita income, cross-country development
Executive Summary

We analyse why some countries and regions have higher capital intensity than others. This issue is at the heart of economic development analysis since capital intensity, per capita incomes and welfare are closely linked. It is a question that is highly relevant to understanding New Zealand’s economic development.

A number of recent studies have examined why New Zealand’s labour productivity growth has lagged behind that of neighbouring Australia, despite both countries having similar institutions and similar historical experiences. One proximate explanation for this difference is that capital intensity has increased markedly in Australia, both absolutely and relative to New Zealand; i.e. New Zealand is “capital shallow”. A related explanation is that wages are low compared with capital returns in New Zealand relative to the same ratio in Australia. However these are only partial explanations since capital intensity and wages are themselves endogenous, i.e. determined in response to exogenous (externally-set) variables. To understand the foundational determinants of capital intensity, it is important to explain capital stock outcomes as a function solely of variables that are exogenous to the relevant country or region.

To analyse these issues, we develop a two sector general equilibrium model relevant to small open economies that import capital goods and produce export goods priced in world markets. This model is used to derive a taxonomy of factors that lead to differing capital intensities across countries. The model includes the impacts of resource endowments, sectoral structure, the cost of capital (including country risk premia), relevant world prices, and factors affecting multi-factor productivity (implicitly including technology, entrepreneurship, managerial ability and regulation).

Our focus is on determining long run (equilibrium) determinants of the capital stock, output and sectoral structure. Model results indicate the importance of terms of trade changes for a country’s overall output, capital stock, consumption, utility, allocation of output to traded versus non-traded sectors, and its capital/output ratio. Low terms of trade leave a country relatively capital shallow and poor compared with a country with high terms of trade. Consequently, the amount of capital stock in a country will,
inter alia, reflect the value of its traded output relative to the cost of its traded inputs. If the world values its traded output highly, the country will deepen its capital and increase production; capital intensity and the capital/output ratio each rise in these circumstances.

We show that the terms of trade is just one of a set of determinants of capital intensity. A country will have low capital intensity (relative to other countries) if it has the following (holding other variables constant): low traded sector multi-factor productivity (MFP); a low capital share parameter (especially within the traded goods sector); a high risk premium; high capital goods prices; and/or low traded goods sector prices. Each of these situations results also in output, consumption and utility being low. A country with relatively high non-traded sector MFP will have the same capital intensity as another (otherwise alike) country but will have higher aggregate output, consumption and utility. Output, consumption and utility, however, do not increase as much following an increase in non-traded sector MFP as they do through an equivalent increase in traded sector MFP.

Our results can be used to interpret the factors underlying long run development outcomes across a range of countries. They provide explanations for observed country behaviour and can be used to diagnose specific factors underpinning, and constraining, a country’s development path.
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Capital Intensity and Welfare: National and International Determinants

1. Introduction

Why do some countries, and some regions within countries, have higher capital intensity than others?¹ This question is at the heart of economic development analysis since cross-country comparisons demonstrate that per capita incomes are closely related to capital intensity. Recent studies that have addressed this question analyse the roles of sectoral productivity and the price of capital (Hsieh and Klenow, 2003) and the value on international markets of domestically produced output (Caselli and Feyrer, 2005). We extend these analyses deriving some new, and in some cases counter-intuitive, findings despite adopting a conventional neoclassical structure.

Economic development analysis has traditionally questioned why some countries are poor (underdeveloped) and others are rich (developed). The same questions are relevant in comparing economic growth across developed countries. For instance, a number of recent studies have examined why New Zealand’s labour productivity growth has lagged behind that of neighbouring Australia, despite both countries having similar institutions and similar historical experiences.² One proximate

¹ We define capital intensity as the capital/labour ratio. In some treatments, capital intensity is defined as the capital/output ratio (for example, see the discussion of growth by Bradford DeLong at: www.j-bradford-deong.net/macro_online/gt_primer.pdf). We refer to this latter concept explicitly as the capital/output ratio.

² See Black et al (2003), Mawson et al (2003), Claus and Li (2003), McLellan (2004), Fox (2005), Hall and Scobie (2005). Black et al (2003) find that multi-factor productivity increased by a similar amount across the two countries over 1988-2002, but labour productivity rose by 40% in Australia compared with 30% in New Zealand. Output increased by almost 60% in Australia compared with an increase of
explanation for this difference is that capital intensity has increased markedly in Australia, both absolutely and relative to New Zealand; i.e. New Zealand is “capital shallow”. A related explanation is that wages are low compared with capital returns in New Zealand relative to the same ratio in Australia. However these are only partial explanations since capital intensity and wages are themselves endogenous. To understand the foundational determinants of capital intensity, it is important to explain capital stock outcomes as a function solely of variables that are exogenous to the relevant country or region.

In this paper, we extend the analyses of Hsieh and Klenow and of Caselli and Feyrer to derive a general equilibrium taxonomy of factors that may lead to differing capital intensities and differing output/labour ratios across countries. Our analytical framework is designed to provide insights that are relevant to small open economies that import capital goods and produce export goods priced in world markets. This situation is typically faced by many developing countries, and by some small developed countries. The model includes the impacts of endowments, sectoral structure, the cost of capital (including country risk premia), the relevant vector of world prices, and factors affecting multi-factor productivity (implicitly including technology, entrepreneurship, managerial ability and regulation).

The issues that we analyse relate to long-term outcomes. Our focus is on determining long run (equilibrium) determinants of the capital stock, output and sectoral structure. Neoclassical growth models\(^3\) typically leave the optimal capital stock determined implicitly by equating the marginal product of capital to the cost of capital; but they do not make explicit the underlying determinants of capital intensity. Further, they are generally specified as closed economy one-sector models, as in the original Solow-Swan formulations. Barro and Sala-i-Martin (1999) include an open economy one-sector specification, but again do not make explicit the determinants of capital intensity. The single sector specification means that the model is unable to account for the importance of sectoral productivity and relative price impacts discussed by Hsieh and Klenow and by Caselli and Feyrer. Nevertheless, their open

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almost 40% in New Zealand, a key difference being the impact of the respective increases in the capital stock. The latter increased by 75% in Australia and by 30% in New Zealand; capital intensity increased by 55% in Australia compared with 22% (on a comparable industry basis) in New Zealand. \(^3\) For example, see expositions in Barro and Sala-i-Martin (1999) and Aghion and Howitt (1998).
economy extension makes explicit one important point that is frequently overlooked: the domestic capital stock is not dependent on domestic savings since, with open capital markets, foreign agents can invest in the domestic economy. Domestic savings propensities instead determine the amount of (domestic and overseas) capital owned by the domestic population.

A related neoclassical literature addresses short run investment determinants (see section 2.1). However, this literature is not well placed to explain long run determinants of a country’s aggregate capital stock. Capital investment models often include output as a determinant of capital, but output itself is co-determined with the capital stock; a useful model has to explain the capital stock independent of the level of output. Ultimately, we require a model that determines capital stock and output as a function of variables that are exogenous to the domestic economy. That is a principal task of this paper.

The resulting model is a two-sector specification with traded and non-traded domestic output produced under neoclassical conditions; additionally, the capital good is imported. We find that aggregate capital intensity is a function of multi-factor productivity (MFP) in the traded goods sector (but not in the non-traded sector), the capital share parameter in the production function for each sector, the cost of capital to the country (including any country risk premium), and the terms of trade (price of domestically produced tradable goods to the price of imported capital goods). Total output and consumer utility are affected by the same variables and by MFP in the non-traded sector.

We subject the model to a range of permanent shocks and examine the change in capital intensity in response to these shocks. Perhaps counter-intuitively, identical shocks to traded and non-traded sectors can have different effects on capital intensity. Identical shocks to different sectors also have different impacts on overall welfare despite the model being symmetric across sectors. The model is entirely neoclassical, but the results have certain mercantilist features. In particular, wages are a function solely of (exogenous) tradable goods prices and of parameters of the tradables production function. Further, domestic welfare increases more through an
incremental increase in traded sector MFP than through an identical incremental increase in non-traded sector MFP.

Prior to specifying the model, we discuss other studies relevant to these issues (section 2) including models of capital investment, and studies that model a country’s overall level of development, including its capital stock. None of these studies, however, explains the overall capital stock (and output) as a function of the range of variables required to address the circumstances faced by many small open economies.

In section 3, we specify a theoretical model that underpins subsequent analysis. The model incorporates a range of features relevant to small open economies. We subject this model to eight experiments, corresponding to changes in non-traded sector MFP, traded sector MFP, the capital share parameter of the non-traded sector, the capital share parameter of the traded sector, a change in the country risk premium, a change in the world price of traded (exportable) goods, a change in the world price of capital goods and a change in consumer preferences between traded and non-traded goods. Section 4 discusses the results. It demonstrates how the results of the experiments may be used to distinguish between competing hypotheses explaining capital intensities across countries.

2 Prior Studies

2.1 Investment Determinants

Numerous studies and surveys of investment determinants have been published (e.g. Rossana, 1990; Chirinko, 1993; Hamermesh and Pfann, 1996; Hubbard, 1998; Tevlin and Whelan, 2003; Roberts, 2003). Generally, these treatments derive a formulation whereby the level and/or changes in the capital stock are a function of the level and/or changes in output (both at the firm and aggregate level). A major focus of this literature is on the nature of adjustment of the capital stock to changes in the economic environment (e.g. Roberts, 2003; Tevlin and Whelan, 2003; Hamermesh and Pfann, 1996). However, the capital stock and output are not generally solved jointly as a function of exogenous variables facing the firm or the economy as a whole. For instance, capital is often expressed a function of output. Alternatively (e.g.
Rossana, 1990) the demand for capital is solved as a function of relative prices (e.g. wages, capital costs, raw materials) but these relative prices are treated as exogenous (which may be applicable for the firm, but not for an aggregate economy). Another alternative is to model investment as a function of Tobin’s “q” (e.g. Hubbard, 1998) but this leaves the capital stock as a function of the share price (and cost of new investment goods) which again fails to solve out capital as a function of exogenous variables.

In discussing the standard neoclassical specification of the demand for capital, that relates capital stock to output and the real cost of capital, Chirinko (1993) notes that output is itself a function of capital but, under constant returns to scale, the optimal capital stock is not well defined. This reasoning may underlie why the capital stock is not normally solved out as a function of exogenous variables in microeconomic contexts. However there is no need to retain output as a separate explanatory variable for capital within an aggregate context; exogenously determined labour supply enables derivation of a solution for the optimal capital stock as a function solely of variables exogenous to the domestic economy.

2.2 Capital Stock and Development

Hsieh and Klenow (HK, 2003) note that one of the strongest relationships in the empirical growth literature is the positive correlation between the investment rate in physical capital and the level of output per worker. Differences in physical capital intensity play an important role in accounting for why some countries are rich and others are poor. Standard explanations for capital intensity differences relate to savings rate differences and capital tax differences. Another explanation is that poor countries have policies and institutions that drive up the cost of capital (e.g. tariffs on capital goods). This view is consistent with empirical data showing that the relative price of capital is typically two to three times higher in a poor country than in a rich country. These types of price effects cannot be examined within one-sector macroeconomic growth models.

The standard relationships between investment rates and income per head relate to PPP-adjusted variables. When evaluated at domestic prices, HK find there is virtually no relationship between investment rates and incomes per head. They find that
investment goods are no more expensive in poor countries than in rich countries, whereas consumption prices tend to be lower in poor countries. HK interpret this finding to mean that poor countries have low investment rates in PPP terms primarily because their investment sectors have low productivity compared to their (non-traded) consumption sectors. Thus HK see the key challenge in explaining poor countries’ low capital intensity as explaining low productivity in investment goods production relative to consumption goods production. More generally, they see the issue as low productivity in tradables relative to nontradables sectors.

Caselli and Feyrer (CF, 2005) take the issues raised by HK further. They calculate the marginal product of capital (MPK) across a large sample of countries and assume an equilibrium relationship in which there are no adjustment costs to the stock of capital. Thus \( MPK = aY/K \) where \( a \) is the capital share in GDP, \( Y \) is aggregate output, and \( K \) is aggregate capital stock. CF find substantial differences in MPK between rich and poor countries which they attribute in large part to differences in the ratio of output prices to capital goods prices (\( p_y/p_k \)). Poor countries tend to have high MPKs while rich countries have low MPKs. These differences may arise due to tax effects; alternatively, poor countries may have relatively low MFP in producing capital goods relative to producing final goods.\(^4\) Relative price differences may also reflect differences in the composition of output or in unmeasured quality.

CF recognise that where \( p_y/p_k \) differs across countries, it is MPK.\( p_y/p_k \) (which they label PMPK) that should be equalised across countries. Assuming Cobb-Douglas technology, CF calculate what the capital stock in each country would be if MPKs were equalised. They also calculate PMPK and find that differences in \( p_y/p_k \) explain a sizeable proportion of the variation in MPK across countries: “One way to put this is to say that the main reason for capital’s failure to flow to poor countries is that what it produces there is of little value, compared to the cost of installation” (CF, p.19).

CF examine two theoretical specifications that might result in \( p_y/p_k \) varying across countries. The first is a model of “Complete Country Specialization”. Each country \( i \) specialises in producing a tradable consumption good with dollar price \( P_i^y \). There is a

\(^4\) However, CF do not analyse why poor countries don’t just import the capital goods.
unique tradable investment good with price \( P_k \).\(^5\) If investors worldwide can borrow and lend dollars at the common rate \( R^* \), and if depreciation is denoted by \( d \), then:

\[
P_{iy}/P_k = \frac{[R^* - (1-d)]}{MPK^i}
\]

The relative price ratio \( P_{iy}/P_k \) will differ across countries inversely to differences in \( MPK^i \) across countries. CF specify a “More General Model” by assuming that each country produces an identical tradable consumption good (with dollar price \( P_T \)) and a non-tradable consumption good or, equivalently, a country-specific consumption good (with dollar price \( P'_{NT} \)). In this specification, however, CF assume that labour is sector specific and in each sector there is a given fraction of the labour force. One can then solve the model for the proportion of total capital allocated to each sector as a function of the sector specific complementary factors, prices and proportion of labour in each sector. The usefulness of this approach, however, is limited by the need to assume that a constant fraction of the labour force is assigned to each sector. This assumption is unrealistic when an economy has changing structure, particularly when the changed structure is an endogenous reaction to changes in exogenous variables. The model in the next section does not suffer from this constraining assumption; it also generalises the approach to consider a number of other determinants of capital intensity including those considered by HK.

3 The Model

Following the insights of Caselli and Feyrer (2005) and Hsieh and Klenow (2003), we develop a small computational model relevant to small open economies. The following features are considered relevant: capital goods (K) are imported; production is split between non-traded goods (YN) and (exportable) traded goods (YT); capital goods prices (PK) are set in world markets; exportables prices (PT) are set in world markets; PT may differ from PK, so allowing a terms of trade change;\(^6\) non-traded goods prices (PN) endogenously adjust to clear the goods markets; wages (W) adjust to clear the labour market; depreciation rates (d) are set exogenously; real interest

\(^5\) CF refer to evidence suggesting that \( P_k \) does not vary substantially across countries; hence \( P_{iy} \) must vary for \( p_{iy}/p_k \) to vary. Eaton & Kortum (2001) demonstrate that most of the world’s equipment stock is imported from only a few countries.

\(^6\) PT and PK are exogenous to the domestic economy in contrast to the price of non-traded output (PN) and wages (W) which are determined endogenously. In the absence of terms of trade shifts, the traded goods and capital goods prices can be considered the numeraire in the system.
rates \( (r) \) are set internationally and incorporate an exogenously set country risk premium.

We do not include a government sector in the model. Given the exogeneity of \( d, r \) and \( P_K \), and the exclusion of taxes, the user cost of capital is therefore set exogenously. Our model is neoclassical, with no treatment of spillovers or other ‘endogenous growth’ elements. In part this reflects the observation that the underlying neoclassical determinants of productivity and capital intensity remain important whether or not endogenous growth elements are incorporated into the model. Thus we concentrate on the former while remaining agnostic about the importance of the latter.\(^7\)

Since our interest is in explaining long term developments, we examine only equilibrium outcomes. Comparative static outcomes following changes in crucial parameters indicate the sensitivity of long term outcomes to changes in exogenous fundamentals; they also indicate the direction of dynamic adjustments that must occur between different equilibria.

We begin with a two sector model of domestic production. Output of non-traded goods \( (Y_N) \) is a constant returns to scale Cobb-Douglas function of capital used in the non-traded sector \( (K_N) \) and labour employed in the non-traded sector \( (L_N) \); \( A_N \) determines productivity; the capital share is given by \( \alpha \). Similarly, output of traded goods \( (Y_T) \) is a constant returns to scale Cobb-Douglas function of capital used in the traded sector \( (K_T) \) and labour employed in the traded sector \( (L_T) \); \( A_T \) determines productivity; the capital share is given by \( \beta \).\(^8\)

\[
Y_N = A_N.K_N^\alpha.L_N^{1-\alpha} \\
Y_T = A_T.K_T^\beta.L_T^{1-\beta}
\]

\(^7\) See Stiroh (2000) on the relative importance of “neoclassical” versus “endogenous growth” factors as determinants of improvements in labour productivity.

\(^8\) Qualitatively similar results would be yielded by a more general production function (e.g. constant elasticity of substitution); since we are interested here in direction rather than precise magnitude of effects, we use the simpler Cobb-Douglas specification.
Labour is fully employed, with the total labour force exogenously given by \( L \) (i.e. total labour supply is perfectly inelastic):

\[
L_N + L_T = L \quad (3)
\]

The wage cost of a unit of labour is \( W \). The rental price of capital (\( R \)) is a function of the price of capital goods, the real interest rate and the depreciation rate (all exogenous variables):

\[
R = (r+d)P_K \quad (4)
\]

Firms in each of the non-traded and traded goods sectors choose their quantities of labour and capital to maximise profits, taking \( R, W, P_N, P_T, A_N, A_T, \alpha \) and \( \beta \) as given. This yields the standard equations for factor demands:

\[
L_N = (1-\alpha)Y_N.P_N/W \quad (5)
\]

\[
K_N = \alpha Y_N.P_N/R \quad (6)
\]

\[
L_T = (1-\beta)Y_T.P_T/W \quad (7)
\]

\[
K_T = \beta Y_T.P_T/R \quad (8)
\]

Substituting (7) and (8) into (2) determines the wage rate as a function of exogenous variables:

\[
W = (1-\beta)(A_T.\beta^\beta.P_T.R^{-\beta})^{1/(1-\beta)} \quad (9)
\]

From (9), wages are a function of exogenous prices (\( P_T, P_K, r \)), the depreciation rate (\( d \)) and production parameters. Notably, the production parameters (\( A_T, \beta \)) relate solely to the tradables production function. Thus wages relative to external prices are unaffected by production conditions in the non-traded sector. As derived below, however, real consumption wages are affected by non-traded production function parameters. Substituting (5) and (6) into (2) yields (10) which can be rearranged to give an expression for \( P_N \) as a function of exogenous variables plus \( W \) (which, in turn is a function of exogenous variables) as in (11):
\[ W = (1-\alpha)(A_N,\alpha^\alpha.P_N,R^{-\alpha^\alpha})^{1/(1-\alpha)} \]  \hspace{1cm} (10) \\
\[ P_N = \alpha^{\alpha}(1-\alpha)^{\alpha-1}A_N^{-1}.W^{1-\alpha}R^\alpha \]  \hspace{1cm} (11)

All prices in the system have now been determined.

Substituting (6) into (1), and (8) into (2) determines the output/labour ratios in the non-traded and traded goods sectors respectively:

\[ \frac{Y_N}{L_N} = \left\{A_N(\alpha.P_N/R)\right\}^{1/(1-\alpha)} \]  \hspace{1cm} (12) \\
\[ \frac{Y_T}{L_T} = \left\{A_T(\beta.P_T/R)\right\}^{\beta/(1-\beta)} \]  \hspace{1cm} (13)

Having determined prices, output/labour ratios and total use of labour, we determine the split of production (and/or labour) between the traded and non-traded goods sectors. Caselli and Feyrer (2005) do so by assuming that labour is sector specific, so that each of \( L_N/L \) and \( L_T/L \) is set exogenously. This is an extreme assumption. An alternative method is to determine the relative shares from the consumption side. By definition, the only agents who demand the non-traded good are those who live in the domestic economy. Once we determine \( Y_N \) (as a function of prices and incomes), we determine \( L_N \) and thence \( L_T, Y_T, K_N \) and \( K_T \).

Assume that domestic agents’ utility (\( U \)) is given by a constant elasticity of substitution utility function defined over consumption of the non-traded good (\( C_N \)) and consumption of the traded good (\( C_T \)): \hspace{1cm} (14)

\[ U = \left\{\gamma C_N^{-\varphi} + (1-\gamma)C_T^{-\varphi}\right\}^{-1/\varphi} \]

Maximising utility subject to income (given the constant labour supply assumption) yields the relationship between consumption of the two goods:

---

\(^9\) The capital good is not part of the consumption basket. If \( \varphi=0 \), the utility function is Cobb-Douglas. The utility function is specified in static terms since we are investigating a stationary outcome. The model results in savings equaling depreciation (i.e. gross investment); total consumption (of traded and non-traded goods) equals net income.
Provided no output is wasted:

\[ CN = Y_N \quad (16) \]

Total consumption equals total income accruing to residents (I):

\[ P_N.C_N + P_T.C_T = I \quad (17) \]

Total income (I) is given by wage income (which all accrues domestically) plus net returns to domestically-owned capital, defined as D. Since this is a stationary model, D is treated as constant (i.e. held at the inherited equilibrium level). Consistent with the open economy model of Barro and Sala-i-Martin (1999), if D < K_N + K_T, some domestic capital is owned offshore; if D > K_N + K_T, domestic agents own some capital offshore. For simplicity, our application of the model assumes that domestic wealth equals domestic capital stock, but this assumption is inconsequential as shown in the experiments that follow.

Net return to capital accruing to domestic residents equals the real interest rate multiplied by the domestically-owned capital stock (thus depreciation is reinvested and not consumed). Hence:

\[ I = W.L + r.P_K.D \quad (18) \]

Combining (15)-(18) yields an expression for \( Y_N \) in terms of known variables:

\[ Y_N = \frac{I}{P_T}.g^\delta.(P_T/P_N)^\delta \{1+g^\delta.(P_T/P_N)^\delta-1\}^{-1} \quad (19) \]

where \( g = \left[ \frac{\gamma}{1-\gamma} \right] \) and \( \delta = \frac{1+\phi}{(1+\phi)} \).
With $Y_N$ given by (19), we obtain $L_N$ from (12), thence $L_T$ from (3) and $Y_T$ from (13). $K_N$ and $K_T$ are given respectively by (6) and (8). Thus all variables are determined.

To operationalise the model, we assume the following base case parameters:

- **Productivity:** $A_N = A_T = 1$
- **Prices:** $P_K = P_T = 1$
- **Capital share:** $\alpha = \beta = 0.33$
- **Real interest rate:** $r = 0.07$
- **Depreciation rate:** $d = 0.06$
- **Labour force:** $L = 1$
- **Consumption:** $\gamma = 0.5; \varphi = 0$
- **Domestic capital:** $D = 4.0164$

The base case is symmetric in that the traded and non-traded production functions are identical, prices of traded, non-traded and capital goods are identical, consumption of non-traded goods equals consumption of traded goods. Production of traded goods equals production of non-traded goods plus depreciation (since replacement capital goods must be imported). Over half the labour force and capital stock (57.6% in each case) is therefore employed in the traded goods sector.

Having established the base case, we vary exogenous parameters and establish the impacts of each experiment on a range of variables including: output (non-traded, traded, total); capital stock (non-traded, traded, total$^{13}$); capital/output ratio (non-traded, traded, total$^{13}$); labour (non-traded, traded); consumption (non-traded, traded, total); prices (price of non-traded goods, wages, real exchange rate$^{14}$); and utility. The last of these variables is the appropriate measure of welfare in the model.

The chosen experiments reflect issues that have been mooted as being relevant to explaining countries’ capital intensity. They include: underlying productivity (in non-

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$^{10}$ I.e. a Cobb-Douglas specification with equal consumption shares.
$^{11}$ The value of domestically-owned capital (domestic wealth) is set equal to the sum of traded sector plus non-traded sector capital in the base case solution.
$^{12}$ $P_N = 1$ in the base-case solution.
$^{13}$ Since $L$ is held constant at 1, the total capital stock is identical to overall capital intensity.
$^{14}$ The real exchange rate is defined as the price of non-traded to traded goods.
traded and traded sectors;\textsuperscript{15} sector structure (specialisation in sectors with inherently low or high capital shares);\textsuperscript{16} cost of capital ($r$);\textsuperscript{17} and terms of trade ($P_T/P_K$).\textsuperscript{18} Another experiment relates to a shift in consumption preferences between traded and non-traded goods to test the impacts of this factor on capital intensity, the real exchange rate and other variables.\textsuperscript{19}

We change each of eight parameters (individually) by 1% and examine the effects on the selected outcome variables.\textsuperscript{20} The fact that the base case is symmetric in parameters and in consumption outcomes across sectors allows us easily to compare effects of an increase in parameters applying to the non-traded sector relative to parameters applying to the traded goods sector. Despite the symmetry, the effects of parameter variations across the two sectors are quite different from one another. Tracing through the reasons for these differences is helpful in formulating hypotheses relating to certain countries’ economic outcomes, including capital intensity outcomes.

Table 1 summarises the impacts of each of the eight experiments under the assumption that utility is Cobb-Douglas ($\phi = 0$). With this assumption, the share of nominal consumption across traded and non-traded goods is constant for marginal changes. Table 2 assumes that utility is CES with $\phi = 10$. Under this assumption, an increase in $P_N/P_T$ results in an increase in the share spent on non-traded goods.

**Experiments 1 & 2: Non-Traded Sector Productivity Increase ($A_N \uparrow 1\%$) and Traded Sector Productivity Increase ($A_T \uparrow 1\%$)**

Columns 1 and 2 of Tables 1 and 2 summarise the effects of increasing non-traded sector multi-factor productivity ($A_N$) and traded sector multi-factor productivity ($A_T$) by 1% respectively. In each case, the productivity increase raises overall utility; however

\textsuperscript{15} Factors may include skills, management capability, distance from major sources of knowledge, terrain, infrastructure, significant minerals, etc.

\textsuperscript{16} For instance, tourism services (low) or mining (high).

\textsuperscript{17} Countries may be charged a premium on their cost of capital owing to high country debt levels (Orr et al, 1995; Lane and Milesi-Ferretti, 2002; Plantier, 2003).

\textsuperscript{18} Prebisch (1950), Singer (1950).

\textsuperscript{19} This experiment reflects the experience of small open economies with floating exchange rates (such as New Zealand) in which cyclical changes in traded versus non-traded consumption are associated with real exchange rate changes. Here we test whether shifts in consumption preferences have permanent real exchange rate (and capital intensity) effects.

\textsuperscript{20} The risk premium experiment involves a one percentage point change in $r$. 
utility increases more following an increase in traded sector than in non-traded sector productivity (under each of the alternative utility assumptions\(^{21}\)). In each example, the rise in \(A_N\) and \(A_T\) raises domestic production and incomes (and hence total consumption and utility). Foreign prices (\(P_T\) and \(P_K\)) remain unaffected by the productivity changes. Thus we are assuming that the rise in \(A_T\) (and also \(A_N\)) affects domestic producers only and is not shared by world producers. An example might be a domestic minerals discovery.

A rise in \(A_N\) raises production of non-traded goods, so a fall in \(P_N\) relative to \(P_T\) is required in order for \(C_N\) to rise in tandem with \(Y_N\). In the Cobb-Douglas case, the rise in \(C_N\) (and \(Y_N\)) is offset by a commensurate fall in \(P_N\). Since \(C_N, P_N\) is unchanged, \(C_T, P_T\) must also be unchanged; \(C_T\) is therefore unchanged. No labour or capital needs to be reallocated in this case, so capital, labour and output in the traded sector remain unchanged. Labour in the non-traded sector therefore remains unchanged. The effect of the 1% fall in \(P_N\) on non-traded goods sector profitability exactly outweighs the positive profitability effect of the productivity increase; thus \(K_N\) also remains unchanged. Total consumption rises by 0.5% (equal to the 1% rise in non-traded goods consumption plus 0% rise in traded goods consumption) while gross output rises by the lesser amount of 0.42% (since there is no increase in output matching the depreciation portion of gross production).

In the CES (\(\phi=10\)) case, the change in relative prices induces consumers to spread their real income gains over consumption of both goods. Total consumption and total output rise by the same amounts as with \(\phi=0\) but \(C_T\) and \(Y_T\) now increase and a smaller rise occurs in \(Y_N\) (\(C_N\)). There is some reallocation of labour and capital to the traded goods sector away from the non-traded goods sector.

Irrespective of the utility function, production conditions in the traded goods sector are unaffected by the rise in \(A_N\), so capital intensity remains unchanged in the traded sector. However the rise in productivity in the non-traded sector results in non-traded output rising with no change in the non-traded sector capital stock. The non-traded sector and aggregate capital/output ratios therefore fall, while sectoral and aggregate

\(^{21}\) The result is robust to \(\phi\) being anywhere in the admissible range; i.e. \(\phi \in (-1, \infty)\).
capital intensities remain unchanged. The fall in the capital/output ratio is an optimal result of increased non-traded sector productivity and is accompanied by a rise in output, consumption and utility.

A rise in traded sector multi-factor productivity has more complex effects than does the rise in \( A_N \). Since traded goods prices are unaffected by the rise in \( A_T \), the profitability of traded goods production rises, so more capital is demanded in that sector. More labour is also demanded, raising wages and thence \( P_N \). Higher incomes are spread across consumption of non-traded and traded goods (under each utility function) so non-traded goods production and capital also rise. Capital intensity rises in each sector. The overall effect is a rise in the economy’s capital stock and hence in aggregate capital intensity.\(^{22}\) Non-traded goods consumption and output rise more strongly in the \( \phi = 10 \) than the \( \phi = 0 \) case, so a small reallocation of labour to non-traded goods production occurs in the former case; in the Cobb-Douglas case, a reallocation of labour to the traded sector occurs.

In both the \( \phi = 10 \) and the \( \phi = 0 \) cases, overall consumption rises as a result of the traded sector productivity increase. Gross output rises by more than consumption since the capital stock, and hence depreciation, increases. The additional increment to gross output is required to replace the depreciated capital. Gross output, consumption, and utility each rise by more in response to a 1% traded goods productivity increase than to a 1% non-traded goods productivity increase. Capital intensity rises in the face of an \( A_T \) shock and remains unchanged in face of an \( A_N \) shock, despite the built-in symmetry of the model and the symmetrical nature of the changes to the base case.

A key contributor to the differing results is the limited demand for non-traded goods. Traded goods face a flat demand curve: domestic producers can sell as much production as they wish without moving the price against them. By contrast, producers of non-traded goods face a downward sloping demand curve, so extra production moves the price against themselves. In the case of a 1% \( A_N \) increase, \( P_N \)

\(^{22}\) Domestic ownership of capital is held constant by the inherited level of wealth in each of the \( A_N \) and \( A_T \) experiments. Thus the additional capital stock in the \( A_T \) experiment is owned offshore. The returns to that capital accrue to the offshore owners rather than flowing through to domestic income.
falls by approximately 1%, both absolutely and relative to $P_T$. In the case of a 1% $A_T$ increase, $P_N$ rises as pressure on labour resources increases.

If $A_N$ and $A_T$ both rise by the same percentage, capital intensity rises in each sector (and hence in aggregate) whereas the capital/output ratio in each sector (and in aggregate) remains unchanged.\(^{23}\) Gross output, capital, consumption and utility all rise. Traded output rises by more than non-traded output given the need to generate extra traded product to meet the increased demand both for domestic traded goods consumption and replacement capital.

Figure 1 graphs iso-utility curves in $A_N, A_T$ space. The curve passing through $A_N=A_T=1$ is the base case curve. The iso-utility curves represent 5 percentage point increases in utility. Comparing the base case curve with the next curve (downwards and to the right), a 5% increase in utility can be gained either by an approximate 7% increase in $A_T$ (with $A_N$ unchanged) or by an approximate 10% change in $A_N$ (with $A_T$ unchanged).

At the margin, therefore, productivity improvement in the traded goods sector has superior utility (and other) outcomes to an equal productivity increase in the non-traded goods sector, despite the symmetry built into the base case of the model. Put simply, it is preferable to have improved productivity in a sector facing a flat demand curve than one facing a downward sloping demand curve.

This finding has an implication for a number of economic policies. For instance, consider the case where government has scarce research resources which can be used for a limited number of projects, each with an equal potential probability of raising productivity to the same degree. According to this model, in allocating the resources government should give greater weight towards research that can raise productivity in the traded goods sector or, more generally, towards industries with flatter demand curves. This is the case even if there were a marginally greater likelihood of the research increasing non-traded goods productivity than traded goods productivity. This result is similar to a mercantilist argument, favouring traded goods

\(^{23}\) The results of joint experiments are not presented separately in the tables.
production over non-traded goods production. These “non-neoclassical” sentiments nevertheless arise out of a neoclassical (two sector) model.

Experiments 3 & 4: Non-Traded Capital Share Increase ($\alpha \uparrow 1\%$) and Traded Capital Share Increase ($\beta \uparrow 1\%$)

Columns 3 and 4 of Tables 1 and 2 summarise the effects of increasing the capital share in each industry by 1% (i.e. from 0.33 to 0.3333). This can be considered as an exogenous change, caused by a change in optimal production technologies for the relevant industries.

In each case, the increased capital share results in higher aggregate capital intensity and a higher capital/output ratio. Output, consumption and utility all rise. Each of output, capital, the capital/output ratio, consumption and utility rise more in response to a 1% increase in $\beta$ (traded sector) than a 1% increase in $\alpha$ (non-traded sector). The reason for this differential impact again lies with the price behaviour stemming from different demand curves. An increase in the capital share of the non-traded sector ($\alpha$) induces a rise in the capital stock and output in the non-traded sector, but this forces $P_N$ downwards (under both utility assumptions). The reduction in $P_N$ causes labour resources to shift to the traded sector, which encourages extra capital in the traded sector so as to keep the capital/output ratio constant in that sector.

An increase in the capital share of the traded sector ($\beta$) induces a rise in the capital stock and output in the traded sector, but has no effect on $P_T$ which is set in world markets. Labour flows into the traded goods sector, lifting wages, so limiting the inflow of labour to the sector. The rise in wages leads to increased demand for non-traded goods inducing a rise in $P_N$, with the result that non-traded capital and output also rise.

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24 One could consider this experiment a special case since the rise in the traded goods capital share may be accompanied by a change in the traded goods price if the effect were shared globally. However there is no level of $P_T$ that re-establishes the original equilibrium. A 1.7% fall in $P_T$ that accompanies the 1% rise in $\beta$ leaves utility and consumption unchanged, output fractionally lower and capital approximately 1% lower than baseline. Similarly there is no combination of $P_T$ and $P_X$ change accompanying the rise in $\beta$ that re-establishes the original equilibrium.
Figure 2 graphs iso-utility curves in $\alpha$, $\beta$ space. The curve passing through $\alpha=\beta=0.33$ is the base case curve. The iso-utility curves represent 5 percentage point increases in utility. Comparing the base case curve with the next curve (downwards and to the right), a 5% increase in utility can be gained either by an approximate 0.045 (13.6%) increase in $\beta$ (with $\alpha$ unchanged) or by an approximate 0.065 (19.7%) change in $\alpha$ (with $\beta$ unchanged). To the extent that one could engineer a change in the capital share of one sector or another, utility would be increased more by having a capital-intensive traded goods sector than by having a capital-intensive non-traded goods sector. Countries with capital-extensive traded sectors (e.g. countries that specialise in tourist services) might therefore be expected to have lower capital intensity (ceteris paribus) than countries with capital-intensive traded goods sectors (e.g. countries that specialise in mining).

**Experiment 5: Risk Premium Increase ($r \uparrow 1\%$)**

Columns 5 and 6 of Tables 1 and 2 summarise the effects of an increase in the country risk premium, reflected in a 1 percentage point rise in $r$ (from 0.07 to 0.08). The results quantitatively (but not qualitatively) depend on whether we assume that domestic agents own the domestic capital or own foreign capital, since the risk premium change means that returns differ across countries. In the former case, there is much less of an income loss to domestic agents arising from the increase in $r$ than in the latter case. Column 5 adopts the assumption that domestic agents receive this return when investing domestically but receive the world return (0.07) when investing internationally. Column 6 adopts the assumption that domestic agents own foreign capital only (with domestic capital being owned offshore) and so receive the world return on all their wealth.

In each case, the direct effect of the rise in $r$ is a reduction in the capital stock (and hence capital intensity) in each sector. The cost of capital rises by 7.69% (recalling that the depreciation rate and the price of capital goods are held constant) so the capital/output ratio in each sector falls by a similar amount (given the Cobb-Douglas production assumption). With lower capital stock, labour demand falls, so wages fall (by 3.58% in each case) to re-establish labour market equilibrium.

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$^{25}$ The percentage fall in the capital/output ratio exactly matches the percentage rise in the cost of capital for small changes in $r$. 

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When domestic capital is owned onshore, there is very little net income loss to domestic residents with the higher risk premium. Wages decline, but there is less depreciation owing to the reduced capital stock. The reduction in depreciation means that traded goods production (which is required, in part, to fund depreciation) falls relative to non-traded goods production. The latter is maintained at close to its base case level as a result of the offsetting forces noted above.

When domestic capital is entirely owned abroad, there is a much more substantial income loss arising from the increased risk premium. The same mechanisms are at work as discussed above, but the levels of $C_N$ and $C_T$ now each fall by 2.83% rather than by 0.15% when domestic capital is owned domestically. The reason is that foreign owners of capital obtain a greater proportion of the returns generated domestically than in the former case.

**Experiments 6 & 7: Capital Goods Price Increase ($P_K \uparrow 1\%$) and Traded Goods Price Increase ($P_T \uparrow 1\%$)**

Columns 7 and 8 of Tables 1 and 2 summarise the effects of increasing the price of capital goods and the price of traded goods by 1% respectively. In real terms, the effects of these two experiments are virtually mirror images of each other. Each involves a terms of trade decline for the domestic economy, one driven from the import side and one from the export side. An increase of 1% in both $P_K$ and $P_T$ (a zero terms of trade change) leaves all real variables unchanged with a 1% rise in all domestic nominal variables (consistent with treating traded goods prices as numeraires within the system). For that reason, the combined increase is not discussed further.

A 1% increase in $P_K$ increases the cost of capital, so reducing the capital stock in both sectors. The reduced capital stock lowers depreciation and hence traded output decreases by more than non-traded output. Consumption of each of non-traded goods and traded goods declines by the same amount as the decline in non-traded

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26 Thus net domestic product (NDP) does not fall as heavily as gross domestic product (GDP). This raises the observation that measuring cross-country welfare by comparing per capita GDP biases the results against “capital shallow” countries; the more relevant comparison is to use per capita NDP.
output (0.18%) under each utility function. The capital/output ratio decreases by virtually 1% in response to the 1% increase in $P_K$ given the Cobb-Douglas production function. The aggregate capital stock (i.e. aggregate capital intensity) falls by approximately 1.5% with an accompanying approximate 0.5% decline in total gross output.

A 1% increase in $P_T$ increases the profitability of traded goods production, raising capital in that sector. The rise in capital stock induces a switch of labour from the non-traded to traded sector and an increase in wages. Higher incomes result in consumers spreading consumption over both non-traded and traded goods, resulting in a slight rise in non-traded output following a 1% rise in $P_N$. This increased output is achieved through an increase in non-traded sector capital stock. Mirroring the $P_K$ experiment, the capital/output ratio rises by 1% in response to the 1% increase in $P_T$; aggregate capital intensity increases by 1.5% and total gross output expands by 0.5%.

Figure 3 depicts the iso-utility curves in $P_T$, $P_K$ space. Increases in utility occur as shifts are made downwards and to the left (each line represents a 1 percentage point increase in utility). For small changes in $P_T$ and $P_K$ the lines are virtually parallel to each other, demonstrating the equivalent nature of increases in $P_T$ and decreases in $P_K$ on utility. The base case line (passing through $P_T = P_K =1$) demonstrates that equivalent percentage changes in both $P_T$ and $P_K$ result in unchanged utility.

**Experiment 8: Consumption Preference Shift ($\gamma \uparrow 1\%$)**

Column 9 of Tables 1 and 2 summarises the effects of an increase in $\gamma$, representing a change in consumer preferences away from traded goods towards non-traded goods. Consumer preferences do not affect production conditions, and hence all prices are left undisturbed by the shift in $\gamma$. In the Cobb-Douglas case (Table 1) a 1% rise in $\gamma$ induces a 1% rise in $C_N$ (and in $Y_N$, $K_N$ and $L_N$) offset by a 1% fall in $C_T$. The fall in $C_T$ is accompanied by a 0.74% fall in each of $Y_T$, $K_T$ and $L_T$ (recalling that exports of the traded good are still required at the base case level to finance imported capital goods).
As $\phi$ increases (Table 2) the transfer from traded to non-traded consumption decreases. Nevertheless, the same patterns occur. Aggregate output and capital intensity remain unchanged (for any value of $\phi$) consequent on a change in $\gamma$. Thus capital intensity and output per person is not a function of domestic preferences relating to traded versus non-traded consumption goods; nor is the equilibrium real exchange rate affected by changes in consumption preferences.

4 Discussion

The results of experiments 6 and 7 indicate the importance of terms of trade changes for a country’s overall output, capital stock, consumption, utility, allocation of (gross) output to traded versus non-traded sectors, and its capital/output ratio. Consistent with the findings of Hsieh and Klenow (2003) and Caselli and Feyrer (2005), low terms of trade leave a country relatively capital shallow and poor compared with a country with high terms of trade. Consequently, the amount of capital stock in a country will, *inter alia*, reflect the value of its traded output relative to the cost of its traded inputs. If the world values its traded output highly, the country will deepen its capital and increase production.27 Because labour is limited, capital intensity and the capital/output ratio each rise in these circumstances.

We show that the terms of trade is just one of a set of determinants of capital intensity. A country will have low capital intensity (relative to other countries) if it has the following (holding other variables constant): low traded sector multi-factor productivity; a low capital share parameter28 (especially within the traded goods sector); a high risk premium; high capital goods prices; 29 and/or low traded goods sector prices. Each of these situations results also in output, consumption and utility being low (ceteris paribus).30 A country with relatively high non-traded sector multi-factor productivity will have the same capital intensity as another (otherwise alike) country but will have higher aggregate output, consumption and utility. Output, consumption and utility, however, do not increase as much following an increase in

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27 See Grimes (2006) for analysis of the relationship between the terms of trade and production specifically for New Zealand.
28 I.e. low $\alpha$ and/or $\beta$.
29 Consistent with the risk premium and capital goods price results, a country with a high depreciation rate (possibly due to extreme climate factors, poor maintenance skills/practices, or through the possibility of expropriation of capital) will also tend to have low capital intensity.
30 The ceteris paribus condition is maintained (unless otherwise stated) in the following discussion.
non-traded sector MFP as they do through an equivalent increase in traded sector MFP.

We summarise the qualitative response of certain ratios to changes in exogenous variables in Table 3.\textsuperscript{31} Each of the indicated changes lowers the capital/output ratio (K/Y), but the effects on other variables, including capital intensity, differ across experiments.

A rise in AN/AT yields the same qualitative results as a rise solely in AN provided both AN and AT have increased by a small amount (e.g. by 2% and 1% respectively). Larger increases in each (e.g. 10% and 9% respectively) lead to an increase in Y\textsubscript{T}/Y, driven by the need to generate the extra traded goods to match the additional imported capital stock. An increase in AN (relative to AT) has a unique combination of effects. It is the only case in which a decline in the capital/output ratio is associated with an increase in output, consumption and real wages (with no change in capital intensity).\textsuperscript{32}

An increase in the country risk premium has the same directional effects on every listed variable other than PN/PK as does a rise in PK and a fall in PT. For each of these three shocks, international prices move against the domestic economy. They can therefore each be conceptualised as an external price shock, whether occurring in the goods or financial markets. Together, these shocks can be differentiated from all other listed shocks by the prediction that they have no effect on the real exchange rate, measured as P\textsubscript{N}/P\textsubscript{T}. However, if the real exchange rate were interpreted as P\textsubscript{N}/P\textsubscript{K}, each of the P\textsubscript{T} and P\textsubscript{K} shocks leads to a fall in the real exchange rate whereas an r shock has no effect on that ratio. An r shock can therefore be differentiated from a goods market terms of trade shock.

The qualitative effects on each listed variable of a decline in the traded goods sector capital share (\(\beta\)) are identical to those for a decline in traded goods sector multi-

\textsuperscript{31} We express Y and C as \(Y/L\) and \(C/L\) respectively, so that all variables are in ratio form. K is expressed both as \(K/Y\) and \(K/L\) for clarity. We do not include a change to \(\gamma\) in the table since experiment 8 demonstrates that this change has no effect on capital intensity or other aggregate variables.

\textsuperscript{32} The Balassa-Samuelson case (a rise in A\textsubscript{T} relative to A\textsubscript{N}, where both A\textsubscript{N} and A\textsubscript{T} are rising) leads to increased output, consumption, capital intensity and traded output as a proportion of total output.
factor productivity, $A_T$. The two sets of results differ from all other sets of qualitative results. Over long periods of time one might rule out declines in $A_T$ within a country; thus if this set of observations is apparent, one may attribute it to a decline in $\beta$. In comparing results across countries at a single point in time, it is impossible to distinguish (from the qualitative findings) whether this set of results is due to $A_T$ or $\beta$ differences across countries.

By contrast, low capital intensity due to a decline in the non-traded goods capital share ($\alpha$) has a unique set of outcomes. It results in lower output, consumption and real wages, but a high real exchange rate, measured by non-traded goods prices relative to each of capital goods prices and traded goods prices.

The results summarised in Table 3 can be used to interpret the factors underlying long run development outcomes across a range of countries. They highlight a range of fundamental factors that explain particular combinations of development outcomes. These factors vary across price-related factors (in international goods and financial markets) and production-related factors (production opportunities and the capital share). Notably, they do not include consumption preferences which are demonstrated to have no impact on aggregate real outcomes in the model. Unlike previous analyses, the advantage of this set of results is that each result is derived from a general equilibrium framework (albeit a static one) and so includes all interactions contributing to observed outcomes. The model and results provide explanations for observed country behaviour and can be used to diagnose specific factors underpinning, and constraining, a country’s development path.
Table 1: Experiment Results (Cobb-Douglas Utility)

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<tr>
<th>Variable</th>
<th>$A_N$</th>
<th>$A_T$</th>
<th>$\alpha$</th>
<th>$\beta$</th>
<th>$r^a$</th>
<th>$r^b$</th>
<th>$P_K$</th>
<th>$P_T$</th>
<th>$\gamma$</th>
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</table>

NB: Suffix T denotes traded; N denotes non-traded; no suffix denotes total.

Figures in the table show percentage change in the vertically listed variable.

* indicates experiments involve a 1 percentage point increase (from 0.07 to 0.08)

$r^a$ assumes domestic capital stock is owned wholly onshore

$r^b$ assumes domestic capital stock is owned wholly offshore; domestic agents own foreign capital
Table 2: Experiment Results (CES Utility: $\varphi=10$)

<table>
<thead>
<tr>
<th>Variable</th>
<th>$A_N$</th>
<th>$A_T$</th>
<th>$\alpha$</th>
<th>$\beta$</th>
<th>$r^a$</th>
<th>$r^b$</th>
<th>$P_K$</th>
<th>$P_T$</th>
<th>$Y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Y_N$</td>
<td>0.54</td>
<td>0.63</td>
<td>0.25</td>
<td>0.29</td>
<td>-0.15</td>
<td>-2.83</td>
<td>-0.18</td>
<td>0.18</td>
<td>0.09</td>
</tr>
<tr>
<td>$Y_T$</td>
<td>0.33</td>
<td>1.39</td>
<td>0.52</td>
<td>0.29</td>
<td>-6.11</td>
<td>-4.14</td>
<td>-0.72</td>
<td>0.72</td>
<td>-0.07</td>
</tr>
<tr>
<td>$Y$</td>
<td>0.42</td>
<td>0.07</td>
<td>0.40</td>
<td>0.78</td>
<td>-3.58</td>
<td>-3.58</td>
<td>-0.49</td>
<td>0.49</td>
<td>0.00</td>
</tr>
<tr>
<td>$K_N$</td>
<td>-0.45</td>
<td>1.64</td>
<td>0.79</td>
<td>0.76</td>
<td>-7.28</td>
<td>-9.77</td>
<td>-1.17</td>
<td>1.18</td>
<td>0.09</td>
</tr>
<tr>
<td>$K_T$</td>
<td>0.33</td>
<td>1.39</td>
<td>0.52</td>
<td>2.16</td>
<td>-12.82</td>
<td>-10.98</td>
<td>-1.70</td>
<td>1.73</td>
<td>-0.07</td>
</tr>
<tr>
<td>$K$</td>
<td>0.00</td>
<td>1.50</td>
<td>0.63</td>
<td>1.56</td>
<td>-10.47</td>
<td>-10.47</td>
<td>-1.47</td>
<td>1.50</td>
<td>0.00</td>
</tr>
<tr>
<td>$L_N$</td>
<td>-0.45</td>
<td>0.14</td>
<td>-0.70</td>
<td>0.07</td>
<td>3.56</td>
<td>0.78</td>
<td>0.31</td>
<td>-0.31</td>
<td>0.09</td>
</tr>
<tr>
<td>$L_T$</td>
<td>0.33</td>
<td>-0.10</td>
<td>0.52</td>
<td>-0.05</td>
<td>-2.62</td>
<td>-0.57</td>
<td>-0.23</td>
<td>0.23</td>
<td>-0.07</td>
</tr>
<tr>
<td>$C_N$</td>
<td>0.54</td>
<td>0.63</td>
<td>0.25</td>
<td>0.29</td>
<td>-0.15</td>
<td>-2.83</td>
<td>-0.18</td>
<td>0.18</td>
<td>0.09</td>
</tr>
<tr>
<td>$C_T$</td>
<td>0.45</td>
<td>0.72</td>
<td>0.21</td>
<td>0.34</td>
<td>-0.15</td>
<td>-2.83</td>
<td>-0.18</td>
<td>0.18</td>
<td>-0.09</td>
</tr>
<tr>
<td>$C$</td>
<td>0.50</td>
<td>0.68</td>
<td>0.23</td>
<td>0.32</td>
<td>-0.15</td>
<td>-2.83</td>
<td>-0.18</td>
<td>0.18</td>
<td>0.00</td>
</tr>
<tr>
<td>$P_N$</td>
<td>-0.99</td>
<td>1.00</td>
<td>-0.46</td>
<td>0.46</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>$P_N/P_T$</td>
<td>-0.99</td>
<td>1.00</td>
<td>-0.46</td>
<td>0.46</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>$W$</td>
<td>0.00</td>
<td>1.50</td>
<td>0.00</td>
<td>0.69</td>
<td>-3.58</td>
<td>-3.58</td>
<td>-0.49</td>
<td>1.50</td>
<td>0.00</td>
</tr>
<tr>
<td>$U$</td>
<td>0.50</td>
<td>0.68</td>
<td>0.23</td>
<td>0.32</td>
<td>-0.15</td>
<td>-2.83</td>
<td>-0.18</td>
<td>0.18</td>
<td>0.00</td>
</tr>
</tbody>
</table>

NB: Suffix T denotes traded; N denotes non-traded; no suffix denotes total.

Figures in the table show percentage change in the vertically listed variable.

* experiments involve a 1 percentage point increase (from 0.07 to 0.08)

$^a$ assumes domestic capital stock is owned wholly onshore

$^b$ assumes domestic capital stock is owned wholly offshore; domestic agents own foreign capital
### Table 3: Potential Reasons for “Capital Shallowness”

<table>
<thead>
<tr>
<th>Reason</th>
<th>Qualitative Effect on:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>K/Y</td>
</tr>
<tr>
<td>A_N ↑</td>
<td>↓</td>
</tr>
<tr>
<td>A_T ↓</td>
<td>↓</td>
</tr>
<tr>
<td>α ↓</td>
<td>↓</td>
</tr>
<tr>
<td>β ↓</td>
<td>↓</td>
</tr>
<tr>
<td>r ↑</td>
<td>↓</td>
</tr>
<tr>
<td>P_T/P_K ↓</td>
<td>↓</td>
</tr>
</tbody>
</table>

**Notes:**
- ↑ denotes variable increases
- ↓ denotes variable decreases
- ? denotes direction of effect uncertain (depends on parameters)
- 0 denotes no change
Figure 1: Iso-Utility Curves in $A_N, A_T$ Space
Figure 2: Iso-Utility Curves in α, β Space
Figure 3: Iso-Utility Curves in $P_T$, $P_K$ Space
References


Hamermesh, Daniel & Gerald Pfann (1996) “Adjustment Costs in Factor Demand”, *Journal of Economic Literature* 34, 1264-1292


