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Capital/Skills-Intensity and Job Creation: An Analysis of Policy Options

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INTRODUCTION

The South African government's objectives of job creation and poverty reduction depend on the success of policies that promote the employment of unskilled labour. Over the past decade, formal sector unskilled jobs have been lost, while the demand for scarce skilled labour and capital has risen. In sectors that heavily employ less educated workers, capital intensity has increased. Recent economic growth has mainly benefited sectors that rely more on relatively educated labour, and in these sectors capital intensity has not significantly increased. This paper explores how growth and job creation depend on private sectors choices concerning *how* to produce--the relative proportions of capital and skilled or unskilled labour employed.

EMPLOYMENT AND GROWTH
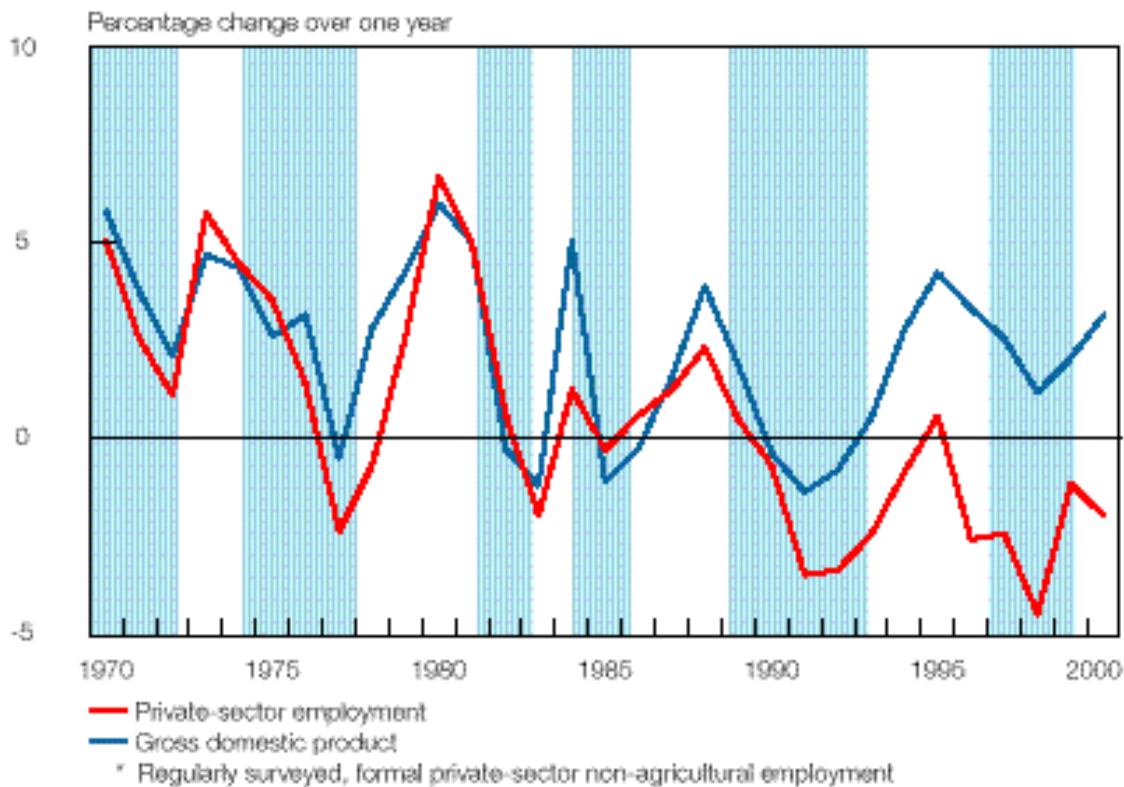
The Reserve Bank's 2001 Annual Report documents the decline in formal sector non-agricultural employment since 1989. (The Reserve Bank's graph is reproduced below). Given the government's objective of job creation, identifying the causes of this decline is important for developing appropriate policy responses.

Employment

Regularly surveyed, formal-sector non-agricultural employment
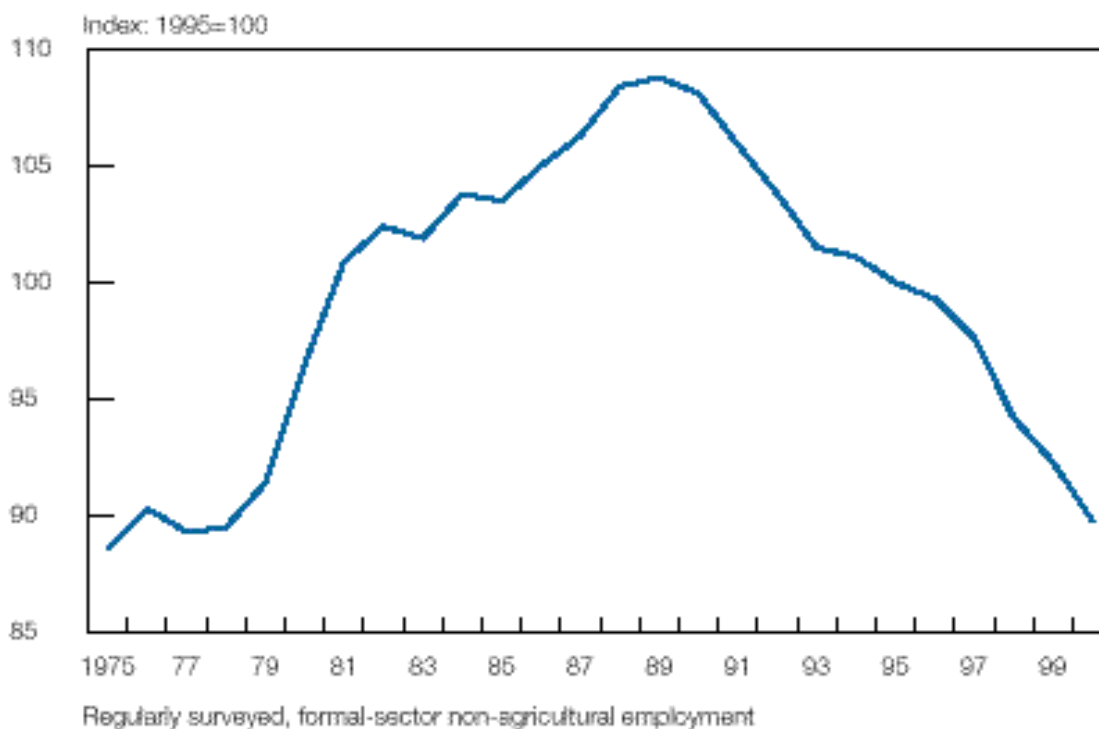
Low growth is frequently cited as a principle cause of the decline in employment. Through the 1980s, rates of GDP growth and rates of formal sector job creation were highly correlated. However, as the Reserve Bank's 2001 Annual Report points out, this relationship broke down during the 1990s. Rates of job creation began to rise more slowly than economic growth during economic upturns, and fell more rapidly during downturns. This "de-coupling" of growth and employment gave rise to a phenomenon that some economists have termed "jobless growth". Recently, rates of job creation have fallen even as GDP growth rates have risen. (The Reserve Bank's graph is reproduced below).

Private-sector employment* and gross domestic product

Percentage change over one year

- Private-sector employment
- Gross domestic product
    * Regularly surveyed, formal private-sector non-agricultural employment

CAPITAL INTENSITY

The Reserve Bank attributes this jobless growth in part to rising capital intensity.[1] The following graph documents the time path of the capital-to-labour ratio in South Africa

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[1] "The decline in formal-sector employment over the past twelve years can be attributed to the combined influence of a number of factors. These include the consistent pressure on domestic producers to be competitive in an increasingly globalised market, the slow pace of foreign direct investment into the economy, increasing rates of capital intensity and determined efforts on the part of the government to reduce the overall size of the public sector." South African Reserve Bank Annual Report 2001.

over the past two decades. The relatively flat trend in the 1980s is consistent with the close correlation between job creation and economic growth. The upward trend in the 1990s depicts in part the substitution of capital for labour--formal sector production increases even as employment falls.

**Capital-to-labour ratio in manufacturing**
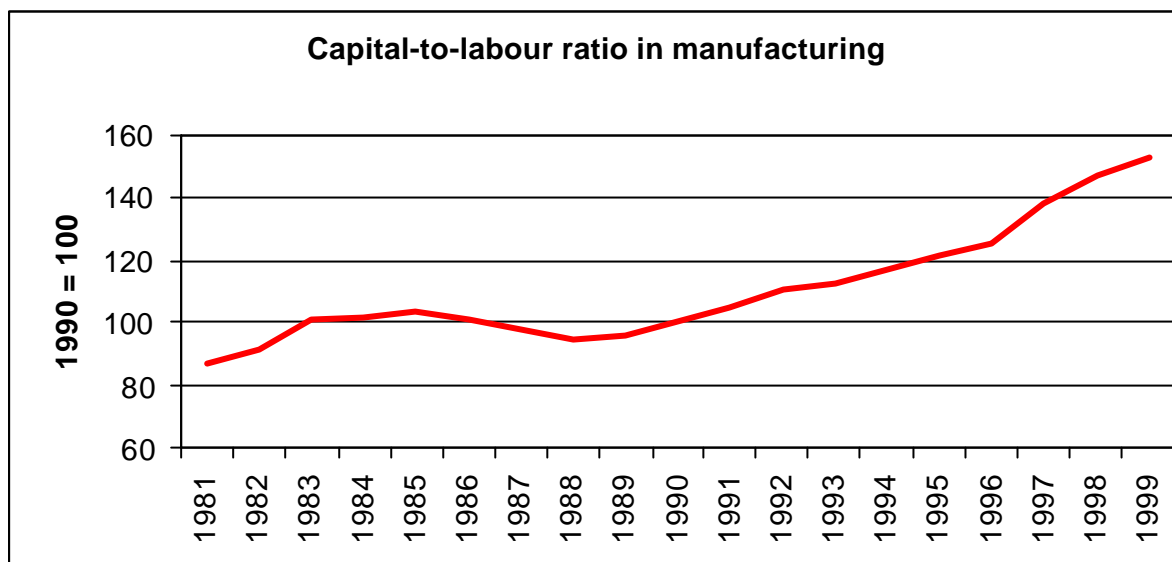
SECTORAL SIMULATIONS

The impact of this rising capital intensity (declining labour intensity) can be quantified through sectoral simulations. Projecting economic growth rates and time paths for the capital-to-labour ratio enables a sectoral econometric model to predict aggregate employment trends over the medium term. The estimates discussed below are documented in further detail in Appendix 1. Two sets of growth rate assumptions are employed--one based on an extrapolation of recent growth rates by economic sector, and a higher growth scenario based on the government's Medium Term Expenditure Framework. Labour intensity is modelled under two alternatives--an extrapolation of the current trends in capital-to-labour ratios by sector, and the more labour-intensive case where the capital intensification stabilises.

The graph below compares job creation performance under three scenarios--(1) a baseline scenario which simply extrapolates recent trends in output growth and capital intensity by sector, (2) a higher growth scenario which assumes the same trends in capital intensity as in the baseline scenario but projects consistent growth across sectors in line with the National Treasury's Medium Term Expenditure Framework, and (3) a scenario with the

same higher growth rates as in the second scenario but with greater labour intensity, modelled as a stabilisation of the capital-to-labour ratio in the projections.

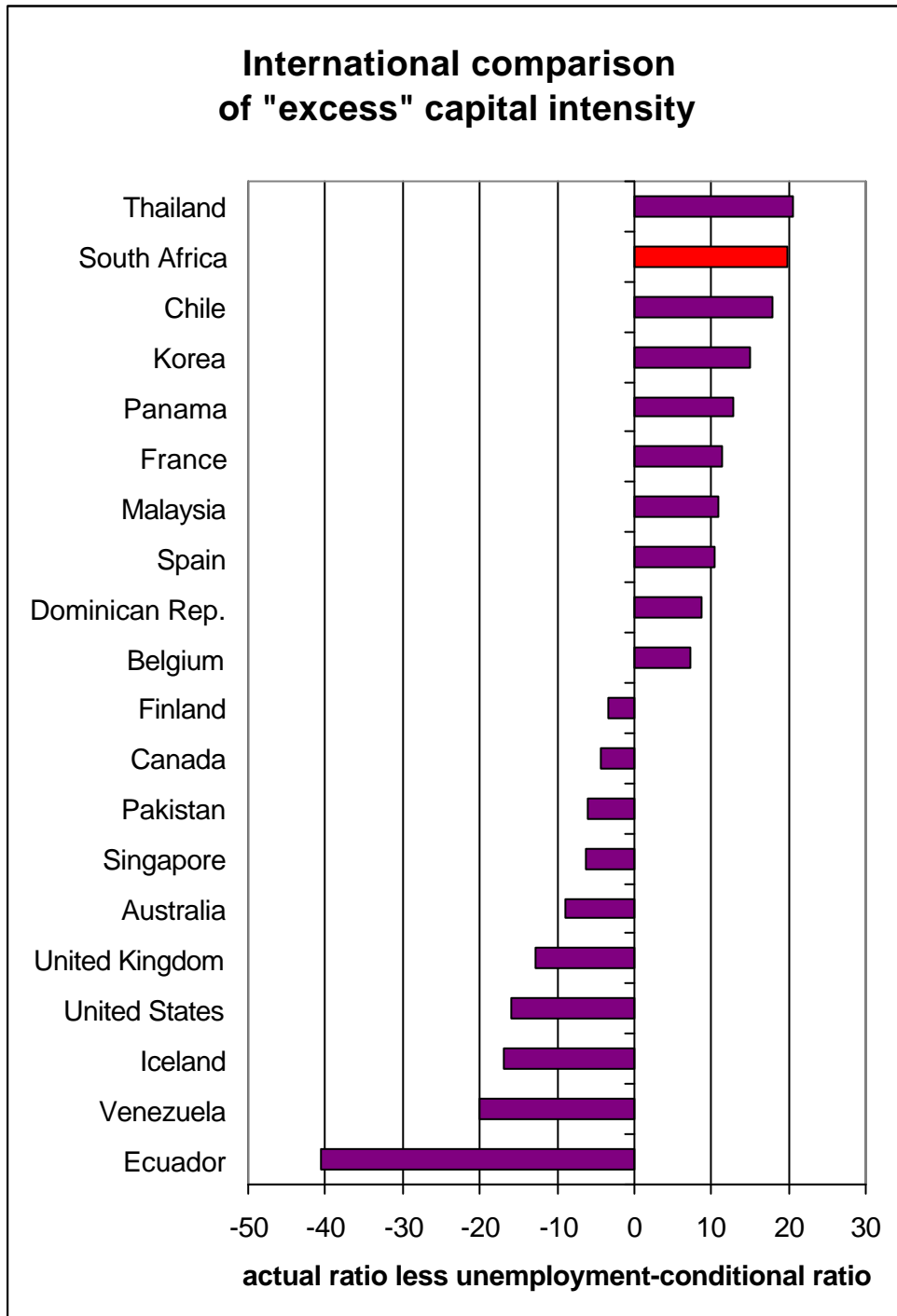### The impact of labour intensity on job creation
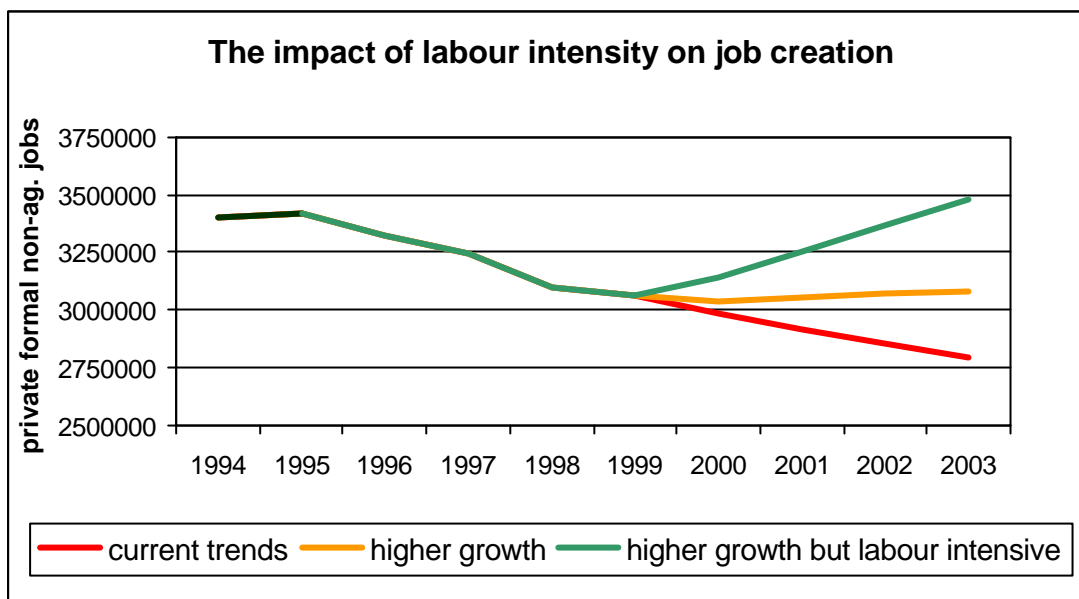
The three scenarios yield very different implications for employment, with a range of outcomes in 2003 differing by nearly seven hundred thousand jobs. Projecting the "current trends" scenario, jobs continue to be lost at a fairly rapid rate. The "higher growth" scenario turns around this trend, but fails to maintain job creation at a rate higher than population growth. The "higher growth but more labour intensive" scenario generates sufficiently high rates of job creation to begin to make a contribution to reducing unemployment.

The scenarios document an important principle. Higher rates of job creation do not necessarily require higher rates of growth or private capital investment. Both the "higher growth" and the "higher growth but more labour intensive" scenarios are associated with the same rates of economic growth, but the more labour intensive scenario requires a lower capital investment rate than the straight higher growth scenario. The explanation for this apparent paradox lies in the capital-to-labour ratio.   Stabilising the capital-to-labour ratio allows an investment-constrained economy to economise on capital inputs.

INTERNATIONAL COMPARISONS

South Africa's rising capital intensity and increased demand for skilled labour are part of global phenomena.   Yet country-specific structural characteristics and policy decisions exert an impact on these trends. Cross-country comparisons help distinguish the effects of globalisation from the structural and policy consequences, shedding light on options for policy-makers. The optimal capital-to-labour ratio for a country depends in part on the abundance of available labour. Countries with persistently high unemployment rates

waste human resources by failing to substitute labour for capital. Once countries reach full employment, growth in wages and output is effectively driven through greater capital intensity. The estimates below represent the difference between the observed increase in the capital-to-labour ratio and the expected increase given the specific country's abundance of available labour. (The details of the calculations are provided in Appendix 2.)

International comparison of "excess" capital intensity

Country	actual ratio less unemployment-conditional ratio
Thailand	21
South Africa	20
Chile	18
Korea	15
Panama	13
France	11
Malaysia	11
Spain	10
Dominican Rep.	8
Belgium	7
Finland	-3
Canada	-4
Pakistan	-6
Singapore	-6
Australia	-9
United Kingdom	-13
United States	-15
Iceland	-16
Venezuela	-19
Ecuador	-40

actual ratio less unemployment-conditional ratio

The graph depicts the "excess" growth in the capital-to-labour ratio for each country in the sample, based on the expected value of the capital-to-labour ratio conditional on the country's unemployment rate. Thailand demonstrates the highest unexplained growth, followed by South Africa. This research suggests that South Africa's rising capital intensity is greater than what would be expected given international experience.

REASONS FOR INCREASING CAPITAL INTENSITY

The International Labour Organisation recently completed a report that sheds light on some of the causes for increasing capital intensity, concluding that "trade liberalisation may have shifted production in favour of capital-intensive sectors and to the detriment of labour-intensive ones. This result reflects the fact that South Africa turns out to have specialised in capital-intensive products, which according to several authors is a legacy of past industrial policies."[2] Another reason cited is the shortage of skilled labour, which undermines growth and hinders the development of labour-intensive sectors. This reinforces the question of the complementarity or substitutability of skilled labour vis-à-vis capital.

The ILO report underscores the contradiction of South Africa continuing to specialise in capital-intensive goods in the face of high rates of unemployment, arguing that "liberalisation and the removal of the peculiar set of industrial incentives which had favoured capital-intensive sectors could have been expected to shift export patterns in favour of labour-intensive sectors, which would have stimulated job creation. This has not happened." Part of the explanation they offer is the complementarity of natural resource industries and capital employed in the production process. Reinforcing this are two legacies of apartheid-era industrial policies that favoured capital-intensive industries. "For example, mining companies can fully deduct capital expenditure from their taxable income of the year in which expenditure was undertaken, while other companies have to spread the tax deduction over a five-year period. This would favour mining and immediate downstream industries, which are capital-intensive."

The Katz Commission interim report identifies tax distortions that have historically lowered the user cost of capital and made labour relatively more expensive. These have included skewed depreciation rules, investment allowances, payroll levies, and registration

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[2] Hayter, Susan; Gerhard Reinecke and Raymond Torres. 1999. ILO Report on the Social Impact of Globalisation. International Labour Organisation, Geneva.

fees.[3] Relatively low reliance on capital taxes has supported the comparative attractiveness of capital over labour.

Second, there is a problem with what economists term "path dependency". "Though the institutional framework may be relatively neutral in its incentives to different types of sectors, enterprises that used to benefit from incentives under prior institutional frameworks have accumulated experience on where to obtain information and how to apply for these benefits. Information costs may be a considerable barrier in this respect, especially for small enterprises."[4] The advantages capital-intensive industries have gained through these industrial policy incentives have an inertial effect, locking in comparative advantage.

Stringent monetary policy that historically tended to support the rand exchange rate effectively subsidised imported capital equipment. The current weakness in the rand tends to discourage capital intensity by raising the rand price of imported capital goods.

Fourie characterises South Africa's pattern of capital and labour use as typical of industrialised economies with far lower unemployment rates. He identifies numerous possible causes, among them tax distortions, unqualified admiration of inappropriate technology from industrialised countries, scarcity of skilled workers, imported consumer preferences that skew demand towards capital-intensive goods, and anti-competitive behaviour by large South African conglomerates that undermine smaller labour-intensive enterprises.[5] One study estimates two million job losses over the past twenty years from inappropriate capital intensity.[6] Statistical analysis links this inappropriate capital and labour use to consistent under-pricing of capital relative to labour.[7]

PUBLIC VERSUS PRIVATE SECTORS

Furthermore, the allocation of fixed capital is skewed within the economy. Certain industries are characterised by abundant labour-saving capital, while others—particularly in the informal sector—lack adequate capital to effectively employ labour. Gross domestic fixed investment in the public sector has fallen since 1975, while private sector investment has grown in step with economic performance. Certain measures of private capital utilisation indicate relative abundance. The graphs below depict South Africa's relatively

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[3] *Interim Report of the Commission of Inquiry into certain aspects of the Tax Structure of South Africa.* 1994. (Chaired by M. M. Katz.) Pretoria: Republic of South Africa Government Printer. Pages 254-255.

[4] Hayter, Susan; Gerhard Reinecke and Raymond Torres. 1999. ILO Report on the Social Impact of Globalisation. International Labour Organisation, Geneva.

[5] Fourie, Frederick C v N. 1997. How to think and reason in macroeconomics. Cape Town: Juta. Pages 367-368.

[6] Bowles, Samuel. 1995. "Wages, Aggregate Demand, and Employment in an Open Economy: An Empirical Investigation". In *Macroeconomic Policy after the conservative era: Studies in investment, savings, and finance.* Edited by Gerald A. Epstein and Herbert M. Gintis. Cambridge: Cambridge University Press. Pages 143-171.

[7] Van Seventer, D. E. N. and van Niekerk, F. D. 1991. "An evaluation of the price structure in South Africa. *South African Journal of Economics.* Volume 59, Number 1. Pages 45-57.

high levels of certain kinds of capital equipment--for instance, 27 computers for every thousand people in South Africa, compared to 17 per thousand in Latin America, 4 per thousand in East Asia, and 18 per thousand in Eastern Europe and South Asia.[8]

Private Capital Indicators
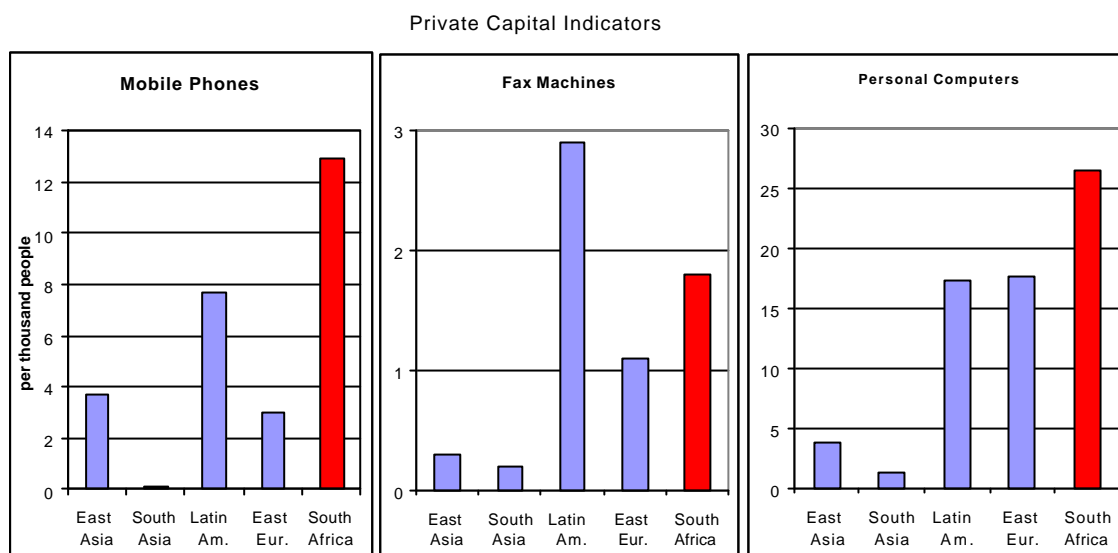
An analysis of private and public capital-to-labour ratios (summarised in the graph below) demonstrates that production in the private sector has shown a steady increase in the capital-intensity of production, and this choice of capital over labour has accelerated beginning in 1996. Meanwhile, the public sector has maintained a more constant proportion of labour and capital employment.

Private and Public Sector Capital:Labour Ratios
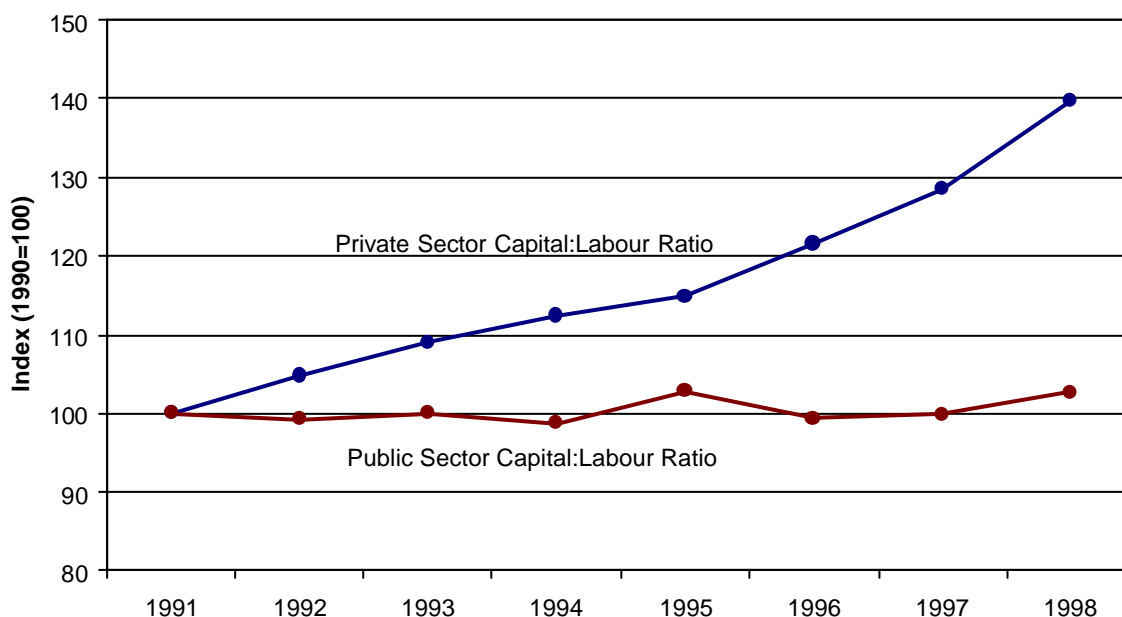
[8]du Toit, J. *The Structure of the South African Economy*. Cape Town: Southern Book Publishers.

CAPITAL INTENSITY BY ECONOMIC SECTOR

An analysis of the capital-to-labour ratio by major sectors of the economy documents substantial heterogeneity in sectoral trends.[9] The graph below depicts rising capital intensity in the mining, manufacturing and construction sectors. The financial services and trade sectors, on the other hand, have experienced relatively stable capital-to-labour ratios.
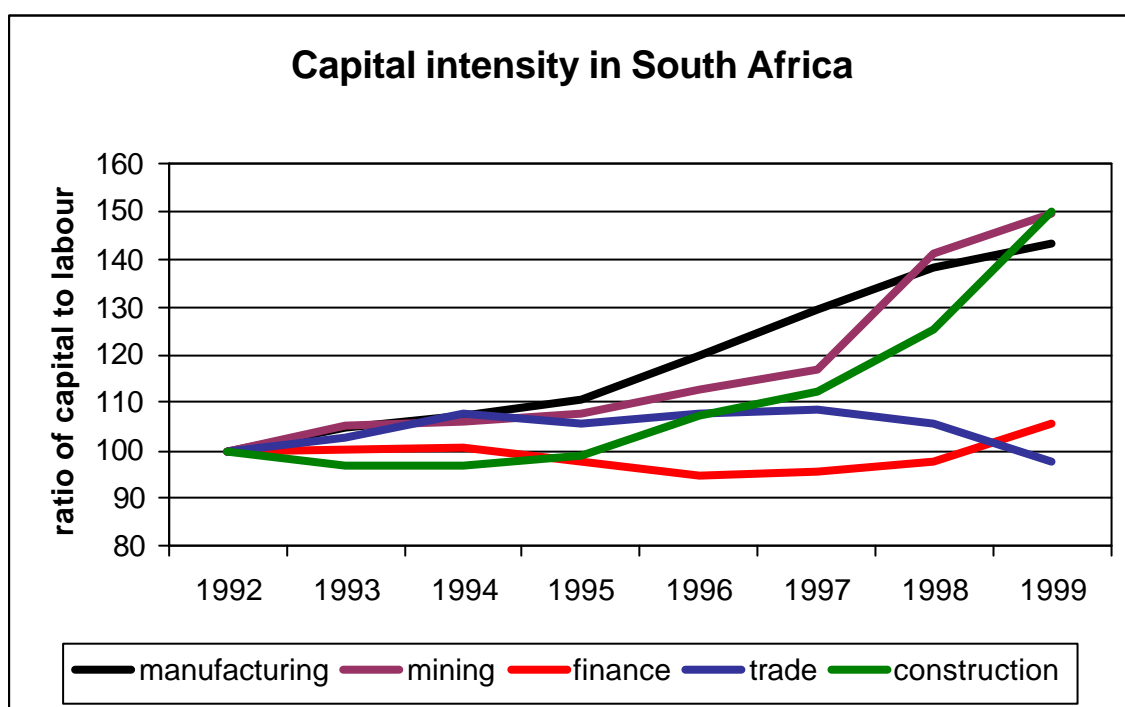
South Africa's situation of rising demand for skilled labour in the face of falling demand for unskilled labour raises the question of the complementarity between capital and skills. Many studies have found that capital complements skilled labour but substitutes for unskilled labour in the production process.[10] An important question for policy-makers is whether government investment in education and skills development can help to address the problem of rising capital intensity and falling formal sector employment. In order to assess the relevance of this hypothesis in South Africa's case, the education-intensity of the five sectors was measured. Using data from the 1999 October Household Survey, this study calculates the relative numbers of "less educated" workers (attainment of less than twelve

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Page 7 (Source: World Bank).

[9] These capital-to-labour ratios are calculated from data provided in the South African Reserve Bank's quarterly bulletins and annual reports. The sectors included are those for which consistent employment and capital stock data are available.

[10] Bergstrom, V. and E. Panas. 1992. "How Robust is the Capital Skills Complementarity Hypothesis?" *Review of Economics and Statistics.* Vol. 74, #3. (August). Pages 540-546.

years of schooling) and "more educated" workers (attainment of twelve or more years of schooling). The results are summarised in the table below.

EDUCATION INTENSITY OF LABOUR BY ECONOMIC SECTOR

Economic Sector	% of workforce with less than 12 years of education	% of workforce with 12 or more years of education	total
Construction	70.6	29.4	100.0
Financial Services	23.0	77.0	100.0
Manufacturing	54.1	45.9	100.0
Mining	72.5	27.5	100.0
Trade	45.3	54.7	100.0

SOURCE: OHS 1999

The evidence is circumstantial, but it is consistent with the hypothesis that education-intensive sectors of the economy are not flowing with the economy's trend towards capital intensity. The two education-intensive sectors of the economy--financial services and trade--are growing more rapidly but without significant increases in capital intensity. And they are creating jobs. The sectors that are not education-intensive--mining, construction and manufacturing--are growing more slowly or contracting even as their capital intensity increases. And they are shedding jobs.

The model developed in Appendix 3 provides one possible explanation for this phenomenon. In the model, job creation depends on the rate of capital investment, the nature of productivity growth, and the degree of substitutability of capital and labour. Rising investment rates are not sufficient to generate job creation. If productivity growth is labour-augmenting and labour can't be readily substituted for capital, more investment can lead to job losses, even as the economy growths. A symptom of this is a rising capital-to-labour ratio.

POLICY DISCUSSION

The evidence discussed in this paper suggests a number of important policy implications. Given the preliminary nature of this research, the following discussion aims to illuminate issues on the table rather than to pose solid policy recommendations. Further research--particularly with more disaggregated sectoral data and micro-economic analysis--is required to derive robust policy conclusions.

The cost of capital in South Africa does not reflect the true cost to society of diverting resources to employing machinery and equipment. Enterprises lay off workers and replace them with automated machinery based on expected cost-benefit analysis that assesses the relative costs to the firm. The additional costs to society of increasing unemployment do not enter the calculation—yet they are substantial, in terms of social safety net costs (both public and private) as well as increased crime and social unrest. In this sense, policy that affects the relative prices of capital and labour is important. Yet any policy mechanism is likely to succeed only in the medium to long term. Transitional policies are therefore important.

The final section of this paper examines policy options, which can be categorised into two groups. The first takes as given the trend towards skills- and capital-intensity, coping with the consequences by stimulating growth to offset the unemployment impact or by strengthening social security. The second set of options focuses on reversing the trend through policies that affect relative prices, productivity or specific industrial interventions. Relative prices can be shifted through labour policy, tax reform, industrial subsidies, or monetary policy. The policy options are not mutually exclusive. For instance, social security can be strengthened in a manner that emulates wage subsidies, improving society's ability to cope with high unemployment while potentially addressing the underlying problem.

COMPREHENSIVE SOCIAL SECURITY

A key conclusion of the ILO's report on globalisation asserts that "South Africa's integration into the global economy will most likely involve the dislocation and exclusion from the formal economy of the least skilled and most economically vulnerable workers." The report recommends that "adequate social security nets need to be designed to both: (a) provide some form of social protection to deal with labour market problems; and (b) facilitate the adaptability of the labour market by providing transitional benefits combined with active labour market policies." The report recognises that "a notable feature of the White Paper on Social Welfare is a shift to 'developmental social welfare' -- helping people to help themselves." Yet the report expresses concern that "this policy objective appears to be thwarted by budgetary constraints."

The research in this paper supports the conclusions of the ILO report, but for reasons that go beyond South Africa's integration into the global economy. The entrenched trends towards capital and skills intensity imply pressures for short to medium term increases in unemployment and poverty among society's most vulnerable. This reinforces the need to implement a comprehensive approach to social security reform, particularly with a

developmental focus. In particular, approaches to social security that build capacity for social risk management and support labour markets on the demand and supply sides can help cope with the social dislocation while addressing the fundamental problem of unemployment.

The model developed in Appendix 4 suggests that appropriate social security reforms that effectively address the problem of poverty may support an increased demand for labour. Particularly among the poorest workers, additional income may have important productivity-enhancing benefits. Yet, analysis of the October Household Survey and the World Bank/SALDRU data sets documents that the working poor supply significant remittances to the very poor, and these remittances rise progressively with the remitter's income. Social security reform that reduces pressure on this private safety net releases productivity-enhancing wage resources, making workers more competitive vis-à-vis capital. This tends to raise the demand for labour. This conclusion is consistent with the statement in the government's human resource strategy recognising that poverty and inequality limit "the ability of individuals, households and the government to finance the enhancement of skills, education and training that are critical prerequisites for improved participation in the labour market, and therefore, improved income."[11]

INDUSTRIAL POLICY, FACTOR PRICES AND SKILLS DEVELOPMENT

The link between developmental social security and skills development provides just one opportunity for government to intervene effectively. Likewise, proactive industrial policy can foster job creation by not only supporting more labour-intensive production but also by nurturing technology with a high degree of substitutability of labour for capital. Labour-intensive production need not entail low wage activities—industrial policy that raises labour productivity while increasing the substitutability between capital and labour can increase labour intensity while improving wages.

Higher capital-oriented taxes, reduced capital subsidies (particularly through the tax system), and a weaker rand raise the relative price of capital. These policies are not necessarily detrimental to economic growth, if they can effectively shift factor demand towards job creation. These policies also have ancillary benefits—the capital taxes and resources freed from eliminating capital subsidies can support social investment objectives, and a weaker rand promotes job creation in export-oriented industries. Promotion of internal competition supports expansion of output with lower prices, creating jobs while stemming

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[11] Human Resource Development Strategy for South Africa. 2001. RSA: Government Printers.

inflationary pressure. Weak competition policy biases the economy towards excess capacity to protect monopoly and oligopoly, contributing to employment-depressing capital intensity.

The Reserve Bank's 2001 Annual Report identifies a number of "competitiveness" reforms implemented by the government which aim, among others, to raise the degree of labour intensity within the economy:

- the introduction of an employment subsidy
- the impending introduction of a wage-related tax incentive
- the implementation of the skills development levy
- an extension of tax privileges to small businesses
- the launch of a national skills development strategy
- the launch of a "learnership" programme

The research in this paper underscores the importance of these policy reforms. Employment subsidies and tax incentives can help to re-balance the skewed relative prices of capital and labour that reinforce the trends towards capital intensity. The sectoral analysis in this paper underscores the importance of the government's skills development initiatives, suggesting that these may reinforce not only higher wages and improved income distribution but also more labour-intensive growth.

CONCLUSIONS

The rising capital-intensity of South African industry is in part responsible for the country's experience with formal sector job losses. Evidence suggests that this process is more extreme in South Africa than in other countries, and that creating formal sector jobs in the face of increasing capital intensity is extremely difficult. Appropriate policy responses depend in large part on why this phenomenon is occurring. Evidence points to a number of factors, including historical industrial policy, relative factor prices, and increasing globalisation. Some of these factors are difficult to modify--suggesting the need to address comprehensive social security reform that can cope with social dislocation while promoting job creation in a developmental manner. Yet other factors are amenable to policy intervention. The government's current and proposed industrial policies aim in part to address factor price distortions, skills shortages, and bottlenecks stalling labour-intensive small and medium enterprise promotion. This paper suggests that support for these policies--to the extent that they focus on increasing labour intensity--will yield returns not only in terms of economic growth but also job creation.

Appendix 1) Modelling the impact of labour intensity on job creation

The model is based on data from the Reserve Bank of South Africa, the National Treasury, and Statistics South Africa. Production functions are econometrically estimated for the manufacturing, mining, construction, financial, and trade sectors based on capital and labour inputs. Output growth trends and capital-to-labour ratios are projected by sector based on modelled assumptions. The model is solved to estimate real output, capital utilised, and employment by sector. Aggregation across sectors yields real output growth rates for the non-agricultural formal private sector and the associated capital stock and employment levels. (Details of the econometric model are available in the EPRI technical paper no. 23, "A sectoral model of the South African economy".)

Fiscal policy is based on the 2000 Medium Term Budget Policy Statement (National Treasury, 2000) issued in October 2000, with modifications as indicated in the scenario descriptions. The baseline assumptions of the National Treasury can be summarised in the following table.

National Treasury fiscal assumptions	2000/01	2001/02	2002/03	2003/04
government revenue (% of GDP)	23.8	23.8	23.7	23.6
government expenditure (% of GDP)	26.4	26.3	25.9	25.7
fiscal deficit (% of GDP)	2.6	2.5	2.3	2.1
public debt (% of GDP)	45.8	44.2	42.1	41.1
real GDP growth rate	2.6	3.7	3.5	3.3

Government revenue and expenditure as well as the fiscal deficit (calculated as a percentage of GDP) fall steadily over the medium term. Growth is projected to increase rapidly in 2001/02—to 3.7% real GDP growth compared to 2.6% projected for 2000/01, and then to fall moderately for the following two years. As a result of lower deficits and more rapid growth, government debt as a percentage of national income (GDP) falls.

SCENARIO 1) PROJECTION OF CURRENT TRENDS

The first scenario projects real growth rates for 2000 to 2003 by sector based on the average sector growth rates from 1996 to 1999. The capital-to-labour ratio for each sector is predicted over the same time period using the exponential growth trend of the sector's capital-to-labour ratio from 1992 to 1999. Fiscal policy is assumed to follow the National Treasury fiscal assumptions, but the real growth rates in this scenario are significantly less than those projected by the government. The results of the scenario are summarised in the table below.

current trends	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Non-agri. Formal Sector Growth Rate	2.6	4.3	3.1	2.4	0.1	0.7	1.7	1.7	1.7	1.8
Non-agri. Formal Employment (thousands)	3402	3420	3325	3240	3095	3056	2983	2918	2857	2800
Rate of Non-Agri. Formal Sector Job Creation		0.5	-2.8	-2.5	-4.5	-1.2	-2.4	-2.2	-2.1	-2.0
Required Capital Investment Rate	1	2	2	2	2	1	5	3	3	3
Capital-to-Labour Ratio	100	101	107	112	119	122	132	139	145	152

Real growth in the non-agricultural formal private sector remains sluggish, rising at less than the population growth rate. Employment in this sector continues to fall, from 3.1 million workers in 1999 to 2.8 million workers in 2003--a loss of over two hundred thousand jobs. The rate of job loss over the next four years is approximately equal to the average rate

over the past five years. With per capita income rising but employment falling, the distribution of income is likely to worsen significantly. The required net investment rate for 2000 is substantially higher than previous years--in part to compensate for the very low growth rate of the capital stock in 1999. The required investment rate levels off to a moderate 3% from 2001 to 2003. This is sufficient to keep the capital-to-labour ratio on its growth trend, rising in 2003 to over 50% of its 1994 level.

SCENARIO 2) HIGHER GROWTH SCENARIO

The second scenario projects real growth rates for 2000 to 2003 homogeneously across sectors based on the National Treasury's projections for the economy-wide real GDP growth. The capital-to-labour ratio for each sector is predicted over the same time period using the exponential growth trend of the sector's capital-to-labour ratio from 1992 to 1999 (the same as in the first scenario). Fiscal policy is assumed to follow the National Treasury fiscal assumptions, and the real GDP growth rates in this scenario are the same as those projected by the government. The results of the scenario are summarised in the table below.

government-projected growth	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Non-agri. Formal Sector Growth Rate	2.6	4.3	3.1	2.4	0.1	0.7	2.6	3.7	3.5	3.3
Non-agri. Formal Employment (thousands)	3402	3420	3325	3240	3095	3056	3035	3052	3065	3074
Rate of Non-Agri. Formal Sector Job Creation		0.5	-2.8	-2.5	-4.5	-1.2	-0.7	0.6	0.4	0.3
Required Capital Investment Rate	1	2	2	2	2	1	6	4	4	4
Capital-to-Labour Ratio	100	101	107	112	119	122	130	135	139	144

The non-agricultural formal private sector grows at a moderate rate, slightly higher than the population growth rate. Employment, however, is roughly flat, falling in 2000 and recovering marginally in the following three years. The population growth significantly exceeds the rate of non-agricultural formal private sector job creation. With per capita income rising but employment flat, the distribution of income is likely to worsen significantly. The required net investment rate for 2000 is substantially higher than previous years--in part to compensate for the very low growth rate of the capital stock in 1999. The required investment rate levels off to a moderately high 4% from 2001 to 2003--more than twice the average investment rate from 1994 to 1999. Given the import content of capital goods, this is likely to worsen the balance of payments situation. The capital-to-labour ratio rises rapidly, reaching a level 44% higher than in 1994.

SCENARIO 3) HIGHER GROWTH BUT MORE LABOUR INTENSIVE

The third scenario projects real growth rates for 2000 to 2003 homogeneously across sectors based on the National Treasury's projections for the economy-wide real GDP growth. The capital-to-labour ratio for each sector is predicted for 2000 using the exponential growth trend of the sector's capital-to-labour ratio from 1992 to 1999. However, due to successful labour-promoting industrial policy, the capital-to-labour ratio is assumed to stabilise from 2001 to 2003. Fiscal policy is assumed to follow the National Treasury fiscal assumptions. The results of the scenario are summarised in the table below.

job-creating industrial policy	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Non-agri. Formal Sector Growth Rate	2.6	4.3	3.1	2.4	0.1	0.7	2.6	3.7	3.5	3.3
Non-agri. Formal Employment (thousands)	3402	3420	3325	3240	3095	3056	3138	3254	3368	3479
Rate of Non-Agri. Formal Sector Job Creation		0.5	-2.8	-2.5	-4.5	-1.2	2.7	3.7	3.5	3.3
Required Capital Investment Rate	1	2	2	2	2	1	6	4	3	3
Capital-to-Labour Ratio	100	101	107	112	119	122	126	126	126	126

The non-agricultural formal private sector grows at a moderate rate, slightly higher than the population growth rate. Employment rises at the same rate, since the capital-to-labour ratio has stabilised. Since the rate of job creation exceeds the rate of population growth, unemployment is likely to decline. From 1999 to 2003, over one hundred thousand non-agricultural formal private sector jobs are created each year. With per capita income rising moderately and unemployment falling, the distribution of income is likely to improve. The required investment rate peaks at 6% in 2000 and falls to a moderate 3% by 2003.

COMPARISON OF SCENARIOS

The scenarios differ substantially in terms of their implications for real economic growth. The "current trends" scenario yields the lowest economic growth, failing to keep up with population growth. Both of the "higher growth" scenarios generate the same moderate rates of economic growth, following the same assumptions.

The three scenarios differ primarily in their implications for employment, with a range of outcomes in 2003 differing by nearly seven hundred thousand jobs. Projecting the "current trends" scenario, jobs continue to be lost at a rapid rate. The "higher growth" scenario turns around this trend, but fails to maintain job creation at a rate higher than population growth. The "higher growth but more labour intensive" scenario generates sufficiently high rates of job creation to begin to make a contribution to reducing unemployment.

Appendix 2) Calculating "excess" capital intensity

The calculation of "excess" capital intensity for each country is based on the difference between the observed capital-to-labour ratio in 1997 and the expected value of the ratio conditional on the country's unemployment rate, as a proxy for the relative abundance of labour in the economy. The following notes document the data sources and calculations.

Nominal GDP and GDP deflators:
Gross Domestic Product and deflators are from the International Monetary Fund *International Financial Statistics*.

GDP deflator (1995=100):
The conversion factor was calculated as 100/(GDP deflator value for 1995). Each GDP deflator value was then multiplied by this conversion factor to re-scale the deflator to 1995=100 for all countries. From this point on, the deflators scaled to 1995=100 are used, leaving everything in 1995 prices.

GDP at 1995 prices:
GDP at 1995 prices were calculated by multiplying the nominal GDP values by 100/(GDP deflator (1995=100)).

Gross Fixed Capital Formation:
Gross fixed capital formation is from the International Monetary Fund *International Financial Statistics*. IFS Descriptor: GROSS FIXED CAPITAL FORMATION. The values for the United States were obtained by summing the government gross fixed capital formation and the private gross fixed capital formation values.

Gross Fixed Capital Formation (1995 prices, billions):
Gross fixed capital formation in 1995 local prices, given in terms of billions of local currency. These values were calculated by multiplying the nominal gross fixed capital formation values by the scale factor defined in 'Gross Fixed Capital Formation' and by 100/(the GDP deflator (1995=100) value for the specific year).

Labour Force:
The labour force values are from the International Monetary Fund *International Financial Statistics*. All values are in thousands of workers. IFS Descriptor: LABOUR FORCE.

Employment:
The employment values from the International Monetary Fund *International Financial Statistics*. All values are in thousands of workers. IFS Descriptor: EMPLOYMENT.

Unemployment:
The unemployment values from the International Monetary Fund *International Financial Statistics*. All values are in thousands of workers. IFS Descriptor: UNEMPLOYMENT.

Unemployment Rate:
The unemployment rates from the International Monetary Fund *International Financial Statistics*. All values are expressed as percent per annum. IFS Descriptor: UNEMPLOYMENT RATE.

Population:
The population values from the International Monetary Fund *International Financial Statistics*. IFS Descriptor: POPULATION.

Initial Capital Stock:
The initial capital stock figures are taken from Vikram Nehru and Ashok Dhareshwar. "A New Database on Physical Capital Stock: Sources, Methodology and Results". The original data is annual, covering 1950 to 1990, and is given in 1987 local prices. The physical capital values were converted to 1995 prices by multiplying by 100/(GDP deflator (1995=100) for the year 1987) and then expressed in terms of billions by dividing by a billion.

Capital Stock History:
The history of the capital stock values were obtained by subtracting the consumption (depreciation) of the previous year's capital stock and adding the current year's gross fixed capital formation (in billions, 1995 prices) to the previous year's capital stock. This can be expressed with the following equation:

$$K(t)=(1-d)*K(t-1) + I(t)$$

Where $K(t)$ is the current year's total fixed capital stock, d is the depreciation rate, $K(t-1)$ is the previous year's total capital stock, and $I(t)$ is the current year's total investment (gross fixed capital formation). Following Easterly and Levine, a depreciation rate of .07 was used.[12]

Employment History
The number of employed workers are taken from the International Monetary Fund *International Financial Statistics,* when available. When only unemployment figures were available, values of the number of employed workers were calculated as follows:

$$E(t)=U(t)/u(t) – U(t)$$

Where $E(t)$ is the calculated number of employed workers in year t, $U(t)$ is the number of unemployed workers in year t, and $u(t)$ is the unemployment rate in year t.

Calculation of the expected capital-to-labour ratio.

Ordinary least squares regression of capital-to-labour ratio on natural log of the unemployment rate. The sample includes all countries for which the necessary capital, labour and unemployment data are available.

Dependent variable: 1997 capital-to-labour ratio (1990=100)

Variable	Coefficient	Standard error	t-statistic	P-value
Constant term	148.1	9.4	15.8	0.000
Unemployment rate (ln)	-15.4	4.4	-3.5	0.002

SUMMARY STATISTICS

Summary statistic description	Statistic value
Number of observations	20
F-statistic: (1,18)	12.5
P-value (H: F=1)	0.002
R-squared	41%
Adjusted R-squared	38%
Root MSE	16.6

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[12] Easterly and Levine, "It's not factor accumulation: stylized facts and growth models", World Bank and University of Minnesota, September 2000.

Appendix 3: The labour demand response to income transfers

Consider an economy characterised by a representative firm with a fixed supply of capital facing a production function where both the quantity of labour employed and the wage paid are choice variables. The production function is increasing in both the wage paid and quantity of labour employed, but subject to diminishing marginal returns. The wage rate itself does not directly affect productivity and output, but rather it influences the "net wage", which in turn positively influences productivity and output. The "net wage" is defined as the gross wage less the remittances paid to support poorer family members and friends. The quantity of remittances paid depends positively on the worker's individual gross wage as well as the overall poverty rate in the society. The poverty rate is determined in part by public policy variables, including but not limited to expenditures on income transfers to the poor.

Mathematically, this economy can be represented by the following equations:

(1)   OUTPUT $Y = Y(NW, L)$

Output Y depends positively on the two choice variables—the net wage NW and the quantity of labour employed L—but subject to diminishing marginal returns. That is, $Y_{NW} > 0$, $Y_{NWNW} < 0$, $Y_L > 0$, $Y_{LL} < 0$.

(2)   NET WAGE $NW = w - R$

The net wage NW is equal to the gross wage w less remittances paid to poorer family members and friends.

(3)   REMITTANCES $R = R[p(t), w]$

Remittances R paid by the representative worker depend positively on both the overall poverty rate p and the individual gross wage w paid to the worker. The poverty rate is a decreasing function in the public policy variable t, which in this case represents the total amount of income transfers to the poor.

(4)   WAGE BILL $WB = wL$

The wage bill WB is the product of the wage paid and the quantity of labour employed. The representative firm chooses the wage w and quantity of labour L to maximise profit, which is equal to the value of output less the wage bill. This can be written:

(5)   FIRM'S OBJECTIVE   MAX $Y\{w - R[p(t), w], L\} - wL$
$$\qquad\qquad\qquad\qquad\qquad w,L$$

The solution to this problem can be obtained by differentiating the objective function with respect to the two choice variables, yielding a simultaneous system of first order conditions determining the profit-maximising choices for the wage rate and quantity of labour employed. Calculating the total differential equations for this system yields a simultaneous differential equation system representing the differentials of the wage rate and quantity of labour employed as functions of the parameters of the system and the differential of public policy variable representing income transfers to the poor. This system yields the response of wages and employment with respect to the level of income transfers to the poor.

The system of first order conditions generated by this calculation are:

(6)   LABOUR FOC: $Y_L\{w - R[p(t), w], L\} = w$

(7)   WAGE FOC: $Y_w\{w - R[p(t), w], L\} = L$

These equations have the following interpretation. The profit-maximising firm must choose the wage rate and labour quantity employed to balance two trade-offs. First, the additional amount of output resulting from hiring one more worker must equal the cost of that one additional worker—the wage rate. Second, the additional amount of output resulting from increasing the wage by one more rand must equal the cost of that increased wage paid—that is, it must equal the number of workers employed.

In order to evaluate the impact of the policy variable on wages and employment, it is necessary to calculate the total differential equations associated with the above system. The calculated system of total differential equations is:

(8)   LABOUR DIFFEQ: $Y_{LNI}[dw - R_p p'(t)dt - R_w dw] + Y_{LL}dL = dw$

(9)   WAGE DIFFEQ: $Y_{WNI}[dw - R_p p'(t)dt - R_w dw] + Y_{WL}dL = dL$

This system of simultaneous differential equations in the can be solved to yield closed form solutions for the differentials for wages and labour in terms of the differential of the public policy variable representing income transfers to the poor. The closed form solutions are:

(10) LABOUR
$$\frac{dL}{dt} = \frac{Y_{WNI} R_p p'(t)}{[Y_{LL} Y_{WNI} (1 - R_w)] - \{(1 - Y_{WL})[1 + Y_{LNI}(1 - R_w)]\}} > 0$$

(11) WAGE RATE
$$\frac{dw}{dt} = \frac{[(Y_{LL} Y_{WNI}) - (1 - Y_{WL})Y_{LNI}]R_p p'(t)}{[Y_{LL} Y_{WNI} (1 - R_w)] - \{(1 - Y_{WL})[1 + Y_{LNI}(1 - R_w)]\}}$$

The derivative of employment with respect to transfers to the poor is unambiguously positive.[13] Remittances to poor family members and friends are reduced as the poverty rate falls in response to increased public transfers. Net wages rise, leading to higher productivity and increased employment. The magnitude of the resulting job creation depends on several factors. The more efficiently the transfers reduce poverty, the more employment will be created. The stronger the effect that poverty exerts on inducing remittances, the more jobs will be created as transfers bring poverty levels down. The stronger the wage effect on remittances, the more employment will be stimulated by compensating public transfers. A strong wage effect on remittances acts like an inefficient tax on labour income—while public transfers restore the efficiency of the wage.

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[13] Due to diminishing marginal returns to wages and labour employed, $Y_{WNW} < 0$ and $Y_{LL} < 0$. Since increased wages are not 100% captured by remittances, $R_w < 1$. Poverty increases remittances, so $R_p > 0$, while increases in transfers to the poor reduce poverty, so $p'(t) < 0$.

Appendix 4: The labour absorption equation

This section derives the model's labour absorption equation employing a methodology similar to that developed by Bruton.[14] Profit maximisation equates the marginal productivity of labour to the tax-adjusted wage. Assuming proportional tax rates on capital, labour, and output, this can be represented:

$$Y_L = \frac{W + t_L}{1 - t_Y} = qW \quad where \quad q = \frac{1 + t_L/W}{1 - t_Y}$$

Assuming homogeneity of degree one[15], the production function can be rewritten:

$$Y = bLg(\kappa) \quad where \quad g(\kappa) = Y(\kappa,1) \quad and \quad \kappa = aK/bL$$

Differentiating the production function with respect to labour L and substituting into the first order condition for labour yields:

$$Y_L = (dY/dL) = b[g(\kappa) - \kappa g'(\kappa)] = q\,W$$

Multiplying this expression by L yields:

$$Y - bL\kappa g'(\kappa) = q\,WL$$

Differentiating this with respect to time (using ΔX to denote the differential of variable X, and $\Delta X/X$ to denote the growth rate of X), and dividing through by $Y = bLg$ yields:

$$\Delta Y/Y = [(\Delta b/b)(g'/g)\kappa + (\Delta L/L)(g'/g)\kappa + (g''/g)\kappa\Delta\kappa + (g'/g)\Delta\kappa] + q\,\Delta W/(bg) + q\,(\Delta L/L)[W/(bg)]$$

Differentiating $Y = bLg(\kappa)$ with respect to time and dividing by Y yields:

$$\Delta Y/Y = (\Delta b/b) + (\Delta L/L) + \Delta\kappa(g'/g)$$

Likewise, differentiating $\kappa = aK/bL$ with respect to time and divide by κ yields:

$$\Delta\kappa/\kappa = (\Delta K/K) + (\Delta a/a) - (\Delta L/L) - (\Delta b/b)$$

Then dividing $Y - bL\kappa g'(\kappa) = q\,WL$ by W and $Y = bLg$ yields:

$$(1/W) - (\kappa g')/(Wg) = q\,/(bg)$$

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[14] See Bruton (1997) for an accessible discussion, or Bruton and Frank (1977) for a detailed derivation of a similar formulation. Bruton, Henry. 1997. On the Search for Well-Being. Ann Arbor: University of Michigan Press. Bruton, Henry and Charles R. Frank, Jr. 1977. "Appendix III: Mathematical Appendix" in *Income Distribution and Growth in Less-Developed Countries*, edited by Charles R. Frank, Jr. and Richard C. Webb. Washington, D.C.: The Brookings Institution.
[15] The analysis applies to a generally homogenous production function with modifications and qualifications.

Finally, substituting the previous three equations into the prior one and rearranging yields an expression for the labour absorption equation:

$$\Delta L/L = \Delta K/K + \Delta a/a + [(g-g'\kappa)/(g''\kappa^2) - 1](\Delta b/b) + [(g-g'\kappa)/(g''\kappa^2)](\Delta W/W)$$

To interpret this, the mathematical expression for the elasticity of substitution between labour and capital can be written as:[16]

$$e = \frac{g'g'\boldsymbol{k}^2 - g'g\boldsymbol{k}}{g''g\boldsymbol{k}^2}$$

The equations $Y - bL\kappa g'(\kappa) = \boldsymbol{q}\,WL$ and $Y = bLg$ imply that $g'\kappa/g = 1 - \theta WL/Y$, where $\theta WL/Y$ is the tax-adjusted share of income accruing to labour. Define c = the residual—the tax-adjusted share of income accruing to capital, which is equal to $(g'/g)\kappa$. Dividing this expression for e by $c = (g'/g)\kappa$ and simplifying yields $e/c = (g-g'\kappa)/(g''\kappa^2)$, which allows the simplification of the labour absorption equation as follows:

$$\mathbb{D}L/L = \mathbb{D}K/K + \mathbb{D}a/a + (e/c - 1)\mathbb{D}b/b - (e/c)\mathbb{D}W/W$$

This can be expressed conceptually as:

$$\boxed{\text{rate of job creation}} = \boxed{\text{rate of investment}} + \boxed{\begin{array}{c}\text{capital-augmenting productivity growth}\end{array}} + \left(\frac{e}{c}-1\right)\boxed{\begin{array}{c}\text{labour-augmenting productivity growth}\end{array}} - \frac{e}{c}\boxed{\begin{array}{c}\text{rate of wage growth}\end{array}}$$

This expression is the labour absorption equation for the model, and it demonstrates how the rate of job creation is related to not only the rate of investment, but also the net impact of capital- and labour-augmenting productivity growth as well as wages. The e/c coefficient on wage growth represents a measure of how elastic labour demand is to wages. This coefficient minus one (e/c – 1) is the corresponding measure for the response of labour demand to labour-augmenting productivity growth. The time path of job creation during productivity-driven economic growth depends critically on these coefficients.

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[16] See Bruton and Frank (1977) or Allen (1968). Allen, Roy G. B. 1968. *Macro-Economic Theory*. New York: St. Martin's Press. Page 48.