# Skills, Technology and Capital Intensity: Employment & Wage Shifts in post-*apartheid* South Africa

Haroon Bhorat, Ben Stanwix, Sumayya Goga
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# Outline

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# Introduction

- South Africa an upper middle-income country:
  - Population 51 million
  - Resource rich, well-developed financial sector
  - GDP per capita US$7,507 (World Bank, 2012)
  - High unemployment (25%)
  - High poverty & inequality levels
- In post-*apartheid* period, continued skills-biased labour demand contributes to inequality & high unemployment rates
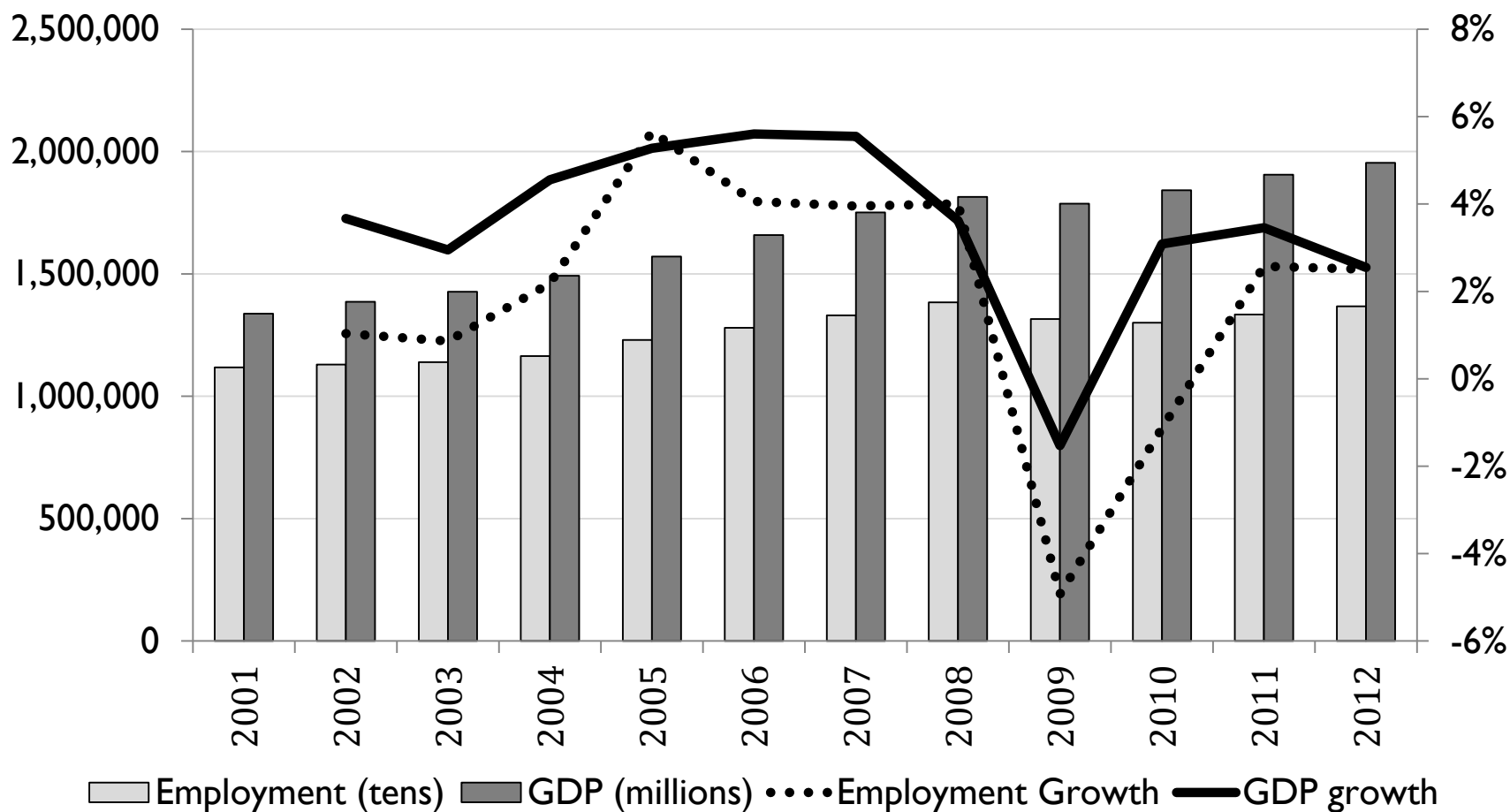
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# Key Questions

- How has structure of economy changed in 10-year period?

- Are employment shifts 'skills-biased'?

- Do within- or between-sector shifts explain changes in employment?

- What has happened to wage returns across occupation task categories (& Its link to technological and capital-intensive change)?

- What are the lessons for 'inclusive growth'?

# Data

- Labour Force Surveys (2001-2007)
  - Bi-annual

- Quarterly Labour Force Survey (2008-2011)
- Stratified random sample of ±30 000 dwellings
- Occupational and Industry codes (ISOC and SIC)
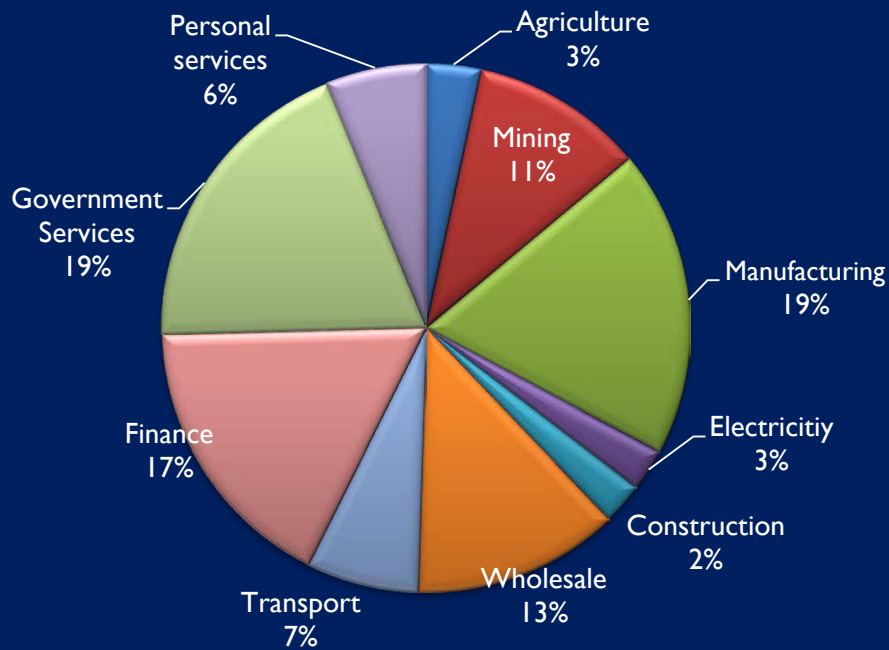- Wage Data:
  - LFS: 2001-2007
  - QLFS: 2010 and 2011 (annual)

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# Real Quarterly Annualised GDP & Total Employment: Total & Percentage Change, 2001-2012



Legend: Employment (tens) | GDP (millions) | •••• Employment Growth | —— GDP growth

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# Main Sector Share of Real GDP, 1993 & 2012



**Share of GDP by Sector: 1993**

- Agriculture 3%
- Mining 11%
- Manufacturing 19%
- Electricitiy 3%
- Construction 2%
- Wholesale 13%
- Transport 7%
- Finance 17%
- Government Services 19%
- Personal services 6%

**Share of GDP by Sector: 2012**

- Agriculture 3%
- Mining 6%
- Manufacturing 17%
- Electricitiy 2%
- Construction 3%
- Wholesale 14%
- Transport 10%
- Finance 24%
- Government Services 15%
- Personal services 6%
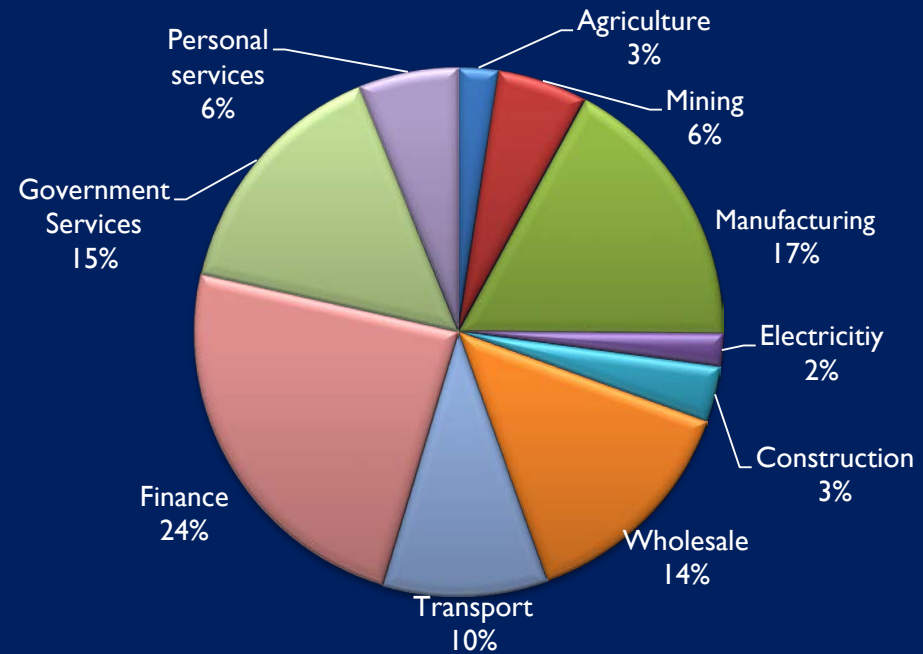
*Source: SARB , Quarterly Bulletin, Various issues and Authors' Calculations*

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# Gross Value Added and Employment Growth, by Sector: 2001-2012
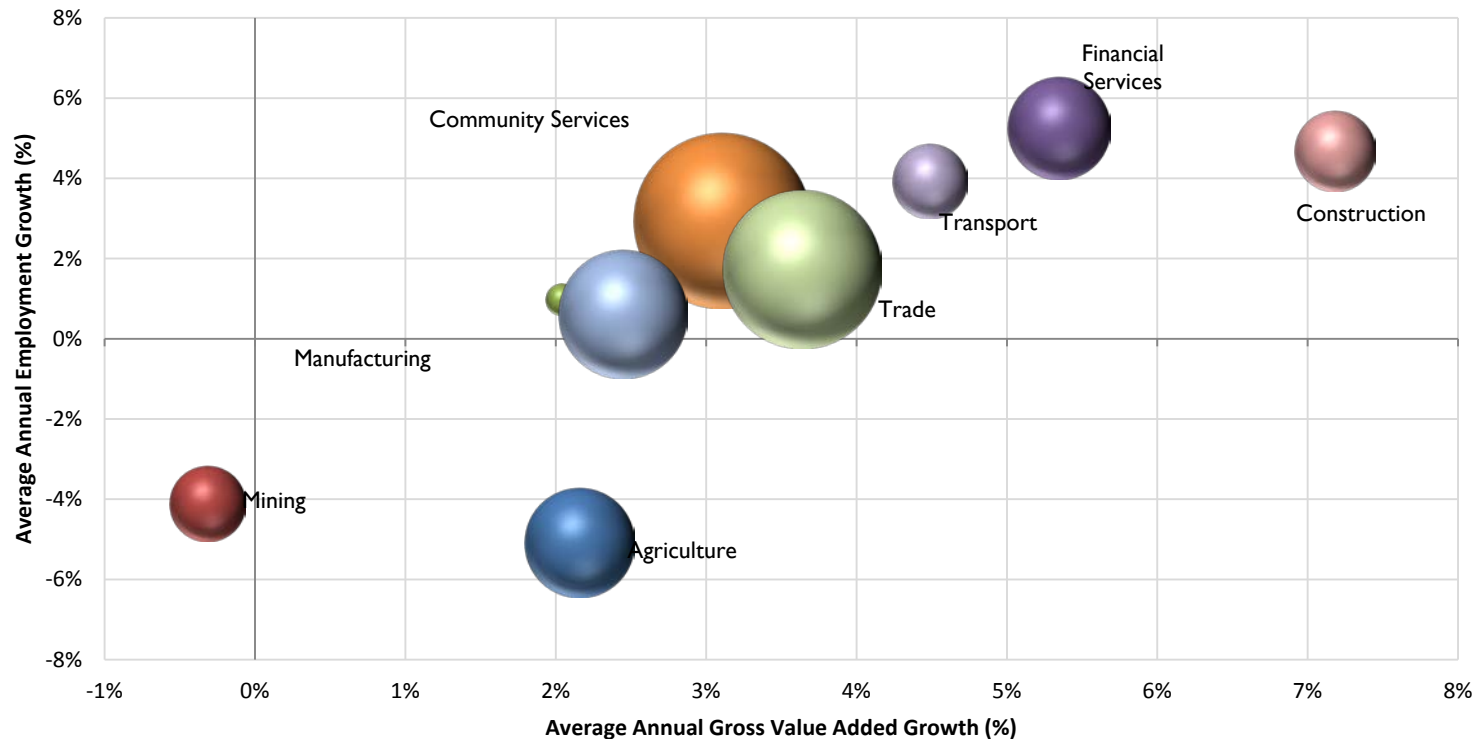
# Employment Shifts by Main Sector, 2001-12

| | Growth (2001-2012) | | Employment Shares | | Share of Change ($\Delta E_i/\Delta E$) |
| --- | --- | --- | --- | --- | --- |
| | **Absolute** | **Relative** ($\%\Delta E_i/\%\Delta E$) | **2001** | **2012** | **(2001-2012)** |
| **Primary** | **-719,232*** | **-2.6** | **0.15** | **0.07** | **-0.28** |
| Agriculture | -514,468* | -2.7 | 0.10 | 0.04 | -0.20 |
| Mining | -204,764* | -2.2 | 0.05 | 0.02 | -0.08 |
| **Secondary** | **537,376*** | **1.0** | **0.21** | **0.21** | **0.21** |
| Manufacturing | 112,149 | 0.3 | 0.14 | 0.12 | 0.04 |
| Utilities | 10,774 | 0.5 | 0.008 | 0.008 | 0.004 |
| Construction | 414,453* | 2.5 | 0.05 | 0.07 | 0.16 |
| **Tertiary** | **2,720,821*** | **1.6** | **0.63** | **0.71** | **1.08** |
| Trade | 513,572* | 0.9 | 0.21 | 0.21 | 0.20 |
| Transport | 288,364* | 2.1 | 0.04 | 0.06 | 0.11 |
| Financial | 782,108* | 2.8 | 0.09 | 0.13 | 0.31 |
| Comm Serv | 1,041,524* | 2.1 | 0.17 | 0.22 | 0.42 |
| Priv Hholds | 95,253 | 0.4 | 0.09 | 0.08 | 0.04 |
| **Total** | **2,497,763*** | **1.0** | **1** | **1** | **1** |

Source:     StatsSA (LFS 2001 and QLFS 2012), Author's Calculations

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# Employment Shifts by Sector-Skill Cells, 2001-2012

| | | Proportions | | Change in Prop | Change in No |
|---|---|---|---|---|---|
| | | **2001** | **2012** | **2001-2012** | |
| **Primary** | **High-Skilled** | 0.03 | 0.08 | 0.05 | 27,602 |
| | **Med-Skilled** | 0.54 | 0.37 | -0.17 | -571,229* |
| | **Unskilled** | 0.43 | 0.56 | 0.13 | -175,392* |
| | **Total** | I | I | **-719,232*** | |
| **Secondary** | **High-Skilled** | 0.14 | 0.18 | 0.04 | 188,518* |
| | **Med-Skilled** | 0.70 | 0.62 | -0.08 | 136,140 |
| | **Unskilled** | 0.16 | 0.20 | 0.04 | 214,002* |
| | **Total** | I | I | **537,376*** | |
| **Tertiary** | **High-Skilled** | 0.27 | 0.29 | 0.02 | 931,498* |
| | **Med-Skilled** | 042 | 0.43 | 0.008 | 1,214,349* |
| | **Unskilled** | 0.31 | 0.28 | -0.03 | 576,288* |
| | **Total** | I | I | **2,720,821*** | |

*Source:*      *StatsSA (LFS 2001 and QLFS 2012), Author's Calculations*

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# A Theory of Relative Labour Demand Shifts

- Relative Labour demand patterns driven at the sectoral level by two forces:
  - *within-sector shifts* (driven, for example, by technological change)
  - *between-sector shifts* (driven, for example, by trade flows and evolving product demand)
- Identifies *relative* demand shifts in net sectoral employment growth

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# Relative Labour Demand Shifts: A Decomposition Analysis

- Estimate using standard Katz & Murphy (1992) decomposition technique:

$$\Delta X_k^d = \frac{\Delta D_k}{E_k} = \sum_j \left( \frac{E_{jk}}{E_k} \right) \left( \frac{\Delta E_j}{E_j} \right) = \frac{\sum_j \alpha_{jk} \Delta E_j}{E_k}$$

- The subscript $k$ refers to occupation (or other groups) and $j$ refers to sectors.

- The total relative demand shift for group $k$ in the period under consideration is measured by

$$\Delta X_k^d$$

- or , $\frac{\sum_j \alpha_{jk} \Delta E_j}{E_k}$ where $\Delta X_k^d$ is group $k$'s share of total employment in sector $j$ in the base year. $\alpha_{jk} = \left( \frac{E_{jk}}{E_j} \right)$

- $\Delta E_j$ is the change in total labour input in sector j between the two years.

- Derive within-sector shift as residual of total- and between-sector shifts.

# Industry-Based Relative Demand Shift Measures, by Occupation: 2001-2012

| | Between | Within | Total | *Share of Within in Total* |
|---|---|---|---|---|
| *High-Skilled* | | | | |
| Managers | 0.92 | 12.63 | **13.32** | *94.9%* |
| Professionals | 3.03 | 15.04 | **17.20** | *87.4%* |
| *Medium-Skilled* | | | | |
| Clerks | 1.59 | 12.88 | **14.07** | *91.6%* |
| Service & Sales Workers | 1.92 | 11.75 | **13.23** | *88.9%* |
| Skilled agric and fishery | -0.55 | -19.60 | **-20.47** | *95.8%* |
| Craft & Trade Workers | 1.35 | 7.88 | **9.01** | *87.4%* |
| Operators & Assembler | 0.19 | 1.63 | **1.81** | *90.1%* |
| *Unskilled* | | | | |
| Elementary Workers | 0.28 | 1.10 | **1.37** | *80.1%* |
| Domestic Workers | 0.37 | 3.49 | **3.83** | *91.1%* |

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# Real Wages Shifts by Occupational Tasks

- How have wages changed for those involved in specific tasks?
- Autor, Levy & Murnane (2003), Goos & Manning (2007), Acemoglu & Autor (2011) identify 'occupational tasks' as a key channel for wages shifts
- Relevant in face of capital deepening and skills-biased technological change

- Jobs requiring cognitive skill, creative problem-solving or face-to-face interaction are unlikely to be automated or threatened by international competition or technological change

-  Routine tasks on an assembly line, for example, face high risks

# From An Occupation- To A Task-based Measure of Skills

- **Information and communication technology (ICT)**-related jobs: High information content; likely to be affected by technological change through adoption of new technologies, or face global low-cost competition. Include activities such as getting information, analysing data, recording information, and often involve interaction with computers. In the SASCO codes this consists of occupations such as software engineers, computer programmers, typists, data entry, and so on.

- **Automation/routinisation**: Jobs routine in nature and potential to be automated; involving repeated tasks; structured work environments, and where the pace of the job is often determined by mechanical or technical equipment. These jobs could also potentially be at risk through increased trade and import penetration. They include occupations such as textile weavers, engravers, machine operators, and assemblers.

- **Face-to-Face**: Work that relies on face-to-face contact, such as establishing and maintaining personal relationships, working directly with the public, managing people, caring for others, teaching, and work requiring face-to-face discussions. Generally these are jobs that cannot be easily automated or replaced by a competing international firm. Such jobs range from room service attendants, food vendors, labour supervisors, travel guides, to therapists and teachers.

- **On-Site**: Jobs that require the worker to be present at the particular place of work, and usually include tasks involving physical work, controlling machines/processes, operating vehicles or mechanical equipment, inspecting equipment, constructing physical objects. Again, these jobs are not easily offshorable and are generally made up of construction workers, machine operators, drivers, mechanics, and various kinds of manual labourers.

- **Decision-Making/Analytic**: Work that requires non-routine decision-making abilities, usually tasks that involve creative thought, problem-solving, developing strategies, taking responsibility for outcomes and results. Such jobs cannot easily be automated and are usually at lower risk of being displaced by international competition. Occupations include artists, all types of professionals, managers, and other jobs generally considered to be high-skilled jobs.

# Occupation Categories and Occupational Tasks, 2001

*LFS September 2001*

| | ICT | | Automated | | Face-to-Face | | On-site | | Analytic | | Total | LFS Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Share | No. | Share | No. | Share | No. | Share | No. | Share | | |
| **Managers** | 0 | *0.00* | 0 | *0.00* | 663 227 | *0.19* | 8 681 | *0.00* | 663 227 | *0.35* | 1 335 135 | **663 945** |
| **Professionals** | 77 922 | *0.12* | 2 986 | *0.00* | 249 490 | *0.07* | 31 776 | *0.00* | 381 861 | *0.20* | 744 036 | **485 829** |
| **Technicians** | 178 638 | *0.29* | 205 165 | *0.05* | 531 864 | *0.15* | 134 110 | *0.02* | 671 219 | *0.36* | 1 720 996 | **1 176 031** |
| **Clerks** | 368 923 | *0.59* | 1 029 770 | *0.26* | 356 139 | *0.10* | 100 998 | *0.02* | 51 481 | *0.03* | 1 907 311 | **1 090 772** |
| **Service** | 0 | *0.00* | 0 | *0.00* | 1 034 643 | *0.29* | 740 526 | *0.12* | 32 993 | *0.02* | 1 808 162 | **1 429 021** |
| **Skilled Agriculture Workers** | 0 | *0.00* | 283 450 | *0.07* | 0 | *0.00* | 292 128 | *0.05* | 43 464 | *0.02* | 619 042 | **520 699** |
| **Craft Workers** | 0 | *0.00* | 724 015 | *0.18* | 0 | *0.00* | 1 297 763 | *0.20* | 30 134 | *0.02* | 2 051 912 | **1 529 375** |
| **Operators and Assemblers** | 0 | *0.00* | 475 869 | *0.12* | 0 | *0.00* | 878 239 | *0.14* | 0 | *0.00* | 1 354 108 | **1 127 155** |
| **Elementary Workers** | 0 | *0.00* | 1 311 656 | *0.33* | 673 791 | *0.19* | 2 055 714 | *0.32* | 0 | *0.00* | 4 041 162 | **2 252 554** |
| **Domestic Workers** | 0 | *0.00* | 0 | *0.00* | 0 | *0.00* | 881 411 | *0.14* | 0 | *0.00* | 881 411 | **881 411** |
| **Total** | **625 483** | *1* | **4 032 912** | *1* | **3 509 154** | *1* | **6 421 344** | *1* | **1 874 380** | *1* | **16 463 277** | **11 156 792** |

*Source:*    *StatsSA (LFS 2001 and QLFS 2012), Author's Calculations*

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# Task Distributions, By Main Sector: 2001

| Sector | ICT | | AUTO | | FACE | | ONSITE | | ANALYTIC | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Share | No. | Share | No. | Share | No. | Share | No. | Share |
| **Primary** | | | | | | | | | | |
| Agriculture | 6 252 | 0.01 | 1 054 458 | 0.26 | 23 619 | 0.01 | 1 195 143 | 0.18 | 53 543 | 0.03 |
| Mining | 19 338 | 0.03 | 415 210 | 0.10 | 26 215 | 0.01 | 453 409 | 0.07 | 23 024 | 0.01 |
| **Secondary** | | | | | | | | | | |
| Manufacturing | 104 652 | 0.17 | 1 028 247 | 0.25 | 197 030 | 0.05 | 968 729 | 0.15 | 237 079 | 0.12 |
| Utilities | 7 170 | 0.01 | 40 058 | 0.01 | 19 569 | 0.01 | 68 856 | 0.01 | 15 792 | 0.01 |
| Construction | 7 244 | 0.01 | 223 553 | 0.05 | 38 761 | 0.01 | 586 422 | 0.09 | 36 106 | 0.02 |
| **Tertiary** | | | | | | | | | | |
| Trade | 85 840 | 0.14 | 505 761 | 0.12 | 1 566 343 | 0.44 | 1 265 933 | 0.19 | 298 041 | 0.16 |
| Transport | 38 665 | 0.06 | 162 219 | 0.04 | 175 122 | 0.05 | 230 025 | 0.04 | 109 699 | 0.06 |
| Financial Services | 240 845 | 0.38 | 302 898 | 0.07 | 491 164 | 0.14 | 338 458 | 0.05 | 343 788 | 0.18 |
| Community Services | 114 706 | 0.18 | 378 878 | 0.09 | 1 032 946 | 0.29 | 544 978 | 0.08 | 794 582 | 0.41 |
| Private HHs | 0 | 0 | 0 | 0 | 6 502 | 0 | 898 622 | 0.14 | 235 | 0 |
| **Total** | 624 712 | 1 | 4 123 115 | 1 | 3 582 898 | 1 | 6 553 495 | 1 | 1 917 247 | 1 |

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# Estimation Strategy

- If we take a general statement of this approach across all points, or quantiles, in the distribution, we have the estimation for the regression quantile as minimising the equation:

$$Min_{\beta \in \Re^k} \left[ \sum_{i \in \{i: y_i \geq X_{i\beta}\}} \theta |Y_i - X_i\beta| + \sum_{i \in \{i: y_i < X_{i\beta}\}} \left(1 - \theta |Y_i - X_i\beta|\right) \right]$$

- This then provides the solution for the $\theta^{th}$ quantile, where $0<\theta<1$, allowing for estimation at any given point in the distribution of the outcome variable. In the above, $Y_i$ is the dependent variable, $\boldsymbol{x_i}$ is the $kx1$ vector of independent variables and $\boldsymbol{\beta}$ is coefficient vector (Koenker and Bassett, 1978)

- Following Firpo, Fortin, & Lemieux (2011) we use 4-digit occupation codes and link every occupation with the 5 task categories and estimate a conditional quantile regression of the form:

- where s the year,  is a dummy for each of the five categories, and  includes controls for age, race, and education. Variable of interest is coefficient on , in each occupational category, for each decile of the income distribution, in a given year

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# Task Wage Premia, plotted by Quantiles: 2001-2011
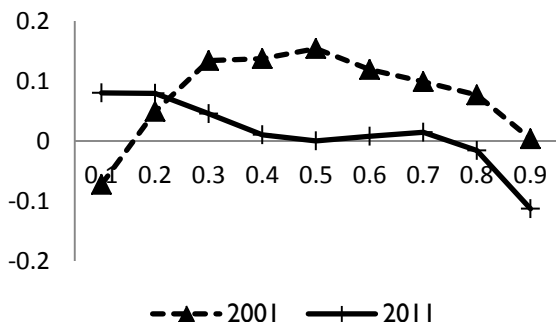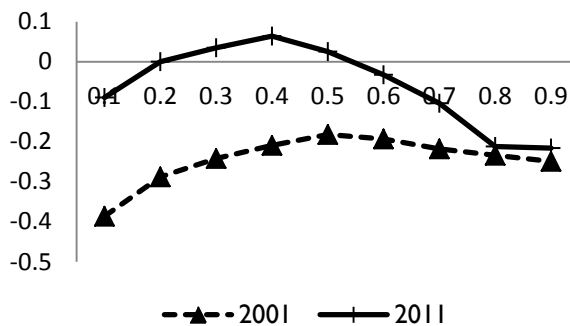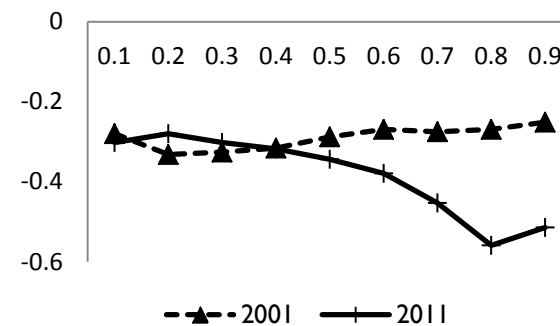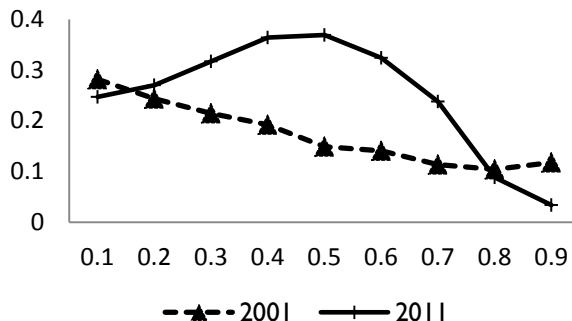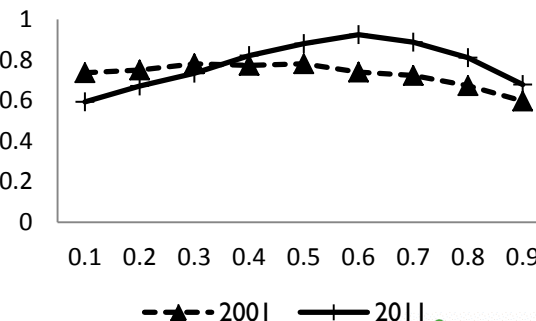
# Conclusions: Employment

- Employment driven by 2001-2008 growth
- Primary sector employment collapse
  - Agriculture (Impact of $W_m$) and Mining together losing over 700 000 jobs
    - Both employers of least-skilled workers
- Lacklustre employment growth in Manufacturing
- Growth within tertiary sectors such as financial services and community services
  - Public sector as a growing source of employment
  - Financial Services & Temporary Empl. Service Providers
- Employment gains in high- and medium-skilled occupations
- Decomposition Results: Technological change, increasing capital intensity: within-sector shifts dominate reasons for relative labour demand shifts in South Africa.

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# Conclusions:
# Wages

- Jobs that involve **automated or routine tasks** have experienced a drop in wage levels (Agriculture, Mining and Manufacturing)

- Jobs involving **face-to-face tasks** and those with an **ICT component** have seen rising wages in general (largely Community, Trade & Financial Services)

- **Onsite jobs** saw falling returns at upper end of the distribution (Manufacturing, Agriculture) but stable returns at the lower end (Domestic Workers)

- **Analytic jobs** posted high and relatively stable wages (community and financial services)

- At the bottom of the distribution wages remained relatively stable or rose in all task categories. Impacts of minimum wages and collective bargaining outcomes.