Trade induced unemployment
The case of post-apartheid South Africa

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Abstract

This paper analyses the link between trade liberalisation and increasing unemployment in post-apartheid South Africa. Since the beginning of the 1990s the South African economy became more exposed to the global economy. From 1993 until 2006 both export and import shares increased steadily over time and South Africa (re)integrated in the world economy. Simultaneously, the newly elected multi-racial government faced a sharp increase of unemployment rates. Within the time span of five years the official rate of unemployment doubled. Although this is not the first research with regard to this topic, it is one of the few that uses a consistent trade framework. By means of a binding minimum wage the impact of trade liberalisation on unemployment can be analysed theoretically in an Heckscher-Ohlin framework. These theoretical insights are used to specify an econometric estimation function. Unfortunately, it is not possible to estimate the direct impact due to data limitations. Therefore, the econometric model tests the theoretical hypothesis in an indirect way and focusses on the impact of trade liberalisation on the factor input vectors for different industries and the effect of unemployment on this change. The econometric results support the findings of the theoretical model, which implies that trade liberalisation did increase unemployment in South Africa. Whereas further liberalisation would deepen the unemployment crisis in South Africa, labour market and social reforms could overcome the negative effect of trade liberalisation.

Introduction

The South African society experienced a negotiated revolution in the beginning of the 1990s, which resulted in the first multi-racial elections in 1994. According to Von Holdt and Webster (2005) this period, i.e. the end of apartheid, can be regarded as a triple transition: a political transition, an economic transition and a social transition. Along with these transitions, which influenced the South African economy in general and the labour market institutions in particular, the economy was exposed to the globalisation process. In 1995 South Africa was one of the founding members of the World Trade Organisation (WTO) and started to simplify its rather complicated trade regime. At the same time it was clear that an unemployment crisis emerged by which less-skilled labour was affected. In the face of these observations it is necessary to assess the impact of trade liberalisation on the labour market.

It should be clear that this paper is not the first study that assesses the effect of trade on (un)employment. In general, three different approaches in the existing literature can be distinguished. First, some studies such as Bell and Cattaneo (1997) and Alleyne and Subramanian (2001) analyse the South African trade structure. From these insights they infer that trade liberalisation has a negative correlation with employment opportunities. A second approach is based upon the input-output decomposition methodology. Both Edwards (2001) and Jenkins (2008) use the structure of the input-output matrix to distinguish between final demand, exports, imports and technological change as variables that influence the demand for labour. By comparing different versions of the input-output matrix the authors analyse the effect of these different variables. This approach yields positive trade effects on the use of labour and highlights the importance of technological change. The last approach estimates a labour demand function, e.g. Jenkins (2008) and Chinembiri (2010). The econometric specification of the labour demand function, which is deducted from a Cobb-Douglas production function, is completed with a set of different control variables. The econometric results show that trade had a direct or indirect negative effect on the demand for labour. None of the studies, however, uses a consistent trade framework to establish the link between trade and unemployment. Therefore, this paper with its specific trade framework extends existing literature on this topic.

Modelling the impact of the South African trade pattern on employment introduces two theoretical challenges. The first challenge is related to the dimensionality of the trade model, whereas the second challenge concerns labour market effects. The trade model that will be used in this paper is

an Heckscher-Ohlin trade model, since inter-industry trade prevails South Africa's trade flows. With respect to the dimensions of the trade model it should be noted that the results of other studies, which are also supported by the data used in this analysis, indicate that the trade model has to include three different production factors as well as three different product classes. Furthermore, to simplify reality and to establish a symmetric trade model this paper neglects the trade relation with developing countries and focusses only on industrialised countries (e.g. EU) and low-wage emerging countries (e.g. China). The model distinguishes between capital, less-skilled labour and skilled labour as three different production factors. The academic discussion on such a multi-dimensional trade model revolved mainly on the generalisation of the price equalisation theorem, the Heckscher-Ohlin theorem, the Samuelson-Stolper theorem and the Rybczynski theorem, e.g. Samuelson (1953), Chipman (1966 and 1969), Batra and Casas (1976), Jones and Scheinkman (1977), Chang (1979), Takayama (1981) and Ethier (2003). These papers remain, however, very general and are not explicitly deployed to the specific problem of a three-dimensional trade model. To overcome this shortcoming the concept of the endowment triangle is used. This concept was developed by McKenzie (1955) and discussed and applied by Leamer (1987), Jones and Marjit (1991) and Jones (1992).

With respect to the second challenge it is worth mentioning that the impact of international trade on employment has long been a blind spot in the theory of international trade. Almost all theoretical models assume factor full employment, i.e. wages adjust to market clearing conditions and as a consequence unemployment is unknown within the model. The political debate on international trade, however, revolves around the impact of international trade on domestic employment. One of the first theoretic papers dealing with this topic was Brecher (1974). The paper extends the Heckscher-Ohlin-Samuelson model by introducing a binding minimum wage. Within a stylised two-dimensional world, i.e. two production factors, two industries and two countries, this minimum wage corresponds to a specific relative equilibrium price. Although various production levels with different levels of unemployment correspond to this equilibrium price, all these levels guarantee production equilibrium. As a result the paper shows that under specific conditions free trade increases the unemployment level of a country. Other papers that apply a similar approach within an Heckscher-Ohlin trade model are Krugman (1995) and Davis (1998). This technique to model unemployed and the insights gathered by these papers are used in this paper to extend the theoretical three-dimensional trade model with employment effects. This results in a three-dimensional Heckscher-Ohlin trade model that allows to evaluate theoretically the impact of economic reintegration on the South African labour market.

The outline of this paper corresponds to the previously described analysis problems. First, South Africa's trade structure is discussed. This section not only refers to existing literature, but also includes an independent analysis of the data series used for the econometric estimation. Second, the basics of the trade model are discussed. By means the concept of the endowment triangle the three-dimensional trade model is visualised. Third, it is argued why a binding minimum wage is an appropriate short cut to include South African labour market rigidities into a trade model. The results of this section deliver some interesting insights on the link between trade liberalisation and unemployment. In the last section these insights are transformed to an econometric specification and the estimation results of this function are discussed. The conclusion of this paper recapitulates the main findings and discusses the policy implications of these findings.

South Africa's trade pattern

The transition to multi-racial democracy in 1994 was accompanied by a policy of trade liberalisation. As shown by Edwards (2005) both scheduled and collected tariff rates decreased between 1990 and 2004. Notwithstanding this evolution, the author remains critical to the claim that trade was substantially liberalised. He refers to some significant sectoral differences and states that there remains a further scope for simplification. Moreover, Edwards (2005) notes that nominal tariff rates neither consider the impact of tariffs on the production process nor account for incentives to trade. Therefore, he also analysis the change of the effective rate of protection (ERP). This approach allows to include differences between the protection of final goods and the protection of intermediates. The ERP analysis supports the finding that South Africa liberalised its trade policy. Notwithstanding this liberalisation Edwards (2005) notes that the trade regime still has a significant anti-export bias.

In general, trade liberalisation leads to increased openness of the economy. This was no exception for South Africa as Figure 1 depicts. Both exports and imports increased relative to output between 1993 and 2006, which is shown by the export share and the import share curves. With respect to this evolution it is important to know, how trade liberalisation did effect the South African economy. At industry level trade liberalisation can have two effects. On the one hand, industries with a comparative advantage will export more, whereas industries with a comparative disadvantage will face increased imports and thus more competition. In this case trade will be characterised by specialisation, i.e. inter-industry trade exists. Theoretical frameworks that explain comparative advantages and disadvantages are the Ricardian and the Heckscher-Ohlin trade theories. On the

other hand, imports and exports within the same industries could increase simultaneously. This trade patterns is know as intra-industry trade and trade theories based on monopolistic competition between firms (e.g. Krugman (1980) and Melitz (2003)) offer possible explanations.
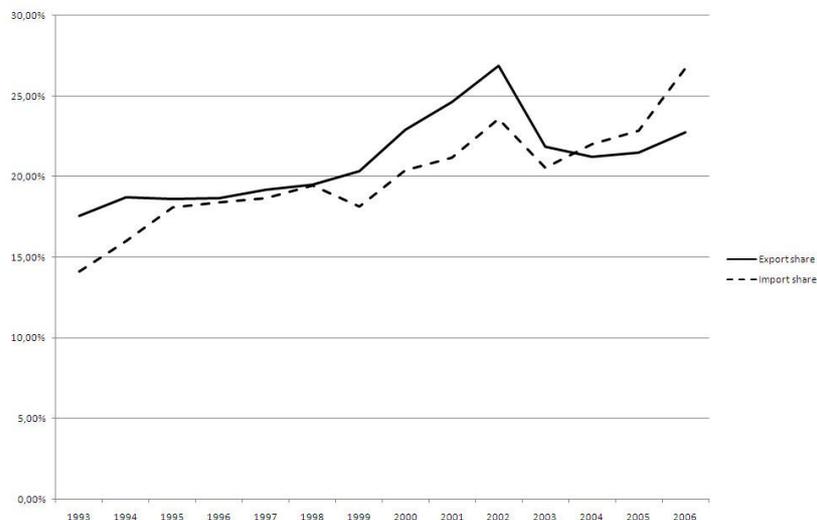

Figure 1: Export and import shares (1993-2006)
Source: TIPS (2009) and Statistics South Africa (2009)

With respect to the South African trade structure most studies indicate a rather high level of inter-industry trade. One indicator to measure the level of intra-industry trade is the Grubel-Lloyd (GL) index. This index compares the absolute value of net exports of all industries with the total sum of exports (X_j) and imports (M_j) of these industries for a specific year and can be expressed as:

$$GL = 1 - \frac{\sum_j |X_j - M_j|}{\sum_j X_j + M_j} \qquad (1)$$

A GL value of one indicates perfect intra-industry trade, whereas a GL value of zero indicates total inter-industry trade. Isemonger (2000) estimated annual weighted GL indices for the period 1993-1996 and found values ranging from 0.20 to 0.24. For the year 1998 Parr (2000) mentions a GL value of 0.35. Moreover, the data used in this paper (TIPS 2009: 4-digit HS classification) yield GL values of 0.23 for the three-year average 1993-1995 and 0.31 for the three-year average 2004-2006. These results indicate without any doubt that the lion's share of South Africa's trade is inter-industry trade.

As a logical consequence it is necessary to explain the comparative advantages and disadvantages of the South African economy. This topic is also discussed by other scholars and their result can be used to obtain a good first impression. One paper worth mentioning is Bell and Cattaneo (1997), which analyses the labour intensity of the manufacturing in general and trade flows in particular. The conclusion of this study is that South Africa has no comparative advantage in labour intensive industries. By means of an econometric approach Alleyne and Subramanian (2001) yield a more detailed result. They show unambiguously that South Africa is a net exporter of capital intensive goods, especially with respect to high income countries. These results are interesting, but should be extended to different trading partners and three production factors.

By combining the industry data of Quantec (2007a and 2007b) it is possible to classify industries according to their production structure. This approach distinguishes explicitly between three different production factors: capital (K), less-skilled labour (L) and skilled labour (H). Regarding South Africa's history of social and educational segregation one ought to treat the two types of labour as separate production factors. Figure 2 displays the factor intensities for industries which shape significantly the South African trade structure.
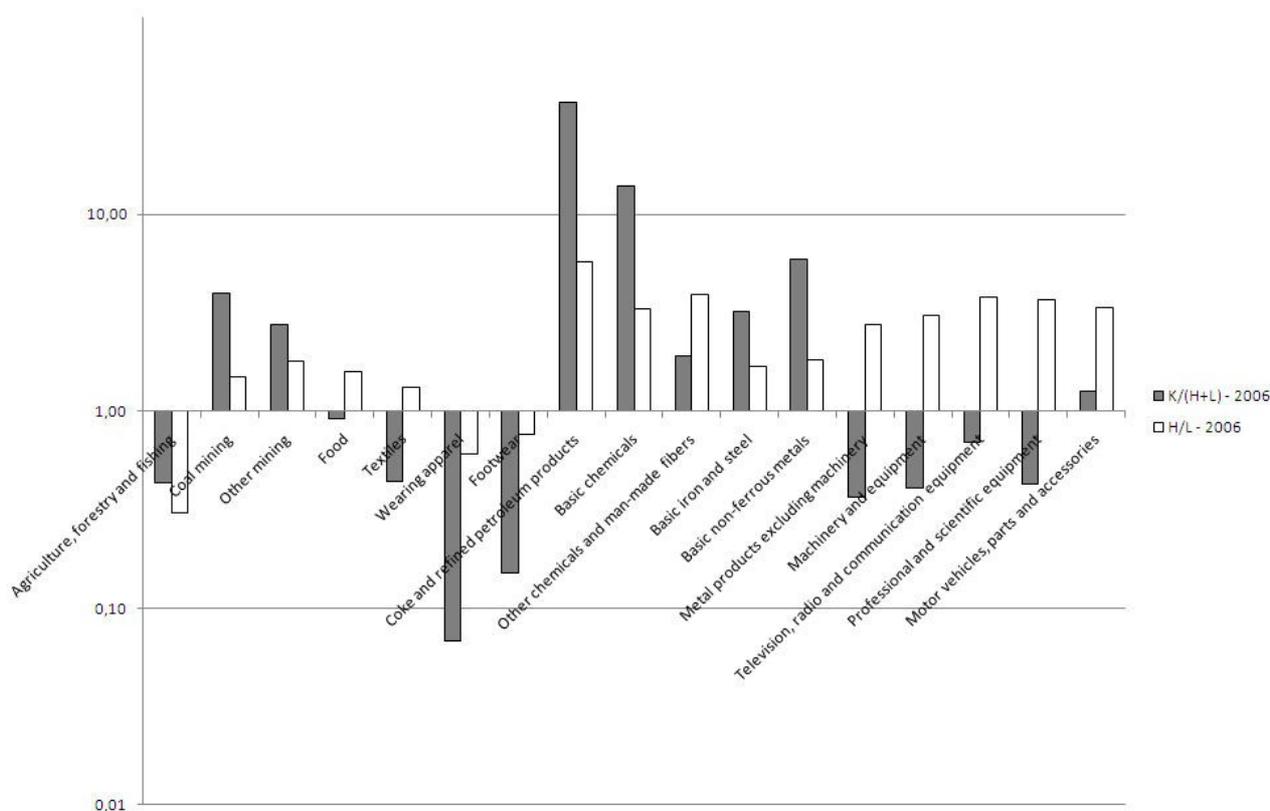

Figure 2: Production structure of some industries in 2006 (logarithmic scale)
Source: Quantec 2007a and 2007b

If one combines the South African Standard Industry Classification, which is used in Figure 2, with the 6-digit HS classification[1] the trade structure can be analysed with respect to its factor content. This approach yields results which are similar to those of Bell and Cattaneo (1997) and Alleyne and Subramanian (2001). First, between 1993 and 2006 aggregate exports are dominated by mineral and mining industries. The combined exports of the *basic iron and steel*, the *basic non-ferrous metals*, the *coal mining* and the *other mining* industry aggregates varied between 40% and 50% of total exports in this period. Simultaneously, the share in total exports of the *machinery and equipment* (mainly centrifuges) and the *motor vehicles, parts and accessories* industry aggregates increased steadily and were just below 10% in 2006. The production of these exports is mainly capital intensive. The overall export structure also roughly describes exports to the EU and China. It should, however, be noted that the export structure to the EU is a bit more diverse, whereas exports to China are even more concentrated on mineral and mining products. All in all, South Africa is an exporter of capital to industrialised countries such as the EU and to low-wage emerging countries such as China.

The import structure is not so homogeneous both with respect to product diversity and with respect to the EU and China. Around half of all imports between 1993 and 2006 can be classified to one of the following industry aggregates: *machinery and equipment*; *motor vehicles, parts and accessories*; *basic chemicals*; *other chemicals and man-made fibres*; *television, radio and communication equipment*. The overall import structure is clearly composed of the heterogeneous import patterns of the trading partners. Over 40% of imports originating from the EU are products of the *machinery and equipment* (mainly automatic data processing machines) as well as the *motor vehicles, parts and accessories* industry aggregates. Specific for the imports from the EU is also the importance of the *electrical machinery and apparatus* and the *professional and scientific equipment* industry aggregates in addition to the *basic chemicals*, the *other chemicals and man-made fibres* and the *television, radio and communication equipment* industry aggregates. Characteristic of the imports from China is the decreasing dominance of the *footwear*, the *textiles* and the *wearing apparel* industry aggregates. The combined share of these industry aggregates in 2006 was about 30% of all China imports. Simultaneous, however, the import share of the *machinery and equipment* and the *television, radio and communication equipment* industry aggregate increased significantly. Based on this information it can be claimed that the South African economy imports capital and skilled labour intensive products from the EU and less-skilled and skilled labour intensive products from China.

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1   I would like to thank Volker Schoer to make the list of concordance between these two classifications available.

The 3x3 Heckscher-Ohlin trade model[2]

In order to model South Africa's trade pattern a trade model that explains inter-industry trade and that keeps account with three different production factors is needed. The Heckscher-Ohlin trade theory meets these demands. According to this theory a country which is relatively rich endowed with a specific factor will export the good whose production uses this factor intensively. Therefore, countries trade with each other due to differences in factor endowment. The textbook version of this theory is, however, two-dimensional. In order to include three production factors, three industry types and three countries this section develops a three-dimensional Heckscher-Ohlin trade model within a general equilibrium framework.

Since standard assumptions apply to the theoretic model they are just mentioned briefly. First, it is assumed that the market clearing condition holds for both the factors market and goods market. This implies that all production factors will be used in the production processes and that none will be unemployed. Moreover, the goods that are produced will also be consumed, i.e. supply equals demand. Second, none of the industries makes pure profit, i.e. production costs are exactly covered by revenues. This also implies that factor remuneration equals marginal productivity. Third, production functions are smooth, homogeneous from the first order, i.e. constant returns to scale, and marginal returns diminish for each production factor. Fourth, consumers have homothetic tastes, derive an income on the factor market and spend this income on the commodity market. Fifth, each industry uses only one production factor intensively. For the rest of this paper it is assumed that the production process of industry 1 is skilled labour intensive (H), the production process of industry 2 is capital intensive (K) and the production process of industry 3 is less-skilled labour intensive (L). The definition of factor intensity with respect to three production factors is given by Jones and Scheinkman (1977). If the share of the product price to remunerate a specific factor in an industry is higher than the share of national income this production factor earns, then it is said that this industry uses this production factor intensively. Sixth, in order that factor price equalisation occurs due to trade, it is also necessary to assume that each country produces all products. It is self-evident that production factors can move freely between industries, but are immobile between countries.

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2   Note that the general results with respect to the impact of trade liberalisation in South Africa are based on insights of a three-dimensional trade model with explicit Cobb-Douglas production and utility functions, which is joined work with Ingrid Kubin.

Although the mathematical treatment of the three-dimensional Heckscher-Ohlin trade model is rather complicated, a clear graphical representation is possible by means of the concept of the endowment triangle. The insights gathered and discussed by McKenzie (1955), Leamer (1987), Jones and Marjit (1991) and Jones (1992) are united in Figure 3. This triangle is a 2-simplex and is a two-dimensional representation of a three-dimensional space. In the remainder of this section the properties of this triangle and its implications for the trade model will be discussed.
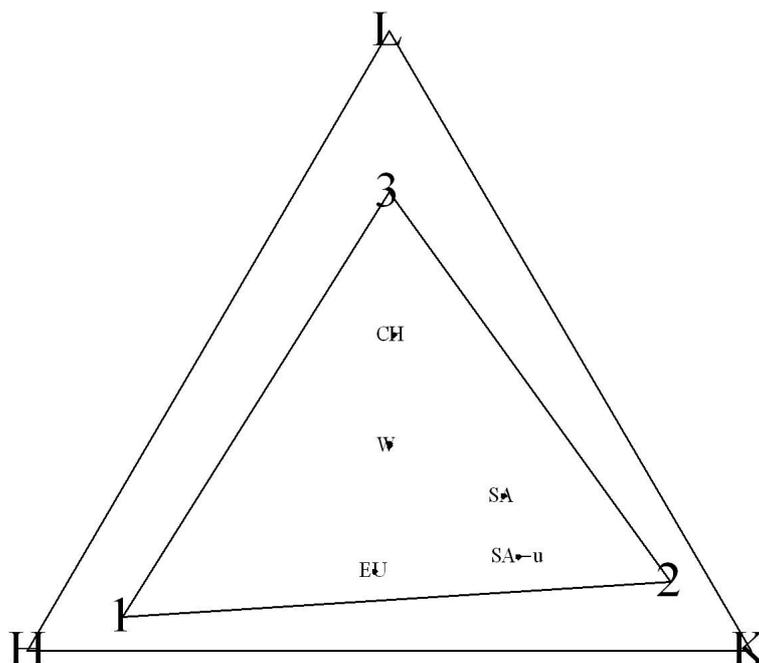

Figure 3: The three-dimensional Heckscher-Ohlin model

The *H-K-L* triangle is the endowment triangle and each vertex of this triangle represents a specific production factor. Points within this triangle are defined by three relative ratios, i.e. the H-to-K, the K-to-L and the H-to-L ratio. Moreover, the endowment triangle has one very useful feature: "Every point on a straight line from one corner of the triangle, which represents a specific factor, will have the same relative ratio of the two other factors." (Leamer 1987: 964) This property is very useful to discuss Figure 3.

Since the information that Figure 3 contains can be overwhelming at first sight, each different aspect will be discussed in a logical order. As already mentioned the *H-K-L* triangle is a two-dimensional representation of a three-dimensional space. Each vertex represents a specific production factor. Moreover, by normalising the scale of three-dimensional space according to the

factor endowment of the world[3], the endowment of the world lies in the middle of this triangle and is represented by point *W*. Through this scaling the relative factor ratios of the world are al the same, i.e. $H^W/K^W = K^W/L^W = L^W/K^W$. By means of statistics of the International Labour Organisation (ILO 2010) for the year 2005 the endowments of the EU, China and South Africa with respect to skilled labour and less-skilled labour can be retrieved. Unfortunately, it was not possible to obtain capital stock data with respect to these three regions. Therefore, capital endowments are based upon an educated guess. Figure 3 shows the relative endowment of four regions with regard to the world endowment and the actual endowments of these regions are given in Table 1. Note that there are two columns referring to less-skilled labour endowment. The first column, *Less-skilled Labour (empl.)*, defines the endowment of less-skilled labour as less-skilled labour that is also employed. The second column, *Less-skilled Labour (total)*, also includes unemployed individuals, which are characterised by a low level of formal education and account for around 40% of South Africa's labour force. Whereas this difference has a significant impact of the position of South Africa within the endowment triangle, the relative position of the EU and China is virtually unaffected by it. This also explains the fact that the South African endowment is once represented by the point *SA*, which keeps account with unemployed less-skilled labour in South Africa, and once by the point *SA-u*, that only considers employed less-skilled labour.

	Skilled Labour (*H*)	Less-skilled Labour (empl.) (*L*)	Less-skilled Labour (total) (*L*)	Capital[4] (*K*)
South Africa	2.02%	1.27%	2.33%	5.00%
China	37.71%	81.67%	80.80%	40.00%
EU	60.27%	17.05%	16.87%	55.00%
World	100.00%	100.00%	100.00%	100.00%

Table 1: Factor endowments
Source: ILO (2010)

By applying the insights of Jones (1992) on Figure 3 some claims can be made. The EU is the only country in which only one factor is scarce, namely less-skilled labour. In the other two countries two factors are scare. Whereas skilled labour is a scarce factor in both China and South Africa, capital is a scare production factor in China and less-skilled labour is scarce in South Africa. This result is independent of the position of the South African endowment, i.e. it holds for *SA* as well as for *SA-u*. This result may be appear counter intuitive, but is the result of the fact that scarcity is defined relative to the world endowment and that China has around 81% of the global less-skilled

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3   Note that the world variable is defined as the sum of the European, Chinese and South African endowments.
4   The capital endowments are an educated guess of the author.

labour supply. The difference between *SA* as and *SA-u* is given by a higher relative K-to-L and H-to-L share for the *SA-u* endowment point. In the remainder of this section only *SA-u* will be considered, since unemployment of less-skilled labour is not considered at first.

Within the endowment triangle the factor input vectors of the three industries can also be represented by the same method. The *1-2-3* triangle in Figure 3 is a possible distribution of the factor input vectors on a global level. The exact position of this triangle is a function of the production technology of the three industries and the world endowment. As assumed industry *1* uses skilled labour (*H*) intensively, the production of good *2* is capital (*K*) intensive and the production of industry *3* is characterised by its less-skilled labour (*L*) intensiveness. Since each country's endowment point lies within the triangle of diversification, all three products are produced in each country. This is another property of the endowment triangle, which is discussed by Leamer (1987). Moreover, since only the points *W, EU, CH* and *SA-u* are regarded, none of the production factors will be vacant, i.e. all factors are fully employed. Another implication of the basic assumptions is that the consumption patterns in each country will be equal to the global consumption pattern and global consumption equals global production.

On the basis of the position of the *1-2-3* triangle in Figure 3 it is possible to deduct the produced amounts of all three industries. From the discussion of the concept of the endowment triangle in Leamer (1987), Jones and Marjit (1991) and Jones (1992) it is clear that *W*, the world endowment point, is a positive combination of the factor input vectors of the three industries. Moreover, the shortest distance between *W* and the *2-3* edge is an indicator for the amount of good *1* that is produced in the general equilibrium. This is a logical consequence of the fact that every point on the *2-3* edge is only a combination of the factor input vectors of industry *2* and industry *3* and point *W* is a combination of the factor input vectors of all three industries. This can be generalised and the shortest distance between the endowment point and an edge of the *1-2-3* triangle is an indicator for the production of the industry opposite to this edge. The same technique can be used to analyse the production levels at the *EU*, *CH* and *SA-u* endowment points.

By comparing the production levels of each country with the world consumption levels, i.e. the production at the global level, following statements can be made:
- Both South Africa and China produce not enough of good *1* to satisfy domestic demand. Simultaneously, the EU has surplus production of this good. Therefore, the EU exports the skilled labour intensive good to South Africa and China.

- In South Africa as well as in the EU the production of the capital intensive good exceeds domestic demand. China will import this surplus production of good *2* in order to satisfy its domestic demand for this good.
- The EU and South Africa produce a relative small amount of the less-skilled labour intensive good. Therefore, these countries import the surplus production of good *3* from China.

Although South Africa's trade flows can be modelled by means of the endowment triangle, this is not enough information yet to answer the paper's research question. What is more interesting, is the difference between an autarkic South African economy and this economy integrated in the world economy. Especially the change of the input vectors are of special interest. Since the factor input of the industries is dependent on the initial country endowment and the distribution of these factors is a function of the production technology, which is assumed to be equal for all countries, it is possible to compare relative factor input vectors. In the case of South Africa two observations can be made. In the wake of trade liberalisation overall production will become less capital intensive with respect to less-skilled and skilled labour. This result is similar to the result of the two-dimensional trade model, that shows that the production in the capital rich country will become less capital intensive over time. In addition, the three-dimensional model also shows that South Africa's production will become more less-skilled labour intensive with respect to skilled labour due to the integration in the world economy. Since these results do not consider labour market rigidities it is necessary to adjust the trade model and to include unemployment of less-skilled labour.

The binding minimum-wage argument

The socio-economic problem of unemployment is a major challenge for the new South African government. Although most observers (e.g. Banerjee et al. 2006 and 2008, Nattrass 2003 and Seekings and Nattrass 2005) agree that unemployment is not a recent phenomenon in the South African society, it cannot be disputed that this problem aggravated since the 1990s. Whereas in 1995 the official unemployment rate was 15.6%, in 2006 it was 26.7% after a peak of 30.3% in 2001 (Banerjee et all. 2008). With respect to the trade model it is a challenge to incorporate this multi-dimensional problem.

To simplify matters this paper combines different labour market rigidities into a binding minimum-wage argument. This paper would like to emphasise three different channels, which influence the wage level for less-skilled labour: labour legislation (incl. minimum wages), reservation wages and labour market frictions. In the following discussion each component and its effect on the wage level will be displayed.

In the wake of the political transition a new regulation of labour markets and the industrial relations system emerged. As noted by Bhorat et al. (2002), the general impression amongst business participants is that the chosen form of labour legislation increased the cost of doing business. Besides new rules with which employers have to comply, this regulation also introduced binding minimum wages. These minimum wages are a result of agreements reached within bargaining councils. Therefore, they vary not only from sector to sector, but also from job category to job category (Braude 2005: 440-444). The regulation of the labour market was part of the new growth path for South Africa which was developed by the new government. Nattrass (2001) describes this growth path as "High Productivity Now" and argues that the aim of the new government is to overcome the legacy of apartheid. With respect to the labour market this legacy consisted of low wages for the non-white labour force, which was also markedly less educated. By means of promoting highly productive industries government officials aspired to create a (fast) growing economic environment which could support higher wages for less-skilled workers. As a result of this regulation one can assume that the wage for less-skilled labour has increased.

Whereas the previous paragraph discussed the demand side of the labour market, it is also possible to interpret rigid wages from the supply side. In this case the reservation wage of workers is higher than the market clearing wage. This topic is discussed by Banerjee et al. (2008). In their paper the authors argue that employment and labour market participation on household levels is influenced by the social pension program. Part of the social transition was the extension of the generous old-age pension that was in place for whites to the rest of the population and which offers a compensation around twice the per capita income. Workers in households receiving such a pension can thus be supported by old members of this household (Banerjee et al. 2008: 735). A general effect on the labour market is that firms have to offer higher wages to find employees. The impact of this reservation wage argument is also an increase of the wage for less-skilled labour.

A third factor that could explain rigid wages within the South African context refers to labour market frictions. Whereas the other two arguments consider the supply and the demand side of

labour markets, the functioning of these markets are now taken into account. The main frictions are the geographical segmentation and the skills of workers. The segmentation policy of the apartheid government did not only create reserves of less-skilled labour in the bantustans, but did also create industrial agglomerations (e.g. Gauteng, Cape Town, Durban, etc.). Therefore, job searchers are less informed concerning the availability of jobs and their characteristics. Moreover, when searching for a job they face a rather basic public transport system, which aggravates the problem (Banerjee et al. 2008: 734). Another problem is the inheritance of the segmented educational system. Whereas older generations only have a few years of schooling, younger generations benefited from the transformation of the educational system and have around ten years of schooling. Older generations are thus partly handicapped. Due to the new schooling system the benefits of education have probably fallen. Moreover, employers face difficulties to assess the skills of potential employees (Banerjee et al. 2008: 736). These frictions result in extra costs in the search and matching procedure on the labour market and thus augment the wage for less-skilled labour (Cahuc and Zylberberg 2004: 518-523).

As already indicated, each of these arguments discusses a different aspect of labour markets. The effect on the wage level of less-skilled labour is, however, similar. In order to discuss this effect without making things unnecessarily complicated wage rigidity will be regarded as a binding minimum wage. In the next step this binding minimum-wage is introduced into the three-dimensional trade model similar to the work of Brecher (1974) and Davis (1998).

The starting point of the theoretical analysis is now the endowment point SA, i.e. unemployed less-skilled labour is also included. This also implies that the market clearing condition for less-skilled labour does not hold anymore for South Africa. This condition is replaced by a minimum wage for less-skilled labour, which is also binding for the closed economy. Therefore, the input of less-skilled labour is defined by this minimum wage and is no longer a function of South Africa's endowment. Moreover, the minimum wage is defined relative to the price of a specific good and the price of this good is not only defined by the amount of less-skilled labour used in the production, but also of the amount of skilled labour and capital necessary to produce this good. In order to meet this minimum-wage on the labour market the amount of employed less-skilled labour should be reduced or the available resources of capital and skilled labour should be increased. The latter would increase the price for less-skilled labour relative to capital or skilled labour. Since it is assumed that factor endowments are fix and are not increasable at will, the only way to pay the minimum wage is to decrease the amount of less-skilled labour used in the South African economy.

This implies that even in the closed economy South Africa faces unemployment of less-skilled labour.

What is the effect of trade liberalisation on this result? The global general equilibrium will also imply partial unemployment of less-skilled labour. Moreover, this burden will only be borne by the South African economy. The fact that the two other production factors, for which no minimum wage applies, influence good prices and thus also the real wage of less-skilled, is helpful to analyse this change. First, the change of the relative factor input of capital-to-less-skilled labour is function of the region's capital-to-skilled labour endowment ratio. This implies for South Africa that production becomes less capital intensive with respect to less-skilled labour. Second, the skilled-to-less-skilled labour ratio is a function of the skilled-to-capital endowment ratio. Contrary to the previous result, this ratio will not decrease, but will increase in South Africa due to trade liberalisation. Third, unemployment is also a function of relative skilled labour and capital endowment. In the case displayed by Figure 3, trade liberalisation will increase the number of unemployment less-skilled labourers in South Africa.

The econometric specification

The insights of the three-dimensional trade model are now used to develop an econometric specification to test the hypothesis that trade liberalisation increased unemployment. Unfortunately, it is not possible to estimate the effect of trade on unemployment directly. The considered time period is to short to yield any significant and reliable econometric results with only one time serie. However, by using industry panel data for the period 1994-2006 it is possible to test the hypothesis indirectly. The theoretical model shows that trade liberalisation has an impact on the factor input vectors of the industries and that labour market rigidities, which result in unemployment, have a significant impact on this relationship.

Moreover, two other restrictions remain. First, the theoretical trade model explains inter-industry trade, i.e. an industry either exports or imports, but will not export and import at the same time. In the real world this is, however, not the case. To overcome this problem it makes sense to use the absolute value of industry net exports as an indicator for trade openness. Industries with a low Grubel-Lloyd index will thus have a higher degree of openness and vice versa. Second, whereas the theoretical model shows a clear change of factor input vectors in all industries, the magnitude of

this effect at industry levels is not clear. Since the econometric analysis uses industry panel data to estimate the overall effect this restriction appears not so important.

From the previous section it should be clear that higher levels of trade openness correspond with a decreasing use of capital relative to less-skilled labour in all industries. With respect to the share of skilled labour relative to less-skilled labour is these industries will, on the contrary, increase. These hypotheses can be formulated as follows:

$$\frac{H_{jt}}{L_{jt}} = f_j\left(\left|NX_{jt}\right|\right) \quad \text{with} \quad \frac{\partial f_j}{\partial\left(\left|NX_{jt}\right|\right)} > 0 \tag{2}$$

$$\frac{K_{jt}}{L_{jt}} = g_j\left(\left|NX_{jt}\right|\right) \quad \text{with} \quad \frac{\partial f_j}{\partial\left(\left|NX_{jt}\right|\right)} < 0 \tag{3}$$

Equation 2 shows that the fraction of skilled-to-less-skilled labour in industry j at time t is a positive function of the absolute value of the net exports of this industry, whereas Equation 3 indicates a negative relationship between trade openness and the capital-to-less-skilled labour ratio. Moreover, the effect described by Equation 2 will be enforced by unemployment. Simultaneously, unemployment will cushion the effect of Equation 3.

Due to the nature of the panel data these basic equation are transformed into error correction models and the White cross-section method is used to overcome the problem of heteroscedasticity. Note that the absolute value of net export shares are used, i.e. the difference between the export and import shares at industry levels. This approach keeps thus account of scale effects due to the economic growth of South Africa.

The econometric results displayed in Table 2 confirm the hypotheses which are based on the theoretical model. Whereas the estimated coefficients of the independent variables are displayed next to these variables, the values between brackets are p-values corresponding to the test of significance. Long-run effects are depicted by the logarithmic and lagged variables, whereas short-run effects are indicated by the Δ-variables. Note that to find the long-run impact of the independent variable on the dependent variable the coefficient of the independent variable is divided by the coefficient of the lagged dependent variable and multiplied by minus one. From Table 2 it is clear to see that increasing inter-industry trade has a positive and significant effect on the ratio of skilled-to-less-skilled labour. Although the effect of trade on the ratio of capital-to-less-

skilled labour is not significant at a ten percent level, the sign indicates a negative relationship between these variables. It should be noted that to obtain these results two data outliers were eliminated and 31 industries were considered. The estimation did account for industry and time fixed effects.

Variable	$\Delta\left(\log\dfrac{H_{jt}}{L_{jt}}\right)$	$\Delta\left(\log\dfrac{K_{jt}}{L_{jt}}\right)$
$\Delta|NX_{j(t-1)}|$	-0.000147	0.005189
	(0.0254)	(0.2926)
$|NX_{j(t-1)}|$	0.000129	-0.005094
	(0.0623)	(0.1661)
log Dependent Variable (t-1)	-0.014265	-0.147095
	(0.0000)	(0.0000)
Dependent Variable (t-1)	0.752775	0.829153
	(0.0000)	(0.0000)
Indicators		
R-squared	0.997917	0.757430
Adj. R-squared	0.997628	0.723740
Observations	370	370
Long-run effect		
$|NX|$	0.009043	-0.034631

Table 2: Econometric analysis - first results

Based on the insights of the theoretical model it is possible to break the coefficient of the absolute net exports down into two effects. The first component is the 'pure' effect of trade on the input vectors. This effect should be the same as the effects discussed in the theoretical trade model without labour market rigidities. This would imply that the trade coefficient with respect to the skilled-to-less-skilled labour ratio is negative instead of positive, whereas the trade coefficient with respect to the capital-to-less-skilled labour remains negative. The second component is the effect of the labour market rigidities on the adjustment process. With respect to the skilled-to-less-skilled labour ratio this effect is big enough to compensate the negative 'pure' effect of trade. It would also decrease the magnitude of the effect of trade on the capital-to-less-skilled labour ratio. This breakdown can easily be included in the econometric specification by means of an interaction term between the absolute value of net trade and the unemployment rate, which indicates labour market rigidities. The unemployment data come from the World Development Indicators database of the World Bank (2011). The results for this advanced specification are displayed in Table 3.

Variable	$\Delta\left(\log\dfrac{H_{jt}}{L_{jt}}\right)$	$\Delta\left(\log\dfrac{K_{jt}}{L_{jt}}\right)$
$\Delta\lvert NX_{j(t-1)}\rvert$	-0.000133	0.005687
	(0.0637)	(0.2598)
$\lvert NX_{j(t-1)}\rvert$	-0.000219	-0.014498
	(0.1264)	(0.0241)
$U_{(t-1)}\lvert NX_{j(t-1)}\rvert$	0.000013	0.000328
	(0.0066)	(0.0687)
log Dependent Variable (t-1)	-0.013887	-0.150556
	(0.0000)	(0.0000)
Dependent Variable (t-1)	0.750228	0.832785
	(0.0000)	(0.0000)
Indicators		
R-squared	0.997934	0.758691
Adj. R-squared	0.997640	0.724325
Observations	370	370
Long-run effect		
$\lvert NX\rvert$	-0.157701	-0.096296
$U\cdot\lvert NX\rvert$	0.000936	0.002179

Table 3: Econometric analysis - advanced results

The long-run 'pure' effect of trade corresponds to the predictions of the theoretical trade model without labour market rigidities. Production becomes less capital intensive and less skilled labour intensive relative to less-skilled labour due to trade liberalisation. The sign of the interaction term is positive and also conform with the theoretical predictions. By comparing the results of Table 2 with those of Table 3 it is clear that the econometric analysis validates the results of the three-dimensional trade model.

Conclusion

This paper analysis the impact of trade liberalisation on (un)employment in post-apartheid South Africa. A literature overview showed that most papers do not use a consistent trade framework to analyse the impact of trade on (un)employment. Therefore, a three-dimensional trade model that captures South Africa's trade pattern with respect to the EU and China was developed. Furthermore, this model was adapted to include labour market rigidities by means of a binding minimum-wage. Based on this model it was possible to define two estimation specifications that capture the impact of trade liberalisation on the relative use of capital and skilled labour relative to

less-skilled labour. Moreover, the influence of unemployment, i.e. labour market rigidities, on these relationships can be tested. The econometric results supported the insights of the three-dimensional Heckscher-Ohlin trade model. Although it is not possible to establish a direct link between trade and unemployment, it was shown that unemployment did influence the change of input vectors according to the theoretical model. The approach developed in this paper extends the existing literature and contributes significantly to the debate on the impact of trade on employment.

The insights gathered in this paper can also be used to discuss some general policy implications. Based on the developed approach it is possible to make policy suggestions with respect to the labour market as well as to the trade regime. According to the developed theory unemployment is a result of labour market rigidities. It was argued that these rigidities result into a wage for less-skilled labour that is higher than the market clearing wage defined by the trade model. Therefore, it is logical that labour market policies should try to overcome these distortions. As indicated the binding minimum-wage for less-skilled labour can only be paid if a part of the less-skilled labour force is unemployed. It would, however, also be possible to change the factor endowment of South Africa, i.e. to induce a relative increase of skilled labour relative to the supply of less-skilled labour. By means of education and training it would be possible to do this. Since transition in 1994 the new South African government did introduce a new educational system and is keen to overcome the educational segregation of the apartheid era. Notwithstanding these efforts, the results are not immediately at hand and benefits can only be reaped after a longer time period. In addition, the Skills Development Act of 1998 can also be interpreted as a policy instrument to induce this endowment shift. All in all, the South African government is already active in this policy field. Another approach could aim at reducing the cost of doing business for employers. A simplification of the legal framework could also reduce the cost of employing less-skilled labour and thus decrease unemployment. It is, however, unclear how this suggestion can be implemented without reducing the new gained democratic rights of employees. Another possibility would aim at increasing the quality of the South African infrastructure. This could also induce a reduction of frictions on the labour market and create new job opportunities in different regions. An alternative policy suggestion would be to increase the support for specific sectors. Trade data show that industries affected by the Motor Industry Development Programme display a more intra-industry trade pattern. Based on this observation it would thus be possible to support less-skilled labour intensive industries. Although the non-tradable sectors were not discussed, it could also be fruitful to support these industries to absorb unemployed less-skilled labour.

Besides these policy suggestions with respect to the labour market it is also necessary to take a look at the trade policy. In general, this paper showed that the reintegration of South Africa in the world economy increased unemployment of less-skilled labour. If one assumes that the increased integration is the result of trade liberalisation, then it is clear that further trade liberalisation will aggravate the unemployment crisis. If the inter-industry trade pattern of South Africa is the result of an anti-export biased trade regime, it would make sense to restructure this regime in favour of exports. This would probably induce a more intra-industry trade pattern. One of the main aims of the South African trade policy should be the diversification of exports to the EU and China. Whereas the theoretical model cannot predict how this change influences unemployment, results of other studies indicate that less-skilled labour could benefit from such a policy.

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