

Human Capital in Economic Development: From Labour Productivity to Macroeconomic Impact*

Kristinn Hermannsson¹ and Patrizio Lecca²

Microeconomic evidence reveals high private returns to education, most prominently in low-income countries. However, it is disputed to what extent this translates into a macroeconomic impact. This paper projects the increase in human capital from higher education in Malawi and uses a dynamic applied general equilibrium model to estimate the resulting macroeconomic impact. This is contingent upon endogenous adjustments, in particular how labour productivity affects competitiveness and if this in-turn stimulates exports. Choice among labour market assumptions and trade elasticities results in widely different outcomes. Appraisal of such policies should consider not only the impact on human capital stocks, but also adjustments outside the labour market.

Keywords: human capital, economic development, higher education, labour markets, trade, Malawi.

1. Introduction

A well-known empirical conundrum is that micro- and macro-impacts of education are not consistent (Pritchett, 2001). The earning benefits of education to individuals when aggregated are typically larger than the economy-wide impact found in macrodata. This has been flagged up as one of the major gaps in education economics (Psacharopoulos & Patrinos, 2004) and fostered a degree of scepticism about the macroeconomic contribution of education (Benhabib & Spiegel, 1994; Pritchett, 2001). Significant efforts have gone into explaining this via statistical/measurement issues (McMahon, 2000; Krueger & Lindahl, 2001; Hanusheck & Woessmann, 2008; Schoellman, 2012). However, as Sianesi and Van Reenen (2003) point out, less attention has been given to the transmission mechanism from a micro- to macro-impact. Increasing access to education could be particularly important for low-income countries, given the high marginal returns found in labour market data. However, as Chirwa and Matita (2009) point out, it is often perceived as a luxury in this context. Therefore, it is

*The author's acknowledge the financial support of the Icelandic International Development Agency. The paper has benefited from the input of seminar participants at Chancellor College, the University of Malawi, and workshops of the Development Studies Association Scotland in Dundee and Edinburgh. Furthermore, we are grateful for the comments of two anonymous reviewers and the editors. The views expressed are the sole responsibility of the authors and not the institutions they are affiliated to.

¹Robert Owen Centre for Educational Change, School of Education, University of Glasgow Glasgow, UK.

²Institute for Prospective Technological Studies (IPTS), Joint Research Centre, European Commission Seville, Spain.

JEL classifications: O15, O22, E17, I25, F16

Correspondence: Kristinn Hermannsson, Robert Owen Centre for Educational Change, School of Education, University of Glasgow, St Andrews Building, 11 Eldon Street, Glasgow G3 6NH, UK.

Email: kristinn.hermannsson@glasgow.ac.uk

important both from academic and policy perspectives, to understand under what conditions the individual benefits of education are transformed into an economy-wide impact.

Looking at existing evidence (summarised in the next section), it is clear that signalling effects and measurement issues are insufficient to explain the gap between the individual-level benefit of education and the macroeconomic impact. Therefore, we focus on the transmission mechanism from the labour market to the wider economy and the extent to which this is likely to account for the micro-macromismatch. The analysis is carried out for Malawi, a small country in sub-Saharan Africa. We draw on comprehensive information on returns to education in self-employment from the 2004/2005 national household survey (Matita & Chirwa, 2009) to calibrate the change in human capital following an increase in the number of higher education graduates in the labour market as a change in effective labour supply.³ A dynamic applied general equilibrium model is used to simulate endogenous adjustments and the resulting macroeconomic impact.⁴ Malawi is a good case study due to the availability of detailed labour market analysis and a 2007 Social Accounting Matrix (SAM) constructed by Douillet *et al.* (2012).

Simulations are carried out under a combination of two common labour market specifications and two sets of parameter estimates for the price sensitivity of exports, as used by the World Bank and the Global Trade Analysis Project (GTAP). Under these assumptions, the projected increase in human capital results in widely divergent macro-impacts. The outcome is driven by the trade mechanism, but exacerbated by the labour market specification. Therefore, we argue that studying labour market issues in isolation is insufficient to determine the development impact of human capital policies, but that analyses need to incorporate the micro-macro transmission mechanism.

The next section summarises previous research. The third section illustrates the projection of the human capital stock. The fourth presents the modelling strategy and macroeconomic data used. The fifth section presents and discusses the results. Brief conclusions are presented in the sixth section. Model details are outlined in Appendix.

2. Wage Premia as Indicator of Labour Productivity

An extensive microeconomic literature documents the rates of return to education at various levels of schooling, in different countries at different times.⁵ These studies reveal a clear association between education and wages, typically finding high returns in low-income countries (see Psacharopoulos & Patrinos, 2004; for a survey). For instance, graduates in Malawi earn approximately three times as much as those with primary qualifications (Chirwa & Matita, 2009, Table 3, p. 12).

Due to an inability to conduct controlled experiments in the field, verifying the causality between education and income is difficult. Interpreted in the spirit of the human capital school (Mincer, 1958; Schultz, 1960; Becker, 1964) education directly increases human capital, which in turn increases the productivity of workers. An alternative view is motivated by the theory of signalling and screening (Arrow, 1973; Spence, 1973; Stiglitz, 1975), which maintains that *in extremis* education does not enhance human capital (and as a consequence productivity), but simply serves the purpose of revealing innate ability to employers (for an overview see Brown & Sessions, 2004). A range of statistical approaches have been applied to address this conundrum, such as utilising natural experiments (Card, 2001; Krueger & Lindahl, 2001) and controlling for fixed effects using twin samples (Bonjour *et al.*, 2003; McMahan, 2009, Appendix A). The weight of evidence suggests education affects income *per se* but is not just a proxy for unobserved ability (Card, 1999, 2001; Harmon & Walker, 2003; Blundell *et al.*, 2005) and that there is a role for signalling, but of modest magnitude relative to

³For simplicity, the focus here is on higher education, but the approach can be applied to any stage of the education system.

⁴This is similar to the approaches used by Giesecke and Madden (2006) for Tasmania and Hermansson *et al.* (2014) for Scotland.

⁵Psacharopoulos and Patrinos (2004) summarise the results of more than 80 studies of the microlevel returns to education. Card (2001) and Harmon and Walker (2003) survey the evidence and discuss how it should be interpreted. For an overview of recent work pertaining specifically to Africa, see Barouni and Broecke (2014).

overall impacts (Lange & Topel, 2006). The empirical evidence is mainly from market employment in high-income countries. However, drawing on the link between education and output in self-employment can be more representative for low-income countries (Soon, 1987; Jolliffe, 2004) and has the added benefit of circumventing the influence of labour market signalling (Heywood & Wei, 2004).

Matita and Chirwa (2009) analyse the productivity of the self-employed by level of education for several occupations in Malawi, based on the 2004–2005 integrated household survey (NSO, 2005). They find higher education to have a varying impact depending on occupation. The least impact is on Maize growers, which are on average 68 per cent more productive than those with primary qualifications (Table 2, p. 15), while tobacco growers are 136 per cent more productive (Table 3, p. 16). The biggest impact is for enterprise earnings, where self-employed graduates earn more than 3 times that of those with primary school qualifications (Table 4, p. 18). On average, self-employed graduates earn about 2.5 times that of those with primary qualifications. Conversely, for market employment (Chirwa & Matita, 2009) graduates earn about 3 times that of those with primary qualifications. If the difference between the two estimates is interpreted as a signalling effect, this would suggest the wage premia of graduates in market employment, overstates the productivity benefits of higher education by about 20 per cent.⁶

In a growth accounting exercise, an increase in the education adjusted labour supply would simply mean more inputs into the labour component of the production function, which in turn would suggest more output. The causal mechanism is clear in principle, but rests on strong assumptions. However, macroeconomic studies based on cross country regression have provided mixed results on the impact of education, and some authors are highly sceptical (Benhabib & Spiegel, 1994). Sianesi and Van Reenen (2003) survey over 20 macrogrowth regressions and argue that overall these support the qualitative notion that human capital stimulates growth, but in the light of methodological complications they urge caution in quantifying the magnitude of such links.

Even if signalling modifies the individual productivity benefit of education, the direct productivity stimulus as captured in self-employment data is still large. The question remains how does this productivity stimulus translate into a macroeconomic impact and can endogenous adjustments in that process be sufficient to account for the mismatch between empirical observations of micro- and macro-impacts of education?

3. Human Capital Projection

The stock of human capital is calculated following a standard approach from growth accounting, where supply of labour at different skill levels is aggregated into a single stock of human capital, constructed as efficiency units of labour. Following Acemoglu and Autor (2012), for two types of labour unskilled (N) and skilled (H) the human capital stock in efficiency units can be presented as:

$$Z = N + \frac{\omega_H}{\omega_N} H = N + \omega H$$

where ω_H is the wage of high-skill workers, ω_N is the wage of unskilled workers, and $\omega = \omega_H/\omega_N$ is the wage premium of high-skill workers.

Population and human capital stocks are fixed, except for graduates from higher education, which enter the labour market at the rate of graduation exhibited by the higher education system in 2004. Every time period the oldest age cohort of workers retires. This contains a smaller share of tertiary graduates than the new cohorts. Gradually, over time the human capital stock (expressed in efficiency units) increases until it reaches a steady state where the number of tertiary graduates entering the labour market equals the number of those retiring. Parameters are informed by the work of Matita and Chirwa (2009) on the return to education among the self-employed, discussed in the previous section. The least skilled workers equal one efficiency unit, whereas the wage premium of graduates with tertiary education makes them equivalent to 4.18 efficiency units. This indicates a

⁶This is a larger signalling effect than found in high-income countries where it is taken to be around 10 per cent. See Hermansson *et al.* (2014) (section 2.2) for a discussion of the evidence for high-income countries.

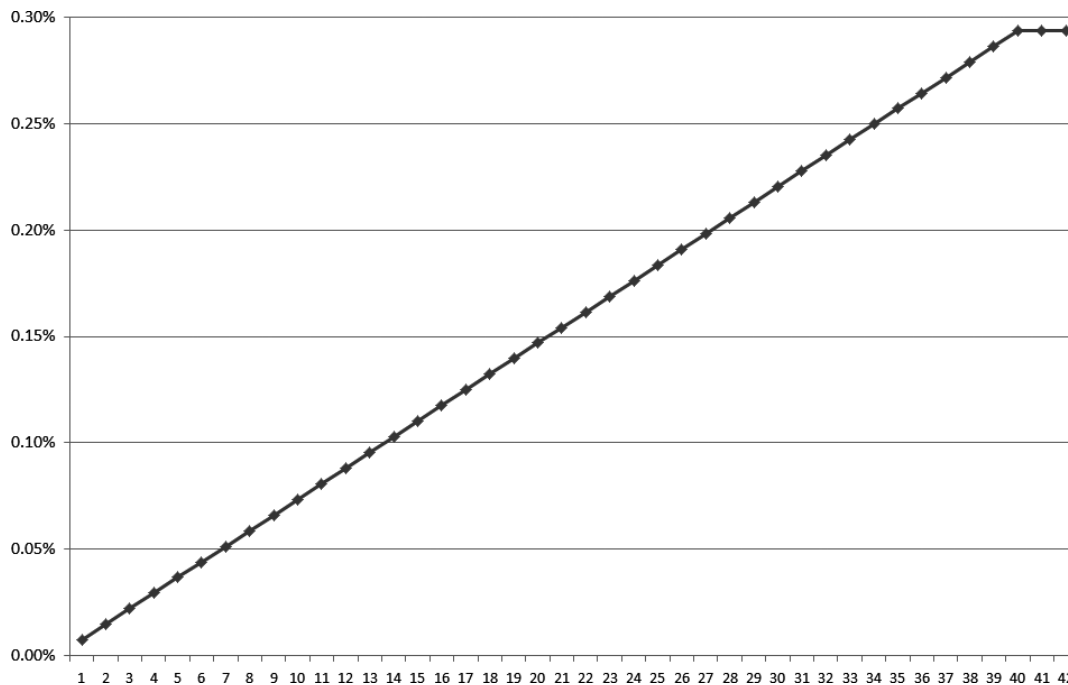


Figure 1. Projected Effective Labour Supply: %-Change from Base Year as a Result of Increases in the Share of Graduates in the Labour Market

significant productivity differential between the least skilled and the most skilled. However, the base of tertiary skilled workers is very small (0.4 per cent), so the overall impact is modest – a 0.29 per cent long run increase in effective labour supply. This process is illustrated in Figure 1.

4. Modelling Approach

An applied general equilibrium model with forward looking agents is used to estimate the macroeconomic impact that results from the increase in the human capital stock. This is derived from a typical neoclassical, one sector closed-economy model (Abel and Blanchard (1983), where investment decisions follow a Tobin's q adjustment (Tobin, 1969) and are separated from savings decisions. Our Applied General Equilibrium model for Malawi extends this skeletal model. It is solved numerically as an open economy model, where the Rest of World (ROW) is considered exogenous and trade is price sensitive. The labour market is characterised by imperfect competition where adjustments are obtained through changes in the unemployment rate. Furthermore, it contains a multisectoral dimension. It is configured for 18 sectors (see Table A2 in Appendix) and three domestic institutions: households, firms and government. Details of the model are presented in Appendix, and model code is available for download.⁷ The model is calibrated using SAM for the year 2007 (Douillet *et al.*, 2012).

The simulation invokes a Harrod neutral productivity change, that is an increase in effective labour supply which progresses from 0.007 per cent in the first period to 0.29 per cent in the long run, as reported in the previous section.⁸ The analysis focusses on two contingencies in the transmission

⁷<http://dx.doi.org/10.5525/gla.researchdata.188>.

⁸More formally, this occurs as an increase of the coefficient A in Equation A6.

Table 1. *Simulation Results*

	RWB		FNW	
	SR	LR	SR	LR
GDP*	0.01	0.356	0.115	0.54
Consumer price index	0.306	-0.071	0.359	-0.109
Unemployment rate	-0.228	-1.723	-3.761	-4.996
Total employment	0.015	0.11	0.24	0.319
Nominal wage	0.329	0.101	0	0
Real wage	0.023	0.172	-0.357	0.109
Replacement cost of capital	0.214	-0.159	0.297	-0.241
Population	0	0	0	0
Consumption*	0.325	0.345	0.503	0.523
Capital stock*	0	0.416	0	0.632
Export*	-0.636	0.116	-0.812	0.176

Note: *Variables expressed in real terms. Short-run (SR) and long-run (LR) impacts under real wage bargaining (RWB) and fixed nominal wage (FNW) (%-change from base year).

from a microlevel increase in human capital to macrolevel output; the extent to which increased labour productivity affects competitiveness; and the degree to which competitiveness stimulates exports. To this end, a comparison is made between the impacts of human capital under two commonly applied labour market assumptions. Firstly, we invoke a wage curve (Blanchflower & Oswald, 1984), where the real wage responds to the local rate of unemployment. This is frequently used for high-income countries, but empirical work suggests (e.g. Hodinott, 1996) it is appropriate for low-income countries such as Malawi. Second, for comparison we impose a fixed nominal wage (FNW). This is a stylised assumption and unlikely to hold in the long run. However, it can be motivated as an approximation of a situation where labour supply is very flexible, such as when a large share of the population is occupied in subsistence activities, as is the case for many countries in sub-Saharan Africa. Furthermore, this gives an indication of the sensitivity to labour market conditions, which are an important transmission mechanism from labour productivity to competitiveness. In addition, the model is solved using two alternative parameter estimates for the price sensitivity of exports. The higher elasticity (4) was estimated for the World Bank Linkage model and the lower one (3) for the GTAP (Anderson *et al.*, 2006; Table 12A.2, p. 392).

5. Simulation Results

Key results from the simulations are presented in Table 1. These are expressed as percentage change from base-year values and should be interpreted as showing the outcome as compared to what would have occurred without the efficiency increase. The first two columns report results obtained under real wage bargaining (RWB), while the last two columns show results under FNW. We shall first explain the long-run and short-run results obtained under RWB, before taking a look at the impact of adopting a FNW labour market closure, the time path of adjustment and the influence of varying the trade elasticities.

In a simple growth accounting set-up, the change in output can be calculated as the percentage change in labour productivity weighted by the share of labour in base-year GDP (47 per cent in our SAM). In the long run, this implies a 0.138 per cent increase in GDP ($0.47 \times 0.00294 = 0.00138$). However, in a general equilibrium framework, the change in output is not only driven by the productivity shock but also by relative changes in the price of output, which in turn affect competitiveness (Adams & Parmenter, 1994; Hermannsson *et al.*, 2014).

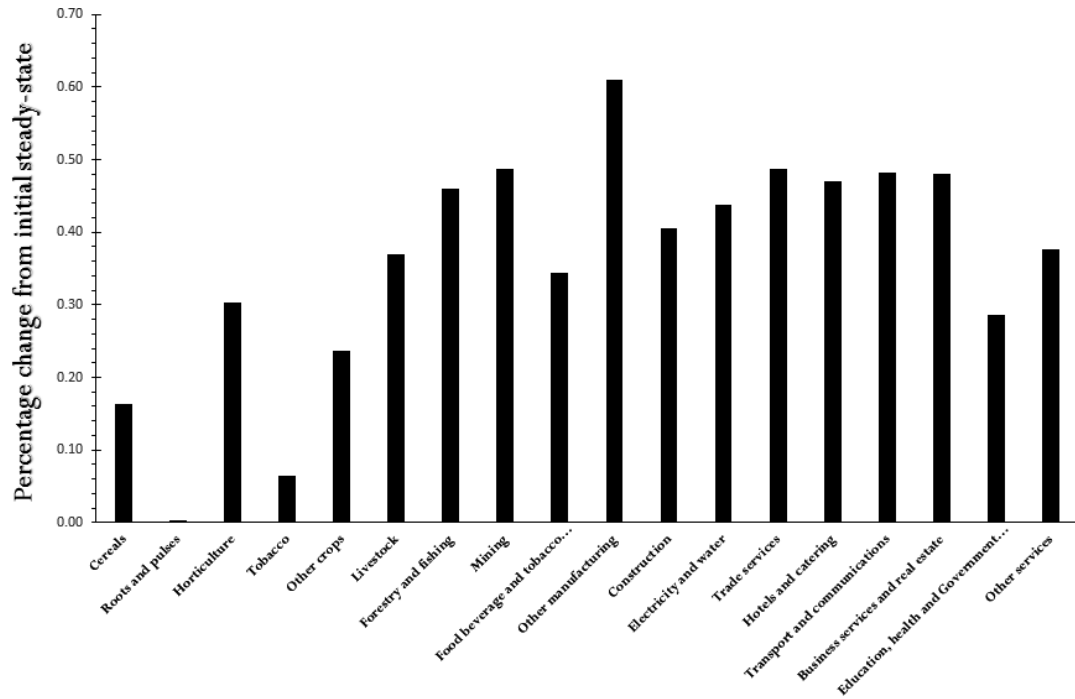


Figure 2. *The Long-Run Output Impact on Individual Sectors Under the RWB Closure*

Looking at the second column of Table 1, we indeed see that, in the long run, real GDP increases by 0.356 per cent relative to base year.⁹ This is more than two times larger than the impact implied by growth accounting. Moving down the second column, we see that the Consumer Price Index is down by 0.071 per cent from the base year. This occurs as the increase in labour productivity means more output can be produced with the same level of labour inputs (in natural units), thereby putting downward pressure on commodity prices.

This, in turn, generates an increase in competitiveness which, given the relative price sensitivity of external trade in our model, is translated into an export stimulus amounting to 0.116 per cent relative to base year. As the downward pressure on prices boosts real income, this encourages household consumption. Similarly, lower prices stimulate investments. Capital stock accumulates with investment until the new steady state is achieved, and results show that the capital stock has grown by 0.416 per cent relative to base year. This occurs as the investment rate in the model is positively linked to the shadow price of capital. As the Replacement Cost of Capital has fallen (−0.159 per cent), additional investment occurs until the return to capital has also been reduced to bring about a new steady state. As reported in Figure 2, the efficiency stimulus generates a positive impact in all sectors.

The same principles apply in the short run. However, the situation is more complicated given the forward looking nature of the model, as agents respond to anticipated events and bring forward

⁹The long run is when the capital stock has fully adjusted to the change in productivity. This is reached in period 100 when steady-state conditions are imposed. Capital stock is at its optimum level, with rental rates equal to user cost of capital. In the model, the supply of land is fixed in each period. However, we allow economic activities to compete for space through a flexible price of land. Population (identified in the model as working age population) is fixed. However, there is labour mobility among sectors.

consumption expenditures. In the general case, as demonstrated by Adams and Parmenter (1994), short-run impacts of efficiency gains have an ambiguous effect. Although more output can now be produced for any given level of inputs, it is not clear a priori whether this will lead to increased output or a reduction in the level of inputs, until long-run adjustments restore equilibrium. Hermannsson *et al.* (2014) analyse such a situation for the case of human capital and indeed find that increased efficiency can lead to a reduction in employment, in the short run.

In the short run, which corresponds to the first period of the model, we assume capacity constraints. Therefore, capital stock is fixed at its base-year values and the initial distribution across sectors is also maintained. As can be seen from column 1 of Table 1, GDP increases slightly with respect to the initial steady state. In this time frame, the increase in efficiency coincides with an increase in employment reflecting agents' forward looking expectations.¹⁰ If we were to run the model based on myopic agents, employment would fall in the first period, so that, given fixed labour supply, unemployment would rise putting downward pressure on real wages. However, as agents have perfect foresight, we have an anticipated effect according to which unemployment falls by 0.228 per cent while real wages rise by 0.023 per cent as reported in Table 1. The short-run GDP impact of 0.01 per cent is still higher than what we would expect in a typical growth accounting set-up (0.47×0.007 per cent = 0.0035 per cent). Although exports are falling, the increase in output is driven by anticipation effects of the agents with perfect foresight.¹¹

With FNW, workers are not sensitive to the excess demand for labour. In our model, the labour market plays an important role in influencing price behaviour. Therefore, the labour market assumption adopted is likely to influence competitiveness effects. The changes in GDP, employment and consumption are greater compared to the case of RWB in both the short run and the long run. For both labour market closures, the change in employment is greater than the change in GDP in the short run. This means that the capital/labour ratio falls in this period, whereas in the long run the capital/labour ratio increases. This occurs as the increase in labour efficiency increases the return to capital and investment is stimulated as a consequence.

The short-run impact is greater under FNWs than RWB. This is generated by a bigger substitution effect in favour of labour. The real wage falls because workers cannot influence wages, which in turn increases the demand for labour. With a fixed working age population, the unemployment rate decreases by 3.7 per cent from base-year values. In the long run, with total adjustment in capital stock, the nominal wage rigidity provides an additional improvement in competitiveness generated by a bigger fall in prices, which stimulates export demand for local goods. Ultimately, it is the greater increase in exports that drives the stronger long-run impact under the FNW.

The results in Table 1 show that competitiveness effects are a key element in realising the macroeconomic impact of human capital. Therefore, it is important to consider the sensitivity of the impact to different estimates of the trade elasticity. Figure 3 reports the period by period percentage change in GDP obtained by performing the same shock described above but varying the trade elasticity. For both labour market closures, an increase in the trade elasticity provides a bigger increase in output. However, for the case of FNW we observe a dramatic increase in GDP when trade elasticities are higher compared to the case where wage bargaining is adopted.

¹⁰This refers to employment in natural units, whereas the change in employment in efficiency unit is given by the change in natural units plus the change in efficiency. However, labour productivity increases can reduce employment. For a more comprehensive discussion of this point, see Adams and Parmenter (1994).

¹¹This is naturally not the case if agents adopt adaptive expectations. The short-run GDP impact when the model is run with myopic expectation equates to 0.0027 per cent which is, as we would expect, similar and in this case lower than the growth accounting approach. The structure of the myopic model is similar to the forward looking model described in the Appendix. The differences are in consumption and investment. In the myopic model, consumption is a linear function of real disposable income and contrary to the perfect foresight case, consumers preserve, in each period, stability between current consumption and wealth. As for investment, the adjustment rule introduced in the myopic model is such that investments are determined as a fraction of the gap between the desired and actual level of capital stocks adjusted for depreciation.

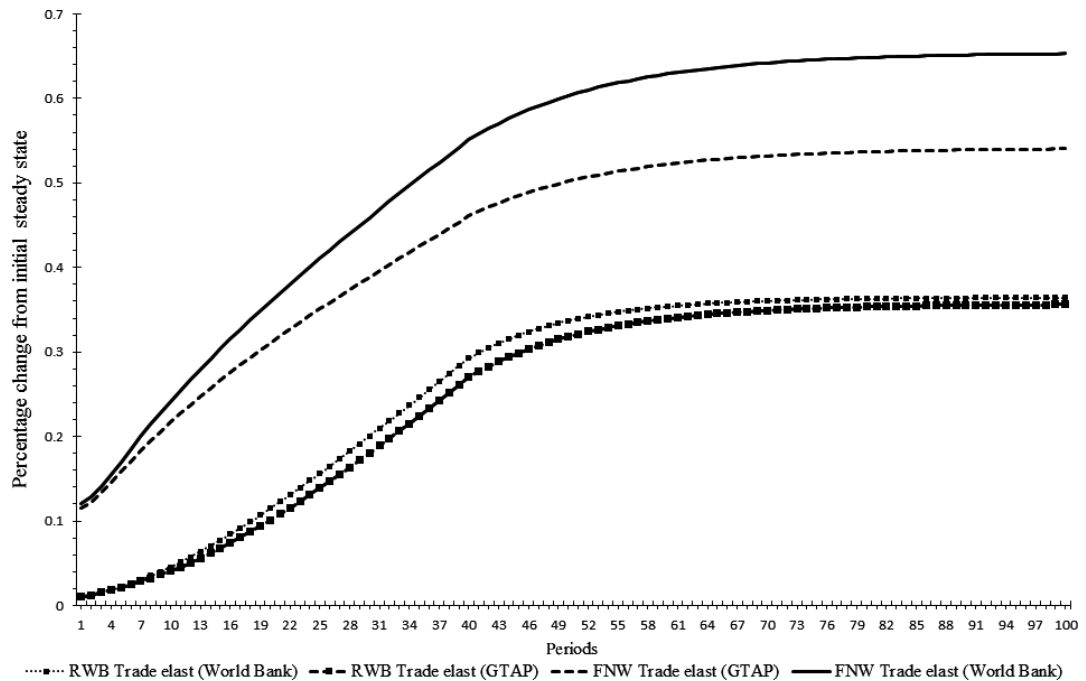


Figure 3. Comparison of Projected GDP Changes Under Alternative Assumptions about Labour Markets and Price Elasticity of Exports (% Change from Base Year)

This suggests that if wages are flexible and depend on the excess demand for labour, the impact of a labour productivity shock is less responsive to changes in trade elasticity compared to a situation of wage rigidity. The competitiveness effects, under RWB, are partially offset by an increase in wage income. We should clarify that these results are the consequence of maintaining the labour supply fixed. Indeed, this would not occur if the Malawi economy was able to attract skilled migrants. In this case, migration would put downward pressure on wages thus increasing competitiveness effects, thereby potentially making the change in economic activity greater under the RWB closure than under the FNW closure. Conversely, the competitiveness effect is conditional on the assumption that labour efficiency is improving in Malawi relative to the ROW. If the ROW is experiencing similar increases in productivity, the competitiveness advantages would, of course be muted (but offsetting what would otherwise be a decline in competitiveness).

6. Conclusions

This paper analyses the macroeconomic impact of increasing the skill level of the population in a low-income country through higher education. The aim is to provide a simple demonstration of the influence of the transmission mechanism when estimating the macroeconomic impact of increasing human capital stock. A growth accounting framework, with parameters obtained from previous microeconomic analysis (Matita & Chirwa, 2009), is used to determine the change in effective labour supply, while a general equilibrium model is used to simulate endogenous adjustments. This reveals that a positive outcome is driven by competitiveness effects boosting exports. A key transmission mechanism is the interaction between labour markets and trade, which makes the overall outcome contingent upon two steps: labour productivity increasing competitiveness and competitiveness stimulating exports.

Interpreting the results from a policy point of view, this suggests that the effectiveness of human capital investment for economic development could be complemented by policies that affect the export elasticity by reducing trade costs, such as through reducing physical and institutional transport barriers (see, e.g. Limão & Venables, 2001; Freund & Rocha, 2011). A further analysis of this point would benefit from extending the model to include a more detailed treatment of trade costs, adopting elements from trade-focussed models, such as the model of Malawi by Löfgren (2001).

The results have further bearing in the context of empirical attempts to estimate the macroeconomic impact of education. A priori it is clear that determining the productivity stimulus of human capital precisely is important for the accuracy of the overall analysis. However, there are significant contingencies in the micro–macrotransmission mechanism, which are less well understood. The analysis presented here reveals that the macroeconomic outcome of a human capital accumulation progress can be affected by orders of magnitude, depending on how the increase in effective labour supply is transmitted and what endogenous adjustments take place in the rest of the economy. In the simulations presented, this variability affects the scale of the impact, but it is always positive. This reinforces the interpretation of the empirical evidence that sees a positive macroeconomic impact from increasing the skills of the population (Krueger & Lindahl, 2001; Sianesi & Van Reenen, 2003) and refutes the notion that there is no impact (Benhabib & Spiegel, 1994; Pritchett, 2001).

That said there are still a number of issues to be clarified in the details of the transmission mechanism. Firstly, the magnitude of the competitiveness impact is very sensitive to labour market specification. This paper has adopted stylised assumptions, namely that population is fixed and that wages setting can either be described by a wage curve or a FNW. Naturally, the labour market is likely to be more responsive in the long run. However, the FNW can be motivated as an approximation of a situation where labour supply is very flexible, such as when a large share of the population is occupied in subsistence activities. It would be useful to explore the influence of an internal “migration” from subsistence to market activities explicitly, for example by building on the CGE-modelling of Gelan (2002). Furthermore, the economic impact of graduates is largely driven by increased competitiveness, with subsequent employment and output impacts critically depending on stimulus to exports. In turn, the magnitude of the impact will crucially depend on the labour market conditions. Naturally, in the short run we might assume nominal wages remaining unchanged. However in the long run there is likely to be in operation a more responsive wage setting mechanism. An increase in productivity, by and of itself, does not improve competitiveness, unless it is greater than that of trade partners. This is demonstrated for the impact of demographic changes in a multicountry analysis by Mérette and Georges (2010), but has so far not been taken into account when examining the economic impact of human capital. Secondly, this analysis only pertains to labour supply and does not allow for other supply-side transmission mechanisms, such as social returns and non-market private returns (McMahon, 2000), which are potentially very important. Finally, to gauge the per capita impacts of the education system, it is important to consider its economic impact in the context of demographic change. This is particularly important for low-income countries, such as Malawi, which exhibit fast population growth. Therefore, it is not clear a priori whether production and retention of graduates will keep up with population growth to maintain a constant or growing share of graduates in the workforce. Therefore, policy analysis would benefit from a framework that explicitly acknowledges population structure, such as in an Overlapping Generations model.

REFERENCES

- Abel, A.B. and Blanchard, O. (1983), ‘An Intertemporal Model of Saving and Investment’, *Econometrica*, **31**, 675–92.
- Acemoglu, D. and Autor, D. (2012), ‘What Does Human Capital Do? A Review of Goldin and Katz’s The Race between Education and Technology’, *Journal of Economic Literature*, **50**, 426–63.
- Adams, P.D. and Parmenter, B.R. (1994), ‘Microeconomic Reform and Employment in the Short Run’, *Economic Record*, **70** (208), 1–11.

- Anderson, K., Martin, W. and van der Mensbrugge, D. (2006), 'Market and Welfare Impacts of Doha Reform Scenarios', in Anderson, K. & Martin, W. (eds.), *Agricultural Trade Reform and the Doha Development Agenda*, Palgrave Macmillan, co-published with the World Bank, London; 333–99.
- Armington, P. (1969), 'A Theory of Demand for Products Distinguished by Place of Production', *IMF Staff Papers*, **16**, 157–78.
- Arrow, K. (1973), 'Higher Education as a Filter', *Journal of Public Economics*, **2**(3), 193–216.
- Barouni, M. and Broecke, S. (2014), 'The Returns to Education in Africa: Some New Estimates', *The Journal of Development Studies*, **50** (12), 1593–613.
- Becker, G.S. (1964), *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*. University of Chicago Press, Chicago, IL.
- Benahabib, J. and Spiegel, M.M. (1994), 'The Role of Human Capital in Economic Development Evidence from Aggregate Cross-Country Data', *Journal of Monetary Economics*, **34**, 143–73.
- Blanchflower, G.D. and Oswald, A.J. (1984), 'Estimating a Wage Curve for Britain', *The Economic Journal*, **104**, 1025–43.
- Blundell, R., Dearden, L. and Sianesi, B. (2005), 'Evaluating the Effect of Education on Earnings: Models, Methods and Results from the National Child Development Survey', *Journal of the Royal Statistical Society A*, **168**, 473–512.
- Bonjour, D., Cherkas, L.F., Haskel, J.E., Hawkes, D.D. and Spector, T.D. (2003), 'Returns to Education: Evidence from UK Twins', *The American Economic Review*, **93** (5), 1799–812.
- Brown, S. and Sessions, J. (2004), 'Signalling and Screening', in Geraint, J. & Johnes, J. (eds.), *International Handbook on the Economics of Education*. Edward Elgar, Cheltenham; 58–100.
- Card, D. (1999), 'The Causal Effect of Education on Earnings', in Card, D. and Ashenfelter, O. (eds.), *Handbook of Labor Economics*, vol. 3. Elsevier, Amsterdam; 1801–63.
- Card, D. (2001), 'Estimating the Return to Schooling: Progress on Some Persistent Econometric Problems', *Econometrica*, **69** (5), 1127–60.
- Chirwa, E.W. and Matita, M.M. (2009), 'The Rate of Return on Education in Malawi', University of Malawi, Chancellor College, Department of Economics: Working Paper 2009/01.
- Devarajan, A. and Go, D. (1998), 'The Simplest Dynamic General-Equilibrium Model of an Open Economy', *Journal of Policy Modelling*, **20**, 677–714.
- Douillet, M., Pauw, K. and Thurlow, J. (2012), 'A 2007 Social Accounting Matrix for Malawi', International Food Policy Research Institute, Washington, DC. Available at: <http://hdl.handle.net/1902.1/18578>.
- Freund, C. and Rocha, N. (2011), 'What Constrains Africa's Exports?', *The World Bank Economic Review*, **25**, 361–86.
- Gelan, A. (2002), 'Trade Liberalisation and Urban–Rural Linkages: A CGE Analysis for Ethiopia', *Journal of Policy Modeling*, **24** (7), 707–38.
- Giesecke, J. and Madden, J. (2006), 'CGE Evaluation of a University's Effects on a Regional Economy: An Integrated Assessment of Expenditure and Knowledge Impacts', *Review of Urban & Regional Development Studies*, **18**, 229–51.
- Hanusheck, E.A. and Woessmann, L. (2008), 'The Role of Cognitive Skills in Economic Development', *Journal of Economic Literature*, **46**, 607–68.
- Harmon, C. and Walker, I. (2003), 'The Returns to Education: Microeconomics', *Journal of Economic Surveys*, **17**, 115–53.
- Hayashi, F. (1982), 'Tobin's Marginal q and Average q: A Neoclassical Interpretation', *Econometrica*, **50**, 213–24.
- Hermannsson, K., Lecca, P., Lisenkova, K., McGregor, P. and Swales, K. (2014), 'The Importance of Graduates for the Scottish Economy: A "Micro-to-Macro" Approach', *Environment and Planning A*, **46** (2), 471–87.
- Heywood, J.S. and Wei, X. (2004), 'Education and Signaling: Evidence from a Highly Competitive Labor Market', *Education Economics*, **12** (1), 1–16.
- Hoddinott, J. (1996), 'Wages and Unemployment in an Urban African Labour Market', *Economic Journal*, **106**, 1610–26.
- Jolliffe, D. (2004), 'The Impact of Education in Rural Ghana: Examining Household Labor Allocation and Returns On and Off the Farm', *Journal of Development Economics*, **73** (1), 287–314.
- Krueger, A.B. and Lindahl, M. (2001), 'Education for Growth: Why and For Whom?', *Journal of Economic Literature*, **39**, 1101–36.
- Lange, F. and Topel, R. (2006), 'The Social Value of Education and Human Capital', in Hanusheck, E. & Welch, F. (eds.), *Handbook of Education Economics*, vol. 1. Elsevier, Amsterdam; 459–509.
- Limão, N. and Venables, A.J. (2001), 'Infrastructure, Geographical Disadvantage, Transport Costs, and Trade', *The World Bank Economic Review*, **15**, 451–79.
- Löfgren, H. (2001), 'A CGE Model for Malawi: Technical Documentation', International Food Policy Research Institute. TMD Discussion Paper no. 70. Available at: <http://www.ifpri.org/sites/default/files/pubs/divs/tmd/dp/papers/tmdp70.pdf>.

- Matita, M.M. and Chirwa, E.W. (2009), 'The Impact of Education on Self-Employment, Farm Activities and Household Incomes in Malawi', University of Malawi, Chancellor College, Department of Economics: Working Paper 2009/02.
- McMahon, W. (2000), *Education and Development: Measuring the Social Benefits*. Oxford University Press, Oxford.
- McMahon, W.W. (2009), *Higher Learning, Greater Good: The Private & Social Benefits of Higher Education*. John Hopkins University Press, Baltimore, MD.
- Mérette, M. and Georges, P. (2010), 'Demographic Changes and the Gains from Globalisation: An Analysis of Ageing, Capital Flows, and International Trade', *Global Economy Journal*, **10** (3), 1–37.
- Mincer, J. (1958), 'Investment in Human Capital and Personal Income Distribution', *Journal of Political Economy*, **66**, 281–302.
- NSO (National Statistical Office) (2005), *Integrated Household Survey 2004–2005*. National Statistical Office, Zomba, Malawi.
- Pritchett, L. (2001), 'Where Has all the Education Gone?', *World Bank Economic Review*, **15**, 367–91.
- Psacharopoulos, G. and Patrinos, H.A. (2004), 'Human Capital and Rates of Return', in Geraint, J. & Johnes, J. (eds.), *International Handbook on the Economics of Education*. Edward Elgar, Cheltenham; 1–57.
- Schoellman, T. (2012), 'Education Quality and Development Accounting', *Review of Economics and Statistics*, **79**, 388–417.
- Schultz, T.W. (1960), 'Capital Formation by Education', *Journal of Political Economy*, **68**, 571–83.
- Sianesi, B. and Van Reenen, J. (2003), 'The Returns to Education: Macroeconomics', *Journal of Economic Surveys*, **17**, 157–200.
- Soon, L.Y. (1987), 'Self-Employment vs Wage Employment: Estimation of Earnings Functions in LDCs', *Economics of Education Review*, **6** (2), 81–9.
- Spence, A.M. (1973), 'Job Market Signalling', *The Quarterly Journal of Economics*, **87**, 355–74.
- Stiglitz, J.E. (1975), 'The Theory of 'Screening': Education, and the Distribution of Income', *American Economic Review*, **65**, 283–300.
- Tobin, J. (1969), 'A General Equilibrium Approach to Monetary Theory', *Journal of Money Credit and Banking*, **1**, 15–29.

Appendix: Summary of Model

This appendix elaborates on some of the features of the dynamic applied general equilibrium model used for simulations in this paper. Inevitably, due to space constraints, the presentation is not exhaustive, but further details of model equations and calibration are available upon request and the model code is available online: <http://dx.doi.org/10.5525/gla.researchdata.188>.

The decision problem of the representative consumer is to choose a sequence of consumption that maximises the present value of utility, as summarised by the lifetime utility function:

$$U = \sum_{t=0}^{\infty} \left(\frac{1}{1+\rho} \right)^t \frac{C_t^{1-\sigma} - 1}{1-\sigma} \quad (\text{A1})$$

where C_t is the consumption at time period t , σ and ρ are, respectively, the constant elasticity of marginal utility and the constant rate of time preference. The dynamic budget constraint ensures that the discounted present value of consumption must not exceed total household wealth, W :

$$\sum_t z(t) P_C C_t \leq W_t \quad (\text{A2})$$

where P_C is the household's aggregate consumption price index and given r the interest rate, $z(t) = \prod (1+r_t)^{-1}$. Once the optimal path of consumption is obtained from the solution of the intertemporal problem, aggregate consumption is allocated between sectors through a constant elasticity of substitution (CES) function. Household demand for local and imported goods is a result of the intratemporal cost minimisation problem.

The path of investment is obtained by maximising the present value of the firm's cash flow (Hayashi, 1982) given by profit π_t less private investment expenditure,¹² I_t subject to the presence of adjustment cost $g(x_t)$ where $x_t = I_t/K_t$ (Devarajan & Go, 1998):

¹²For simplicity of notation, the sector index is omitted. Furthermore, variables not defined over time with the subscript t are assumed to be fixed throughout.

$$\sum_{t=0}^{\infty} \frac{1}{(1+r)^t} [\pi_t - I_t(1+g(x_t))] \text{subject to} \quad (\text{A3})$$

$$\dot{K}_t = I_t - \delta K_t \quad (\text{A4})$$

The solution of the dynamic problem gives the shadow price of capital, λ_t and the time path of investment.

Total gross output X , is given by combining value added (Y) and intermediate inputs (V) through Leontief technology:

$$X_t = \min\left(\frac{Y_t}{a^Y}; \frac{V_t}{a^V}\right) \quad (\text{A5})$$

where a^Y and a^V are input coefficients. Y is given by a CES combination of labour (N), private capital (K) and land (L):

$$Y_t = \left[a(K_t)^\psi + b(A_t N_t)^\psi + (1-a-b)(L_t)^\psi \right] \quad (\text{A6})$$

where A_t is an index of Harrod neutral technical change and given ψ the elasticity of substitution $\vartheta = (\psi - 1)/\psi$. The demand for labour, capital and land is obtained from first order conditions.

Imported and locally produced intermediate goods are considered imperfect substitutes and are combined under a CES function (Armington, 1969). The demand function for intermediate inputs derives from cost minimisation. Each industry produces goods and services that can be exported or sold locally. An export demand function closes the model where foreign demand for Malawi goods (E) depends on the ratio between the ROW price (Pe) and the price of output (Px), and the export price elasticity, η :

$$E_t = \bar{E} \left[\frac{Pe}{Px_t} \right]^\eta \quad (\text{A7})$$

Government taxes labour income ($\tau^N Ly$) and capital incomes ($\tau^K Ky$). Its expenditure comprises current spending in goods and services (G), net transfer to households (Tr) and interest payment on debt (rD).

$$\dot{D} = rD_t + G_t + Tr_t - \tau^N Ly - \tau^K Ky \quad (\text{A8})$$

As this application does not consider changes in natural population, labour force is fixed to the base year. The model is run under two specific labour market closures: real wage bargaining (RWB) and fixed nominal wage (FNW). Under RWB, real wage and unemployment are negatively related as in Blanchflower and Oswald (1984):

$$\ln \left[\frac{w_t}{cpi_t} \right] = c - 0.1 \ln(u_t) \quad (\text{A9})$$

where c is a calibrated parameter, w , cpi and u are the nominal wage, the consumer price index and the unemployment rate, respectively. In the RWB, regime wages are directly related to workers' bargaining power and respond to excess demand for labour.

The total absorption equation provides equilibrium in the commodity market. This is sufficient to guarantee equilibrium in the payments account as money is not considered as a commodity. In the capital market, capital demand equals the capital stock. Equilibrium in the labour markets is achieved through changes in unemployment rate, as the wage rate is not determined via first order conditions.

Share parameters are obtained from the SAM while some structural and behavioural parameters are based on econometric estimation or best guesses. Some selected benchmark values are reported in Table A1. To solve an infinite time horizon model, steady-state conditions are

Table A1. *Selected Benchmark Values*

Investment/GDP	0.23
Capital–labour ratio	0.85
Export/output	0.06
Import/export	0.1
Constant elasticity of marginal utility	1.2
Interest rate	0.04
Depreciation rate	0.15
Wage curve elasticity	0.1
Trade elasticity	3 (4)
Production elasticity	0.3

Note: The sectoral classification of the model is reported in Table A2. We have aggregated the 37 sectors SAM as in Douillet *et al.* (2012) to a more manageable 18 sectors.

Table A2. *Economic Activities in the Model*

1	Cereals
2	Roots and pulses
3	Horticulture
4	Tobacco
5	Other crops
6	Livestock
7	Forestry and fishing
8	Mining
9	Food beverage and tobacco processing
10	Other manufacturing
11	Construction
12	Electricity and water
13	Trade services
14	Hotels and catering
15	Transport and communications
16	Business services and real estate
17	Education, health and Government admin
18	Other services

imposed at a specific point in time. Hence, the transitional pathway is the result of the discrete time solution of the model.