Trade, Growth, and Poverty in Zambia: Insights from a Dynamic General Equilibrium Model

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Abstract. We analyze how trade policy and aid affect poverty and economic development in a dynamic optimizing model that features a full array of imports (intermediates, consumer goods, and capital goods), transport and distribution costs, sector-specific capital, public investment in social and physical infrastructure, learning externalities, and a dualistic labor market. Our main finding is that policy packages that combine an escalated structure of protection with an escalated structure of export promotion score best; there is no support for the view that free trade or a low uniform tariff is approximately optimal.

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1. Introduction

Many LDCs suffer from low levels of private investment, from acute shortages of social and physical infrastructure, and from widespread poverty and underemployment. How can trade policy help combat these problems? Neoclassical trade theory objects that the premise of the question is incorrect. According to the *Principle of Targeting*, it is better to use other policy instruments to counteract market imperfections and to target social objectives. Instead of interfering with free trade, the government should increase domestic taxes to pay for employment subsidies, investment subsidies, transfers to the poor, and additional public investment in infrastructure.

Policy makers reject this advice as impractical. Large-scale direct transfers to the poor and extensive employment and investment subsidies can be implemented with the stroke of a pen in a textbook. The real world is not so accommodating. Good information and skilled administrators are needed to prevent transfer/subsidy schemes from being undermined by fraud. Both are in scarce supply in low-income LDCs. Presumably fraud is less of a problem for public spending on infrastructure. It is naïve, however, to think that domestic taxes alone can pay for all the socially desirable infrastructure projects: tax handles are too few, tax bases are too small, and infrastructure needs are too great. Until development is far along, easy-to-collect trade taxes have a place in the government's optimal tax program (Kubota, 2000; Buffie, 2001).

The upshot of these considerations is that passive trade policy is a luxury few low-income countries can afford. Nowhere is this more true than in Sub-Saharan Africa. Many African policy makers feel that trade liberalization has not delivered the benefits promised by its supporters and that priority should now be given to battling supply constraints (United Nations, 2006). The IMF, the World Bank, and trade negotiators for developed countries continue to press for further liberalization; but since their case is not grounded in any rigorous analysis of development-oriented trade models, it cannot address the concerns of African policy makers. Unfortunately, the perception that free trade is first-best has acted as a formidable barrier to the construction of analytical frameworks that shed light on the channels through which different structures of protection and export promotion affect economic development. Serious, meaningful debate about the merits of activist trade policy ended a while back.

Our objective in this paper is to restart the policy dialogue. In what follows, we build a dynamic general equilibrium trade model that is rich in structural detail and policy instruments

but not a black box. The model features a full array of imports (intermediates, consumer goods, and capital goods), transport and distribution costs, sector-specific capital, public investment in social and physical infrastructure, learning externalities, and a dualistic labor market. It is also firmly grounded in optimizing behavior. The general equilibrium dynamics for the economy emerge from the intersection of market-clearing conditions with the government budget constraint and the perfect foresight solutions to private agents' optimization problems.

We use the model to investigate how trade policy and aid affect poverty, capital accumulation, and real output in Zambia. Throughout the analysis focuses on basic issues, e.g.: Does poverty reduction conflict with broader development objectives? Are there important intertemporal tradeoffs on the transition path to the new long-run equilibrium? How high is the return on aid-financed investments in infrastructure and education? Is it higher than the return in aid-for-trade schemes that use external funds to offset revenue losses from tariff cuts and higher export subsidies? Our main finding is that policy packages that combine an escalated structure of protection with an escalated structure of export promotion score best; there is no support for the view that free trade or a low uniform tariff is approximately optimal.

The rest of the paper is organized into nine sections. In Sections 2 and 3 we discuss the model and how it was calibrated to the data for Zambia. Following this, Section 4 examines the effects of different combinations of trade taxes in the standard trade theoretic scenario where lump-sum taxes/transfers adjust to balance the fiscal budget. Sections 5 and 6 change the scenario by letting tariff revenue underwrite more public investment in infrastructure and education. The final section summarizes the results and argues that future research should concentrate on developing a typology for trade policy.

2. The Model

Below we provide an overview of the model that highlights the connections between policy instruments, growth, and poverty, and the key differences between our modeling approach and the approach in the existing literature. A full statement of the model and a more detailed, technical discussion may be found in the long version of the paper available at http://mypage.iu.edu/~ebuffie.

2.1 Sectoral Structure and Technology

Since our objective is to develop a tool for policy analysis, the model contains a good deal of structure. There are six sectors: smallholder primary agriculture, large-farm commercial agriculture, food processing, other manufacturing, services, and mining. Services are nontraded and mining is treated as an exogenous source of dollars. Schools and physical infrastructure are supplied by the state. Private inputs consist of capital, skilled labor, unskilled labor, land, and imported intermediates. Capital assets are assembled by combining a nontraded domestic input (structures built by construction firms) with imported machinery in fixed proportions. All sectors incur transport costs and the food-processing industry buys raw materials from primary agriculture.

Two-tiered CES productions convert inputs into output. In the lower tier, total labor services are a CES function of skilled labor and unskilled labor. At the upper tier, the composite labor input, capital, and imported intermediates combine in another CES function. (Land is also an input in the agricultural sectors). Infrastructure and learning externalities affect production like Hicks-neutral technical progress. Learning depends on capital accumulation (Arrow, 1962), which serves as a vehicle for the introduction of new technology. Spillovers from learning are confined to firms in the industry. Physical infrastructure, however, is a pure public good that enhances productivity in all sectors.

2.2 Imports and Exports

The economy exports lots of mineral products and some nontraditional cash crops (cotton, sugar, coffee, horticulture and floriculture). Imports comprise machinery and equipment, intermediate inputs, and a mix of agricultural and manufactured consumer goods (processed food and other manufactures).

Allowing for multiple types of imports not only improves the fit of the calibrated model with the data describing the structure of the economy, it also allows us to investigate policies that CGE trade models typically ignore. Most of the literature compares protection (or proportionate tariff cuts) to export promotion without distinguishing between flat and escalated tariff structures. Our analysis is more comprehensive. We contrast flat with escalated tariff structures and one-sided trade regimes with "balanced" regimes that combine protection with export promotion.

2.3 Wages and the Dualistic Labor Market

Labor is mobile across sectors. In the case of skilled labor, this ensures that all firms pay the same wage. The unskilled labor market, by contrast, is dualistic. In construction, services, and agriculture, the wage is determined by market forces. Food processing and manufacturing belong to the formal sector, where unions and/or minimum wage laws compel firms to pay a higher wage.

The gap separating wages in the formal and informal sectors is not the only source of underemployment in the model. In addition, labor productivity may be much lower in primary agriculture than in other branches of the informal sector. This reflects the absence of secure, well-defined property rights in rural areas. In Zambia and many other LDCs, smallholders forfeit their claims to land and its rents when they work outside agriculture (Wichern et al., 1999; Thurlow and Wobst, 2004). Consequently, the worker's share in land rents enters as a wedge between the *shadow* wage of labor in primary agriculture and the market wage in services, construction, and commercial agriculture. When the wedge is large, primary agriculture is a repository of surplus labor à la Lewis (1954).

The dualistic labor strongly conditions many results in the model. Efficient allocation of labor requires that workers' marginal value product, measured at world prices, be the same in all activities. Because of the sectoral wage gaps, however, the initial free trade equilibrium is distorted by too little employment in the formal sector (i.e., manufacturing) relative to the informal sector, and, within the informal sector, by too much employment in primary agriculture relative to commercial agriculture, services, and construction. Policy packages that strengthen aggregate labor demand while fostering job growth in high-wage sectors outside of primary agriculture have the potential therefore to simultaneously reduce poverty and improve allocative efficiency. This theme is consistent with the findings in numerous papers published in this journal and elsewhere that the effects of trade reform on inequality, underemployment, and overall economic development are highly sensitive to the structure of the labor market.[1]

2.5 Preferences of Workers vs. Capitalists and Landowners

Preferences of each agent are described by a nested CES utility function that aggregates consumption of processed and unprocessed food, manufactures, and services. Workers differ from capitalists in two ways. First, they consume all of their income each period. Second, they

spend much more on food relative to other items. The exact consumer price indices for workers and capitalists mirror the differences in their consumption baskets.

2.6 Capital Accumulation and Intertemporal Optimization

The representative capitalist (capitalist-landowner in commercial agriculture) chooses consumption and investment to maximize a time-separable utility function subject to a budget constraint that says total spending cannot exceed profits net of taxes

Dynamics have been incorporated into GTAP, Linkage, and other large CGE models of agriculture and trade. But, with the notable exception of Devarajan and Go (1998), the models rely on ad hoc specifications of saving and investment. If the policy debate is to be better informed, we need more input from medium-sized trade models in which private agents solve explicit optimization problems.

Not everyone agrees with this view. Hertel and Winters (2006, p.7) assert, for example, that "most of the issues that arise in the popular debate over impacts of trade policy [on poverty] are fundamentally comparative static in nature."

While comparative statics effects matter, they are not the whole story. Our case for working with a dynamic model rests on three considerations. First, whether pursuit of poverty reduction conflicts with pursuit of economic development depends in large part on how trade policy affects aggregate capital accumulation. Second, as demonstrated in later sections, changes in the capital stock have large effects on poverty and inequality through their impact on labor demand, real wages, and employment in high- vs. low-wage sectors. Third, trade policies that stimulate private investment increase social welfare when any of the following conditions hold: (i) capital accumulation is a source of learning externalities; (ii) a general concern for the welfare of future generations or a desire to promote national economic development would motivate individuals to save more in a social contract than they would acting on their own (Feldstein, 1964; Sen, 1967); and (iii) increases in the aggregate capital stock serve to reduce underemployment.

2.7 Public Sector Investment and the Government Budget Constraint

The government collects revenue from tariffs, from a lump-sum tax, from aid donors, and from the sale of mineral products. It invests in infrastructure and schools. The instrument that adjusts to balance the budget depends on the policy experiment under investigation. In the *pure*

trade policy scenarios, infrastructure stocks are constant and the lump-sum tax absorbs changes in tariff revenue and export subsidies. When trade policy is used both to alter relative prices and to combat infrastructure bottlenecks, the lump-sum tax is held constant and increases in net tariff revenue finance higher investment in infrastructure or schools. Most CGE trade models analyze only the first scenario (or a closely-related variant in which some tax adjusts to satisfy the government budget constraint). Arguably, however, the second scenario is more relevant. The importance of investment in education and infrastructure to economic development and amelioration of poverty is widely acknowledged (Jung and Thorbecke, 2003; Moreira and Bayraktar, 2008; Letiche, 2010). The importance of trade taxes to government revenue in Sub-Saharan Africa is an established fact. It seems natural to connect the two when thinking about strategies for poverty-reducing growth.

2.8 Zero-Profit and Market-Clearing Conditions

Finally, the model is closed with the zero-profit conditions in the five sectors, the conditions that demand equal supply in the markets for services, skilled labor, and unskilled labor, and the national income accounting identity that the current account inclusive of aid equals zero.

3. Calibration of the Model

Calibration of the model requires data on cost shares, elasticities of substitution, consumption shares, wage differentials, depreciation rates, sector shares in GDP, and marginal rates of return on infrastructure and schools at the benchmark equilibrium. Once values are set for these parameters, all other variables that enter the model can be tied down by budget constraints, the first-order conditions associated with the solution to the private agents' optimization problems, and various adding-up constraints.

Table 1 lists the values we chose for calibration of the model to Zambia. The long version of the paper discusses the data and empirical estimates that justify the value assigned to each parameter. Here we limit ourselves to remarks on three aspects of the calibration that strongly influence the numerical results presented in Sections 4 and 5.

- *Sectoral wage differentials and surplus labor.* The wage for unskilled labor in the formal sector is 75% above the wage in the informal sector. Because the wage gap is large, the increase in real GDP from policies that bolster employment in manufacturing almost

equals the increase in the manufacturing sector wage bill. [Transfers of labor from the informal to the formal sector increase real GDP by $(w_f - w)\Delta L_f$, where the f subscript refers to the formal sector.]

Recall that, due to imperfections in rural land markets, labor is also misallocated within the informal sector. At the initial equilibrium, the shadow wage in primary agriculture is 31% below the wage paid to comparable unskilled labor in commercial agriculture, services, and construction. The efficiency gains/losses from reallocation of unskilled labor within the informal sector are thus small but non-trivial.

- *Sectoral factor intensity rankings*. Agriculture is extremely intensive in unskilled labor while manufacturing and services are highly intensive in capital and skilled labor. The very large differences in sectoral factor intensities limit what can be accomplished with one-sided trade policies. Per the results in Section 4, when protection is confined to one sector, trade policy can either reduce poverty or accelerate economic development by increasing the incentives to invest in physical and human capital. Doing both requires a policy package that protects both sectors and/or expands the resource base through more investment in infrastructure and education.

- *Initial rates of return on schools and infrastructure*. The initial returns on education and physical infrastructure are 25% and 30%, respectively. These are big numbers, but there is plenty of evidence that the return on social and physical infrastructure is high in Sub-Saharan Africa (Psacharopoulous, 1994; Foster and Briceno-Garmendia, 2010).

  In the simulations that link changes in trade revenue to changes in public investment in infrastructure/education, the size of the return determines how much the long-run outcome differs from the short-run outcome. Since we assume high returns in the base case, the difference is often dramatic. In fact, in many cases, the short- and long-run outcomes differ *qualitatively*.

4. Pure Trade Policy Experiments

Our research strategy relies on a systematic, step-by-step analysis of how each trade tax affects poverty, inequality, underemployment, and aggregate capital accumulation directly via its impact on relative prices and indirectly via the fiscal budget and investment in social and physical infrastructure. Once this information is in hand, it is easy to find combinations of tariffs and export subsidies that advance *all* policy objectives.

We start in Table 2 by investigating the long-run outcome in the simplest case where lump-sum taxes adjust to satisfy the government budget constraint. The upper panel of the table shows what happens when trade taxes change one-by-one or in pairs.[2] Five results stand out:

1. *Protection of primary agriculture is highly effective in reducing poverty*. Protecting primary agriculture with a 10% export subsidy increases the real wage for unskilled

labor by 9%.[3] This runs counter to the mainstream view that the impact on poverty is uncertain in sign and probably small in magnitude. Most of the analysis in the literature is of the "on the one hand . . . on the other hand" variety. In fact, the typical discussion (e.g., World Bank, 2005; McCalla and Nash, 2007) requires several hands to enumerate everything on the point-counterpoint list: on the first hand, poverty is overwhelmingly concentrated in agriculture; on the second hand, higher food prices hurt landless laborers and the urban poor and do little to help small farmers, who produce mainly for own consumption; on the third hand, unskilled labor in agriculture might benefit from higher wages; on the fourth hand, labor demand is likely to contract in other sectors, so it is not clear in general equilibrium whether protection of agriculture raises overall demand for unskilled labor in the economy, or, if it does, that wages increase more than the CPI for the poor; etc.

The anything-could-happen answer might be correct for some countries, but not for Zambia. Zambian smallholder agriculture is extremely intensive in its use of unskilled labor. The value added share for unskilled labor is 30-40% greater than in food processing and commercial agriculture and 3-4 times larger than in services and other manufacturing. Consequently, growth of labor demand in agriculture dominates everything else: despite layoffs in manufacturing and services, the wage for unskilled labor increases 13% ─ three times as much as the increase in workers' exact consumer price index.

Although protection of primary agriculture helps in the battle against poverty, it is bad for economic development. Allocative efficiency declines because of the loss of high-wage jobs in manufacturing and the transfer of labor from services and commercial agriculture to primary agriculture (where the shadow wage is 24% lower than the market wage). This and the decrease in the capital stock cause real GDP to contract 4.6% in the long run. The large decrease in the real wage for skilled labor (↓12%) is also inimical to development as it weakens the incentive to accumulate human capital. Strong learning externalities in agriculture improve the chances of pro-development effects. But even when the marginal social return to capital is twice the private return, the results improve little. Unskilled labor gains more, but the decreases in GDP and the real wage of skilled workers are just as large.

2. *Protection of the import-competing manufacturing sector promotes economic development but worsens the distribution of income and exacerbates poverty*. 10% tariffs on processed food and manufactured consumer goods ($t_i = t_x = .10$ in row 3) drive up the price of nontraded services by 6%. Joint expansion of the services and manufacturing sectors then increases the aggregate capital stock by 13% and the real wage for skilled labor by 21%. Overall demand for unskilled labor contracts, but there is some recompense in the form of more good jobs in manufacturing. The share of high-wage jobs for unskilled workers almost doubles, rising from 6.5% to 12.4%. Since the formal sector pays 75% more than the informal sector, total real wage income decreases only 1.9%.

3. *Protection of the food processing sector creates far more high-wage jobs than protection of other manufacturing sectors*. The manufacturing sector is split between food processing industries and other manufacturing. Protecting only the food processing sub-

sector causes the rest of manufacturing to contract.[4] Conversely, food processing contracts when protection is confined to other manufacturing. The two policies have similar qualitative and quantitative effects, with one notable exception: protection of the food processing sector creates many more high-wage jobs. The marked asymmetry reflects the fact that food processing is much more unskilled labor intensive than other branches of manufacturing.

4. *Promotion of non-traditional agricultural exports is ineffective in reducing poverty*. Promoting non-traditional agriculture via a 10% export subsidy leads to small increases in real wages for skilled and unskilled labor. But after factoring in the loss of high-wage jobs, the pre-tax gain for unskilled labor disappears. The poor end up worse off therefore if they bear any of the burden of the fiscal cost associated with export subsidies.[5] On the plus side, the capital stock and real GDP increase slightly. When learning externalities juice the supply response, real GDP and real income of skilled workers increase significantly. The pre-tax gain for unskilled labor, however, stays below 1%.[6]

5. *Ceteris paribus, escalated structures of protection are preferable to flat or de-escalated structures of protection*. It is not a good idea to increase the relative prices of imported intermediates and capital goods. The ugly procession of negative signs in the rows for t_h = .10 and t_m = .10 indicate that factor market distortions worsen and all groups lose. Of course the government may need to tax non-consumer imports to pay for export subsidies or investment in infrastructure. This scenario will be analyzed in Section 7. It is already clear, however, that tariffs should be higher on intermediates than on capital goods.

4.1 Policy Packages

Protecting either agriculture or manufacturing forces policy makers to decide whether it is more important to fight poverty or to promote economic development. But why choose? It is obvious from the results in the upper panel of Table 4 that policy makers can get everything they want ─ less poverty and more economic development ─ by combining an escalated structure of export promotion for agriculture with an escalated structure of protection for manufacturing. The choice set includes *policy packages*. Inward- vs. outward-oriented trade policy is a false dichotomy.

Policy packages offer a better, wider menu of choices, but they do not eliminate tradeoffs. If poverty reduction is the paramount objective, then there is a strong case for mixing export subsidies of 20-25% for primary agriculture and the food processing sector with smaller (possibly zero) tariffs for non-food manufacturing. This policy package reconciles large increases in the real wage for unskilled labor with modest increases in real GDP. On the other hand, if poverty reduction and economic development are equally important objectives, it is

more attractive to protect all manufacturing at the same high rate. Compare the results for $t_a = t_x = .25 + t_i = .15$ and $t_a = t_x = t_i = .25$. When the 25% tariff covers all manufacturing, the increases in the aggregate capital stock and real GDP are 70% larger and the 19% rise in the real skilled wage encourages investment in human capital. The price paid for these gains is that real income of unskilled labor increases 9% instead of 11.6%.

5. Linking Trade Taxes to Investment in Infrastructure

Policy packages that combine export promotion in agriculture with protection of domestic manufacturing and duty-free access to imported intermediates and capital goods get relative prices right. They encourage investment in physical and human capital while strengthening the demand for unskilled labor. Their main limitation is that tariff revenues do not cover the cost of export subsidies. At the free trade equilibrium, net imports of primary agricultural goods and consumer manufactures (including processed food) equal 12.4% of GDP. But after the policy package is put in place and domestic supply expands, combined exports in primary agriculture and manufacturing exceed consumer imports, leaving the government with a net revenue loss. The runs in the lower panel of Table 2 assume that the revenue loss is offset by cuts in lump-sum transfers. This is not particularly realistic. Abundant casual evidence suggests that most of the burden of adjustment will fall on investment in infrastructure. In the case where $t_a = t_x = .25 + t_i = .15$ and expenditure on infrastructure maintenance bears all of the burden, we end up with the depressing results in the first row of Table 3. Skilled and unskilled workers now suffer losses; private capital accumulation holds up, but the infrastructure network deteriorates so much that real GDP declines 8% in the long run.

There is a silver lining in these results. Because mineral exports and aid pay for almost all imports of intermediate inputs and capital goods, net exports of agriculture and the import-competing manufacturing sector do not have to be very large. The fiscal cost of the export promotion + protection package is quite manageable therefore: in the run with $t_a = t_x = .25 + t_i = .15$, for example, the net revenue loss is only 2.3% of GDP. Furthermore, since imports of intermediates and capital goods total 23% of GDP in Zambia, small tariffs on these items can generate enough revenue to finance both the remaining cost of export subsidies and ambitious increases in infrastructure investment. This configuration, and the favorable fiscal arithmetic that goes with it, is special to Africa. Elsewhere in the Third World, the final goods sectors

usually run a large trade surplus to counterbalance large net imports of intermediates and capital goods. Implementation of the policy packages we tout here then requires substantial supplementary fiscal adjustment merely to maintain the balance between export promotion and import substitution. And schemes that mix tariffs with export subsidies and investment in infrastructure are not feasible at all unless trade policy has a pronounced protectionist bias.

5.1 Infrastructure

In rows 2-4 of Table 3 protection is limited to food processing and other manufacturing. When tariffs apply only to consumer goods (t_i, t_x = .10), capitalists and skilled workers reap large gains and unskilled labor loses. The outcome is qualitatively the same as in the pure trade policy experiments. This *appears* to change in the run where t_h also increases. Levying a 10% tariff on intermediate inputs increases government revenue by roughly 1.5% of GDP. In the run $t_x = t_i = t_h$ = .10, the extra revenue purchases a 32% expansion of the infrastructure network. The increase in productivity that comes with more infrastructure induces firms to raise the real unskilled wage 2% and to increase the number of high-wage manufacturing jobs by 90%. These gains, however, take some time to materialize. Figure 1 shows the transition path to the new steady state. The real unskilled wage (total unskilled wage income) decreases for the first five (three) years and then recovers slowly, taking twenty-five (ten) years to climb back to its previous level. Inevitably most of the benefits on the transition path and across steady states accrue to the non-poor, especially skilled labor.

The runs in the lower panel mix export promotion in agriculture with protection of manufacturing in an effort to secure more of the gains for the poor. Several schemes work well. Policy package A (t_a = .25, $t_x = t_i = t_h$ = .20, $t_b = t_m$ = .10) strikes a nice balance between poverty reduction and economic development. Across steady states, real GDP rises 13% and real wages for unskilled and skilled workers increase 18%. Other packages trade more inequality for more growth on terms potentially attractive to policy makers who are not too averse to inequality. Cutting t_a from 25% to 15%, for example, reduces total wage income of unskilled labor only 2 percentage points but adds 8 percentage points to GDP and 21 percentage points to the real skilled wage.

To complete the case for balanced protection + export promotion as the best policy package, we need assurance that nothing goes awry on the transition path from the old to the new steady

state. This is supplied by Figure 2. The early construction boom, persistent growth of the private capital stock, and rapid expansion of the infrastructure network generate continuous economy-wide increases in the demand for unskilled labor. As a result, the real unskilled wage is 11% higher at t = 10 and 14% higher at t = 20. Real GDP and the skilled wage also rise at a smooth, steady pace.

5.2 Education

Table 4 shows the outcome when net tariff revenue is dedicated to additional investment in education. In the long run, the different policy packages increase the supply of skilled labor 51-65%. The resulting large decrease in the skilled wage helps mainly services, non-food manufacturing, and construction, the three most skill-intensive sectors in the economy. Most of the decrease in construction costs gets passed on to producers through a lower supply price of capital. This stimulates private investment in all sectors, but, again, services and non-food manufacturing – both highly capital intensive – benefit disproportionately. The increases in the aggregate capital stock and high-wage employment are generally larger therefore than in Table 3. In the head-to-head matchups for policy packages A and B, real GDP also increases more (14.3% vs. 12.6% and 18.8% vs. 17.6%) even though the direct return on investment in education (25%) is lower than the direct return on infrastructure (30%).

Although capitalists benefit the most, unskilled labor also reaps large gains. This may seem surprising given that services and non-food manufacturing are so skill and capital intensive. But increases in the supplies of skilled labor and capital enhance the productivity of unskilled labor per the principle of gross complementarity. Consequently, both the unskilled wage and the share of high-wage employment increase strongly. In the comparison packages A and B, investing in education instead of infrastructure adds another 3-3.5 percentage points to income of workers who remain unskilled; when the income gain of newly skilled workers is factored in, the differential gain rises to 9-10 percentage points.[7]

Tilting the structure of protection/export promotion in favor of manufacturing leads, as usual, to smaller increases in unskilled wages and to larger increases in the capital stock and GDP. Compare policy packages A and C. In C, the capital stock and high-wage employment increase twice as much and GDP rises an additional eleven percentage points. The real wage increase for

unskilled labor drops from 19% to 12.6%, but since greater growth of high-wage employment offsets half of the loss total real wage income decreases only three percentage points.

5.3 Optimizing the Investment Mix

Investing all net increases in trade revenue in either infrastructure or education is inefficient. Typically the return on the asset included in the policy package drops to a single digit while the return on the other asset rises. Policy package A in Table 4 is a case in point. As the return on investment in education plunges to an embarrassing -1.2%, the return on neglected infrastructure projects increases from 30% to 38.3%.

In Table 5 the government is smarter. It adjusts the mix of investment in education and roads to preserve the initial ratio of returns. "Optimizing" in this manner produces better numbers for GDP growth and poverty reduction together with a fairly even distribution of gains across classes. The more evenhanded distribution of gains – especially compared to the scenario where all trade revenue is channeled into education projects – follows naturally from optimization of the investment mix. Ceteris paribus, when the skilled wage rises relative to the unskilled wage, so also does the return on education relative to the return on infrastructure. As the investment mix shifts toward education, the supply of skilled labor increases relative to the stock of infrastructure, reducing the skilled wage and pulling up the unskilled wage. This re-equilibrating mechanism exercises a continuous, powerful check on wage inequality (glance back at Table 4). On the transition path (Figure 3), the real unskilled wage and total real income of unskilled labor rise rapidly, covering 70% of the ground to their new steady-state values within twenty years.

6. Concluding Remarks

In this paper we have argued that Zambia should jointly protect agriculture and manufacturing. Our argument is firmly grounded in the principles of optimal tax theory. Zambia wants the usual things: less poverty, more high-wage jobs, more private investment, and more social and physical infrastructure. Trade policy should therefore (i) supply the government with more revenue for infrastructure projects and (ii) encourage greater utilization of imported inputs complementary to labor and private capital. This can be achieved by balancing an escalated structure of protection in primary agriculture and non-food manufacturing with an escalated structure of export promotion for non-traditional agriculture and the food-processing

sector. Tariffs on intermediate inputs are comparable to tariffs/export subsidies applied to consumer goods, so escalation in the structure of protection is mainly with respect to capital goods. Each component of this policy package serves a specific purpose. Protection of agriculture is essential to strengthen the demand for unskilled labor and reduce poverty. Protection of manufacturing and tariffs on intermediate inputs are needed to increase revenue, to create more high-wage jobs, and to stimulate private capital accumulation. And escalation in the structures of protection/export promotion raises the return on private investment by lowering the price of imported machinery relative to the prices of final goods.

Although we did not solve the social planner's problem, our results suggest that protection and export promotion should be moderate. In the Zambian case, trade policy is both pro-poor and pro-development when a 20-30% export subsidy + tariff on foodstuffs and manufactured consumer goods combines with a 20-25% tariff on intermediates, a 10-15% export subsidy for non-traditional crops, and a 10% tariff on machinery and equipment. Across steady states, this policy package increases the aggregate capital stock, real income of unskilled labor, and GDP by more than 20%. Unlike in static trade models, there is no need to apologize for small effects. Policy matters.

Conventional wisdom holds that outward-oriented economies do better than inward-oriented economies and that LDCs should aim either for free trade or a low uniform tariff. Our results do not contradict the first claim. Although our recommended policy package includes a protectionist component, it is not generally inward-looking. Imports of manufactured consumer goods decline, but exports of processed food and imports of foodstuffs, intermediate inputs, and capital goods all increase. The economy does not trade less. It trades more and differently as part of a strategy to mitigate poverty, underemployment, and underinvestment.

Clearly we disagree with the other part of the conventional wisdom. The excesses of protectionist policies in the pre-1980 period are well documented. But it does not follow from the fact that extreme protection was harmful in the past that free trade or a low uniform tariff is optimal today. This line is pushed aggressively by the World Bank, the IMF, the U.S. government, and the great majority of trade economists. It is not based, however, on any rigorous analysis of trade policy in dynamic models that resemble LDC economies. In truth, remarkably little is known about moderate protection and about policy packages that mix moderate protection with export promotion.

Our paper fills a small part of this gap. Filling the rest requires a strategy for dealing with the immense structural diversity of LDC economies. The right strategy, in our view, is to build a typology in the space between one size fits all and one size for each. A blueprint for the typology does not yet exist, but it is easy to guess some of its requirements. At a minimum, we need more research on the welfare effects of trade policy in prototype economies differentiated along the following dimensions:

- *Share of the import bill financed by aid and mineral exports*. In Zambia the net trade position of agriculture + manufactured consumer goods is close to zero because aid and mineral exports pay for almost all imported intermediates and capital goods. This is why a balanced escalated structure of protection + export promotion (BESPEP) that spans agriculture and manufacturing supplies the government with revenue to attack infrastructural bottlenecks. In countries where the flow of dollars from aid and mineral exports is smaller ─ say 10% of GDP ─ BESPEP would be a drain on the fiscal budget and it would be more difficult to devise trade policy packages that are self-financing, pro-development, and pro-poor.

- *Wage-setting rules in the formal sector and intersectoral labor mobility*. We abstracted from barriers to labor mobility and concentrated on the dualistic market for unskilled labor. These restrictions should be relaxed in future research. In some countries, dualistic labor markets encompass many types of skilled workers. Geography also matters. Jobs in agro-processing may be nearby and hence more accessible to rural workers than jobs in other branches of manufacturing. This can be captured either by introducing separate market-clearing conditions for labor groups in different regions or by making adjustment costs to changing jobs a function of the sectors of origin and destination. Intuition suggests that the distributional effects of trade policy will be significantly different, and that the case for promotion of agro-processing as an anti-poverty tool will be much stronger, than in models where labor is fully mobile across sectors.

- *Tradable vs. nontradable agriculture*. The spread between import and export parity prices for foodstuffs is often large in Sub-Saharan Africa. When the domestic price lands in-between, foodstuffs are nontradable. This changes the nature of sectoral interactions and the transmission mechanism for trade policy.[8] We would not be surprised therefore if the ranking of policy packages proved sensitive to whether foodstuffs reside in the tradables or nontradables sector.

NOTES

1. See Davies et al. (1998), Maio et al. (1999), Bussolo et al. (2002), Gelan (2002), Harrison et al. (2003), Stifel and Thorbecke (2003), Naude and Coetzee (2004), Vos et al. (2006), Justino et al. (2007), Cororaton and Cockburn (2007), and Maertens and Swinnen (2009).

2. Table 2 shows the effects of changing one or more trade taxes starting from the free trade equilibrium. Since the free trade equilibrium is not observable (Tariff describes the actual tariff-distorted equilibrium), we approximated it by computing the steady-state equilibrium with all trade taxes set equal to zero and stocks of infrastructure and schools adjusted so that the returns to physical infrastructure and education stay at 30% and 25%, respectively. The advantage of starting from the free trade equilibrium is that the policy experiments are conceptually clean. See the long version of the paper for a demonstration that, starting from the equilibrium associated with current trade taxes, a higher, revenue-raising tariff on intermediate inputs combined with more protection for agriculture and domestic manufacturing yields large, double-digit increases in real GDP and real income for all groups.

3. Real wages are computed precisely by deflating the wage by workers' exact consumer price index.

4. The cost share of the primary agricultural input is 40% in the food processing sector. To facilitate comparison with other tariff changes, t_x and t_g always increase by the same amount. (Otherwise, a ten point increase in t_x would increase the effective rate of protection in the food-processing sector much more than a ten point increase in t_i increases the effective rate of protection in non-food manufacturing.)

5. Transfer payments are cut to finance the export subsidy. When the allocation of transfers is distributionally neutral (i.e., each group's share of transfers equals its share in national income), real after-tax income of unskilled labor decreases 1.3%.

6. Unskilled workers may end up worse off than in the run with no learning externalities. Since exports increase more, outlays on the export subsidy are greater and transfers are cut more. In the case where transfers are distributionally neutral, real after-tax income of unskilled labor decreases 2.5%. Without learning externalities, the decrease is 1.3%.

7. 4.2% of formerly unskilled workers become skilled.

8. Protection of agriculture is necessarily indirect, accomplished through tariffs and export subsidies that increase the right subset of tradables prices. Furthermore, since protection of agriculture is a byproduct of protection or export promotion of other sectors, the fiscal effects of trade taxes will be quite different.

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Table 1: Calibration of the Model

Parameter/Variable	Value (base case)
Sector shares in GDP[1]	A = .222, B = .059, X = .075, I = .072, S = .415, M = .113, C = .044
Ratio of aid to GDP	.115
Consumption shares for workers	A = .45, B = .02, X = .23, I = .14, S = .16
Consumption shares for capitalists/landowners	A = .12, B = .06, X = .19, I = .27, S = .36
Factor shares in primary agriculture[2]	K = .10, UL = .64, SL = .06, T = .20
Factor shares in commercial agriculture	K = .30, UL = .48, SL = .12, T = .10
Factor shares in food processing	K = .37, UL = .46, SL = .17
Factor shares in non-food manufacturing	K = .64, UL = .17, SL = .19
Factor Shares in services	K = .59, UL = .20, SL = .21
Cost share of imported intermediate inputs	A = .06, B = .06, X = .06, I = .23, S = .10
Elasticity of substitution between SL and UL (all sectors)	.75
Elasticity of substitution between labor, capital and imported intermediates (all sectors)	.60
Time preference rate	.10
Depreciation rate	.05
Elasticity of substitution in consumption between processed and unprocessed food	.75
Elasticity of substitution in consumption between food, manufactures and services	.50
Intertemporal elasticity of substitution	.50
q-Elasticity of investment spending	10
Initial rate of return on infrastructure	30%
Initial rate of return on education	25%
Ratio of unskilled wage in formal sector to the unskilled wage in the informal sector	1.75
Ratio of skilled wage to unskilled wage in the informal sector	6
Rato of shadow wage in primary agriculture to the unskilled wage in the informal sector	.69
Initial trade taxes (t_j)[3]	t_a = .10, t_x = .10, t_b = .05, t_i = .20, t_h = .10, t_m = .10
Learning externalities from capital accumulation	0

[1] A = primary agriculture; B = commercial agriculture; X = food processing; I = non-food manufacturing; S = services; M = mining; C = construction.

[2] K = capital; UL = unskilled labor; SL = skilled labor; T = land.

[3] a, x, b, and i subscripts refer to primary agriculture, commercial agriculture, food processing, and non-food manufacturing. h and m subscripts refer to imported intermediate inputs and imported machinery.

Table 2: Long-Run Effects of Pure Trade Policy Experiments.[1]

Policy[2]	ω_u	TUWI	ω_s	K	HWE	GDP
$t_a = .10$	8.7	6.5	-11.9	-6.3	-2.8	-4.6
$t_a = .10$, LE = 100%	11.1	8.4	-12.9	-7.1	-3.4	-4.6
$t_x = t_i = .10$	-5.9	-1.9	21.3	13.4	5.9	6.9
$t_i = .10$	-2.9	-2.8	8.1	7.0	.2	2.5
$t_x = .10$	-3.4	.7	14.4	7.4	5.8	4.6
$t_b = .10$	1.2	.3	2.6	2.0	-1.1	.6
$t_b = .10$, LE = 50%[3]	2.5	.8	6.8	5.1	-2.3	3.3
$t_h = .10$	-1.3	-1.6	-4.2	-2.9	-.5	-1.3
$t_m = .10$	-2.2	-2.6	-5.3	-5.8	-.6	-2.5
	Policy Packages					
Policy	ω_u	TUWI	ω_s	K	HWE	GDP
$t_a = t_x = .20$	9.5	12.4	3.3	2.8	3.7	.4
$t_a = t_x = .25$, $t_i = .10$	9.5	12.9	8.3	7.7	4.4	2.1
$t_a = t_x = .25$, $t_i = .15$	8.2	11.6	11.4	10.6	4.4	3.3
$t_a = t_x = t_i = .25$	5.5	8.9	18.8	17.2	4.4	5.4

[1] ω_u is the real wage for unskilled labor; TUWI is total real wage income of unskilled labor; ω_s is the real wage for skilled labor; K is the aggregate capital stock; HWE is the share of unskilled labor employed in the high-wage formal sector; and GDP is real gross domestic product exclusive of mining. The entry for HWE is the change in the share of high-wage employment. All other entries show the percentage change in the variable relative to its value at the initial free trade equilibrium.

[2] t_a is the export subsidy for the primary agricultural good; t_x is the tariff on processed food; t_i is the tariff on other manufactured consumer goods; t_h is the tariff on intermediate inputs; and t_m is the tariff on machinery and equipment. t_x and the duty on raw materials purchased by the food-processing sector increase by the same amount.

[3] Learning externalities raise the social return on capital 50% above the private return.

Table 3: Long-run effects of trade policy when increases in net tariff revenue are invested in physical infrastructure and free trade is the initial equilibrium.[1]

Policy	ω_u	TUWI	ω_s	K	HWE	GDP
$t_a = t_x = .25$, $t_i = .15$	-3.3	-.8	-6.3	4.3	3.6	-8.3
$t_x = t_i = .10$	-4.1	0	24.9	14.5	6.0	8.9
$t_i = .10$	-1.1	-.8	11.5	8.2	.4	4.5
$t_x = .10$	-7.1	-3.4	8.1	5.4	5.5	.6
$t_x = t_i = t_h = .10$	1.8	6.1	34.3	15.4	6.0	15.8
	Policy Packages					
Policy	ω_u	TUWI	ω_s	K	HWE	GDP
A: $t_a = .25$, $t_b = t_m = .10$, $t_x = t_i = t_h = .20$	18.3	18.9	18.4	7.3	.8	12.6
Package A with $t_a = .20$	16.6	18.6	29.6	11.3	2.3	17.4
Package A with $t_a = .15$	13.5	16.7	39.2	14.8	4.0	20.8
B: $t_a = t_x = t_i = .25$, $t_h = .20$, $t_b = .15$, $t_m = .10$	16.6	18.8	32.0	14.6	2.6	17.6

[1] See footnotes 1 and 2 in Table 2 for definitions of terms.

Table 4: Long-run effects of trade policy when increases in net tariff revenue are invested in education and free trade is the initial equilibrium.[1]

Policy Package	ω_u	TUWI	ω_s	K	HWE	GDP
A: $t_a = .25$, $t_b = t_m = .10$, $t_x = t_i = t_h = .20$	19.0	22.4	-38.7	19.3	4.0	14.3
Package A with $t_x = .25$	17.2	22.5	-33.7	22.5	6.3	16.3
Package A with $t_a = .15$	12.7	18.9	-33.4	27.6	7.7	20.1
$t_a = .25$, $t_b = .20$, $t_m = .10$, $t_x = t_i = .30$, $t_h = .20$	13.9	20.3	-22.2	34.7	7.8	21.7
B: $t_a = t_x = t_i = .25$, $t_h = .20$, $t_b = .15$, $t_m = .10$	17.0	22.0	-31.8	27.9	6.0	18.8
C: $t_a = .25$, $t_b = .20$, $t_m = .10$, $t_x = .30$, $t_i = .40$, $t_h = .20$	12.6	19.3	-25.4	41.9	8.2	25.1

Table 5: Long-run effects of trade policy when increases in net tariff revenue are invested "optimally" in education and infrastructure and free trade is the initial equilibrium.[1]

Policy Package	ω_u	TUWI	ω_s	K	HWE	GDP
A: $t_a = .25$, $t_b = t_m = .10$, $t_x = t_i = t_h = .20$	20.9	22.3	8.1	11.6	1.6	15.8
Package A with $t_a = .15$	16.9	21.4	21.1	21.5	5.3	25.3
Package A with $t_a = .20$	19.8	22.8	15.0	17.1	3.4	21.5
$t_a = t_b = .15$, $t_m = .10$, $t_x = t_i = t_h = .20$	16.3	20.1	20.9	21.4	4.6	24.3
$t_a = .20$, $t_b = t_m = .10$, $t_x = t_i = .25$, $t_h = .20$	16.0	20.9	22.7	23.5	5.9	24.1
D: $t_a = .25$, $t_b = .15$, $t_m = .10$, $t_x = .25$, $t_i = .30$, $t_h = .25$	20.6	24.0	20.7	24.8	3.9	25.5

[1] See footnotes 1 and 2 in Table 2 for definitions of terms.

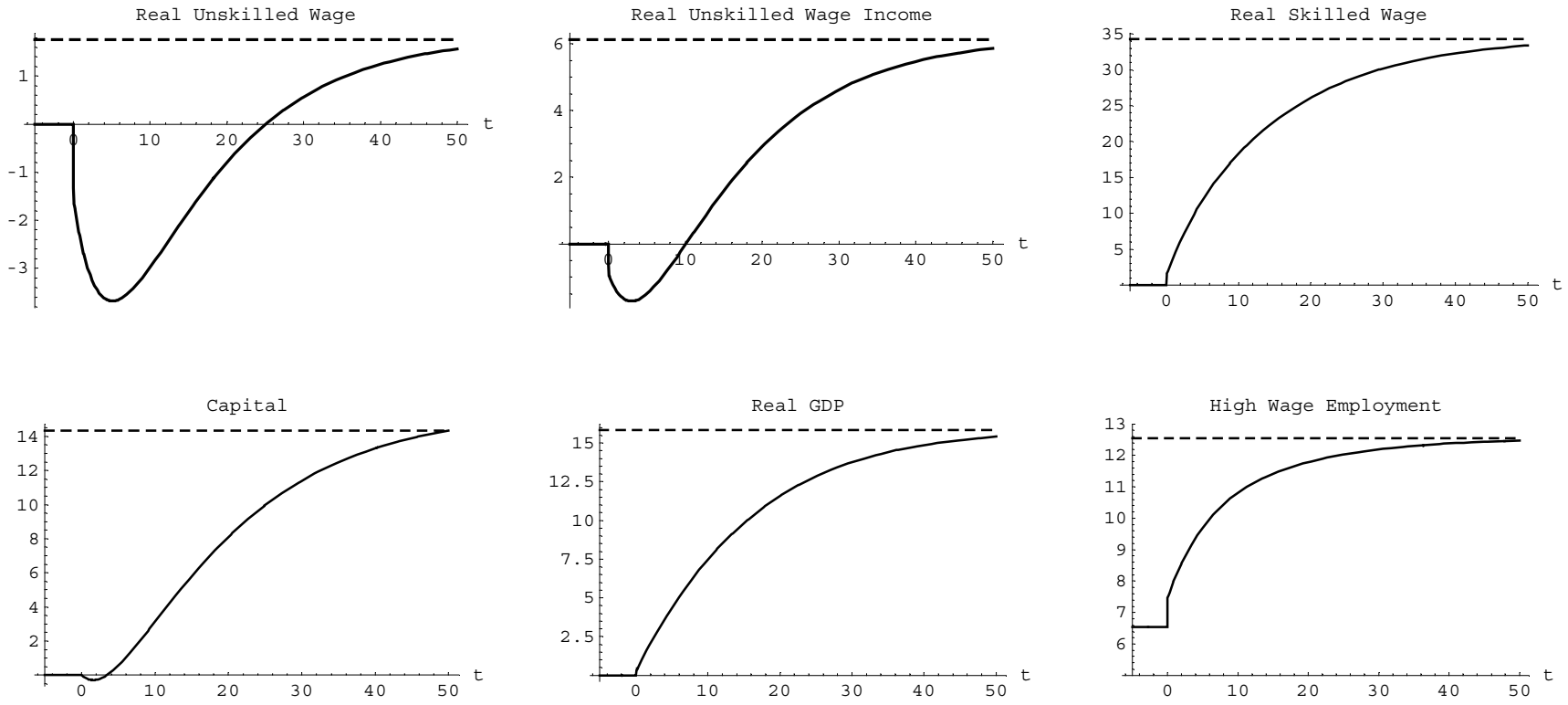

Figure 1: The transition path when net tariff revenue is invested in infrastructure and $t_x = t_i = t_h = .10$.

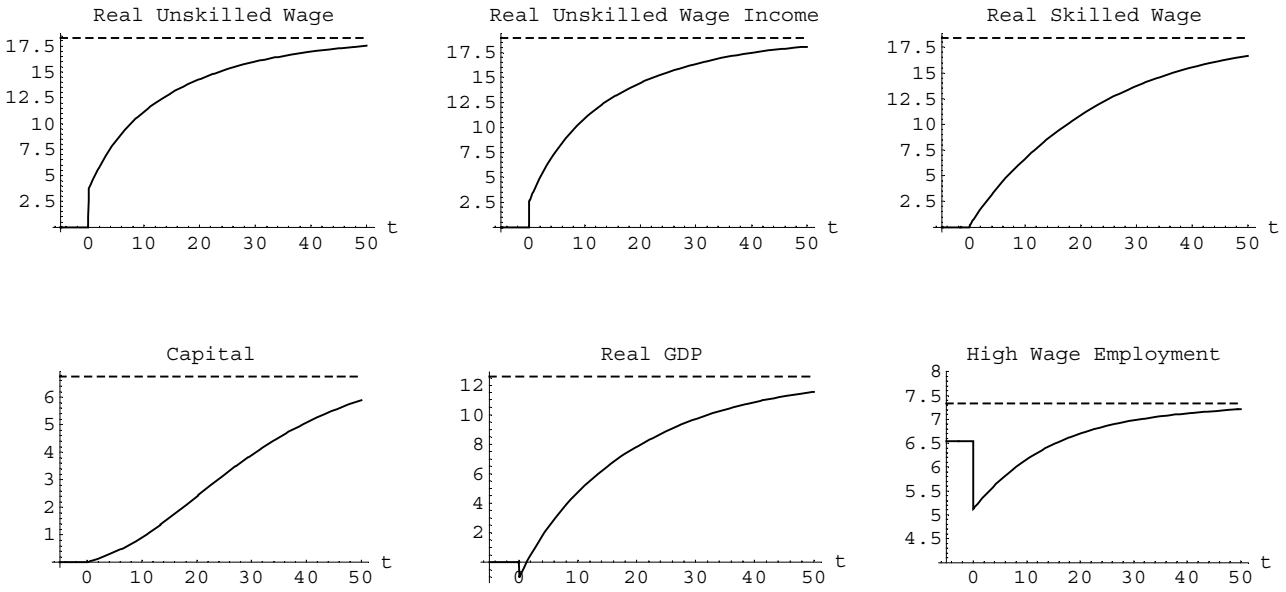

Figure 2: The transition path when net tariff revenue is invested in infrastructure, $t_a = .25$, $t_x = t_i = t_h = .20$, and $t_b = t_m = .10$.

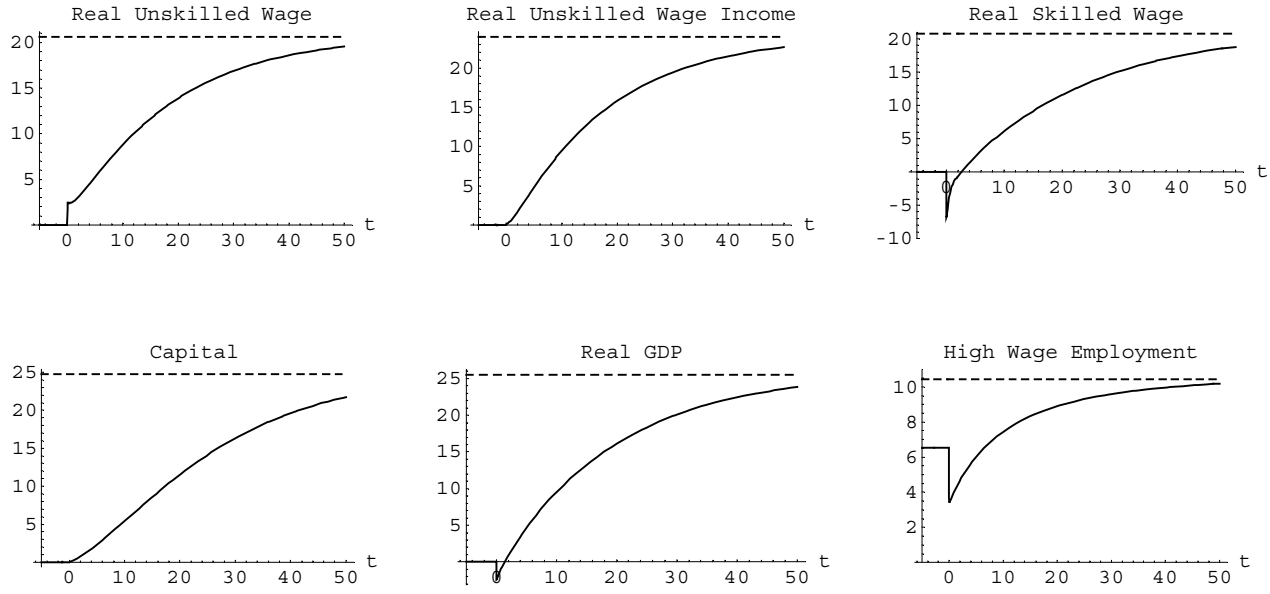

Figure 3: The transition path when net tariff revenue is invested optimally in infrastructure and education, $t_a = t_x = t_h = .25$, $t_i = .30$, $t_b = .15$, and $t_m = .10$.