# ASSESSING THE IMPACT OF TRADE ON EMPLOYMENT: METHODS OF ANALYSIS

# 3

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## 3.1 INTRODUCTION

Since Adam Smith, economists have laboured under the assumption that specialization and trade is the cause of the wealth of nations. For developing countries, this has traditionally meant specialization in relatively labour-intensive branches of production and trade with more developed economies with abundant capital. Early ILO studies concluded that liberalization could facilitate labour absorption in the least developed countries (LDCs) and that, potentially, significant gains could follow (Lydall, 1975). Still, there is considerable scepticism whether trade remains the engine of growth and employment, in terms of both quantity and quality.

It is the purpose of this chapter to investigate the main methodologies that have been used to address the link between trade, growth and employment. Estimates of the employment impact of trade can provide useful information for policy design. How and for which purpose information based on estimates can be used will, to a large extent, depend on the methodology that has been used to generate the estimates. This chapter provides an overview of the different methodologies that exist, their respective advantages and disadvantages when it comes to implementing them and their strengths and weaknesses with respect to policy guidance.

Methodologies to evaluate the impact of trade on employment may be broadly classified as quantitative or qualitative. Quantitative methods include both econometrics and simulations. Qualitative methods involve case studies or consist of "thick description" of specific events, narratives, cultural histories, ethnographies or other portraits of the effects of job creation and destruction as a result of globalization. The bulk of this chapter is devoted to quantitative assessments, but qualitative methods are also discussed.

The discussion in this chapter illustrates that, despite the overwhelming historical evidence that trade and specialization are generally major contributors to the wealth of nations, it is not known with precision whether a marginal change in imports will increase or decrease employment opportunities. Indeed, most studies that investigate the employment impact of shifts in the volume and composition of trade show that the overall impact on employment is small. Baldwin (1994, p. 17), for instance, notes that the net employment effects of changes in exports and imports have not been significant in OECD countries, and this is the mainstream view. To a certain extent, these findings can be explained by the fact that models of trade produced by economists are not designed to take into account the aggregate employment effects of trade, despite public concern that "trade destroys jobs" (Davidson and Matusz, 2004). Standard models assume full employment and, in such models, a shift in the pattern of production in response to trade opportunities causes only a temporary decline in aggregate employment as workers relocate from declining to expanding branches of production. These temporary changes in employment are not a main focus of this chapter, as they are discussed at length in Chapter 6 in this volume.

One could even ask the question of whether a focus on employment effects is warranted at all. In standard economic analysis, a gain or loss of employment is only one part of overall welfare. A reduction in the total amount of employment can be compensated in part by a rise in leisure and opportunities for home production. It also affords individuals an opportunity to accumulate human capital by returning to school or acquiring specialized training. Still, few economists would doubt that trade may lead to large adverse changes in overall well-being, if it is the case that a significant number of quality jobs are destroyed.

Instead of focusing on the short-term effects of trade on employment, this chapter discusses methods to evaluate the long-term effects. Those long-term effects will to a large extent be determined by the interplay of three variables: trade, productivity and employment. Significant attention is therefore given in this chapter to the relationship between those three variables, both at the economy-wide level and at the cross-sectoral level within economies. The chapter also features a discussion of how the interaction between trade and productivity affects the quality of employment, notably in terms of wages and the wage premium between high- and low-skilled labour.

The chapter starts with a section that highlights the challenges faced by those who attempt to assess the employment effects of trade. The section contains a discussion of the need to understand the trade, productivity and employment (both in terms of quantity and quality) relationship. Challenges related to data requirements and model choice are also discussed in that section. Sections 3.3 and 3.4 provide detailed discussions of models available for conducting quantitative assessments of the employment effects of trade. Section 3.3 focuses on simulation methods and discusses different methods in order of increasing level of sophistication. Section 3.4 focuses on econometric approaches. Section 3.5 provides a short introduction into qualitative methods, and section 3.6 concludes with a number of key points that emerge from the preceding sections as to the proper way to model the relationship between trade and employment.

## 3.2 ASSESSING THE EMPLOYMENT EFFECTS OF TRADE: MAIN CHALLENGES

### *3.2.1 Trade, productivity and employment*

Since Edwards and Edwards (1996), it seems clear that increased openness will initially cause a rise in unemployment in the affected sectors. Both the depth and duration of unemployment are correlated with the degree of import penetration. Matusz and Tarr (1999) survey more than 50 studies and conclude that trade adjustment is rapid with a short duration of transitionary unemployment, quick recovery to net zero impact of liberalization, and rapid expansion thereafter. Temporary unemployment during the adjustment phase following trade reform represents an important policy concern that is discussed in detail in Chapter 6 of this volume.

This chapter, instead, focuses on the long-term effects of trade on employment. To evaluate those, it is important to understand how trade reform affects productivity, as the productivity increase triggered by trade reform will ultimately be a crucial determinant of labour market outcomes. Indeed, total employment $L$ is equal to aggregate demand $X$ multiplied by employment per unit of output $I$, as reflected in the following equation:

$$L = lX \qquad (3\text{-}1)$$

Taking growth rates of this equation

$$\hat{L} = \hat{l} + \hat{X} \qquad (3\text{-}2)$$

so that the rate of growth of employment is equal to the rate of growth of the labour coefficient plus the rate of growth of output. Productivity growth causes the labour coefficient to fall.[1]

From this simple demand-driven model, a fundamental truth about trade and employment is revealed. So long as productivity is increasing, aggregate demand must expand by $-\hat{l}$ in order for employment to remain stable. Or, to say the same thing differently, from equation (3-2) we would expect there to be a negative relationship between productivity growth and employment growth. There seems to be widespread empirical support for this account. Dew-Becker and Gordon (2005), for example, find strongly robust negative correlation between growth in labour productivity and growth in employment per capita across Europe. This places the burden of employment growth on the $\hat{X}$ variable, the growth in gross domestic product (GDP). If trade causes growth, it follows that employment can rise. There is one important caveat to this conclusion, however. Equation (3-2) relates the aggregate labour coefficient to employment growth. It is evidently possible to have all sectoral labour coefficients fall with productivity growth, yet the aggregate labour coefficient

[1] Underlying these aggregate changes might well be change in sectoral composition, technology, wages and many other institutional and economic factors. One might also wish to subtract the rate of growth of the population, as well, in order to focus on employment growth per capita.

rises, as the sectoral mix comes to favour more labour-intensive sectors. This could come about due to specialization in labour-using industries as the result of trade. This is an obvious point, but one that should be kept in mind throughout the discussion to follow. Still to a first order approximation, growth in demand per capita appears to be the main determinant of employment growth.

Supply side models with full employment might be applicable for developed countries but are much less convincing when applied to developing economies. Still, there are important links between the two: even in models without full employment, if trade can be shown to increase the rate of growth of output, then *ipso facto*, trade would increase the rate of growth of employment. The question of whether trade is good for employment then can evidently be decomposed into whether trade is good for growth and how growth and productivity change are related. Davidson and Matusz (2010) point out, though, that the trade-growth relationship may be affected if the labour market is characterized by imperfections. In their book on trade with equilibrium unemployment, they argue that multiple equilibria is more the rule rather than the exception in such cases. This implies that, with the same initial conditions, economies can follow a "low-trade" or "high-trade" growth path.[2]

The question of how growth and productivity changes are related has received a good deal of attention in theoretical discussions of the last century. For Keynes, in the *General Theory*, the decision to invest was shrouded in mystery. In the simplest account, investment is driven by profitability, which rises with productivity and capacity utilization. The relationship is complicated by the fact that current profitability might not be a good indicator of future profitability, and certainly it is the latter that drives investment. Moreover, investment does not occur in isolation: there are problems of coordination between sectors. Keynes' investors had to think both about what the future was to bring as well as what their colleagues thought about what the future was to bring. This was all too complicated for theory to handle so, for Keynes, investment was determined by a mixture of the objective measures of productivity and capacity utilization with a subjective component he called "animal spirits" (Keynes, 1936).

Other important theorists, such as Solow (1956), followed suit, taking the propensity to accumulate as essentially given and technical change as exogenous. *New growth theories* have attempted to endogenize technological change depending upon the path the economy takes, the availability of human capital, positive externalities or spillovers and deliberate investment in technical progress (Romer, 1986; Romer, 1990). These models, well worth exploring in their own right, are essentially elaborations of the problem identified by Keynes. In every case, productivity matters and is directly related to investment and growth.

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[2] A fundamental finding is also that factor endowments no longer determine the pattern of trade-induced specialization, which can instead be driven by differential turnover rates across domestic sectors.

The connection to trade in this new way of thinking about investment and technical change is immediate. Consider a producer in a developing country who is limited by the extent of the domestic market. The producer is afraid to expand production and employment, fearing the price might fall and with it profitability. Similarly, she cannot easily expand output because the price of her *inputs* will go up, unless the local suppliers of those inputs also decide to invest at the same time. A classic "coordination" failure creates multiple equilibria: one in which output and employment are low and another when coordinated expansion leads to higher levels of both. In the first equilibrium, production is plagued by economies of scale in reverse, costs are high and profits and employment are low. The alternative equilibrium is the product of a virtuous cycle of increasing returns to scale, higher productivity, lower input prices and much higher employment, an accelerated accumulation of capital all woven together in a process of cumulative causation.[3]

### *3.2.2 Taking into account wage effects*

When sectors expand in response to trading opportunities, this is precisely the moment at which technological change can occur. As a general rule, labour productivity is higher in export industries. Clerides et al. (1998) and many others find similar results.[4] The reason is evident: new investment brings with it state-of-the-art technology, often supplied by foreign investors and designed and developed to cope with the relative labour scarcity there. Indeed, the combination of high technology and extremely low wages is often irresistible, but the new capital employs far fewer people than in the past. The labour market effects of trade combined with technological change can take any combination of the following two forms: pressure on wages in the occupations or sectors most affected by the technological progress and/or employment losses in those occupations or sectors. Because of this combined effect on the quantity and quality of employment, a discussion of the employment effects of trade that only focuses on the quantity of employment would be incomplete.

Indeed, traditional trade models predict that the labour market effects of trade reform mainly take the form of changes in relative factor prices. Standard Heckscher-Ohlin-Samuelson (HOS) theory, for instance, suggests that firms in countries with excess supplies of labour will find it profitable to increase production of goods for

[3] What could shift the economy from the low- to high-level equilibrium? One answer is free international trade. Note that in a perfectly competitive economy none of the considerations of the last paragraph pertain. Each producer is so small that it is impossible to have an impact on the market as a whole. In developing countries, the scale of production is frequently large relative to the size of the internal market and so the assumption of a perfectly competitive economy scarcely applies. Free international trade, however, can restore the competition lost to the mismatch of technology to market size in developing economies. With trade, it is impossible to sustain a coordination failure.

[4] Abraham and Brock (2003) find that trade has induced changes in technology in the EU.

which cheap labour produces a cost advantage relative to competitors. As the trade-favoured sector expands, the contracting sector must then release the factors of production in proportions suited to its rival. If countries specialize in goods intensive in their most abundant factor, then the return to that factor should rise with trade. Since the inception of this theory, economists have held that poor countries should specialize in labour-intensive goods so long as capital is in short supply relative to labour. The expansion in demand for the labour-intensive good will then drive up the price of labour. HOS is a theory with fully employed factors of production, however, and so even though overall employment cannot rise, the quality of jobs in poor countries improves with the trade, in so far as quality is measured by the wage rate.

The HOS framework thus suggests that developing countries should specialize in labour-intensive goods, given their excess supply of labour. Here the aggregation across skill categories required for analytical models obscures the basic fact that labour is heterogeneous with respect to skill and experience. There is no reason to expect that an increase in demand for exports in a developing country would not cause some disruption in those labour markets, similar to what is experienced as a result of intra-industry trade in developed markets. While the broad range of developing country exports might well be more intensive in unskilled labour, it is impossible to ignore that in practice labour appears quite heterogeneous to firms in developing countries. In South Africa, for example, textile manufacturers frequently complain of a "labour shortage" despite the fact that there is 40 per cent unemployment. This will have to be explained by increasing the resolution in the labour market until differences as perceived by the firms themselves can be identified. Once the detailed nature of the market is analysed, it is far less surprising that a bubble in export demand might generate significant wage inequality, even in developing countries and contrary to what standard HOS models predict.

There is, indeed, evidence that relative wages, of skilled compared to unskilled workers, have tended to increase in numerous developed and developing countries in the aftermath of trade liberalization. Outsourcing provides one mechanism by which such wage inequality can legitimately arise.[5] To the extent that a ladder of comparative advantage exists, countries will simultaneously take advantage of opportunities to expand employment in a given skill category, while typically contracting employment in less-skilled branches. Part of the phenomenon is that as unskilled branches of production migrate from developed to developing countries, the demand for skilled labour rises in both. This increases skill-based wage inequality on both sides of the border. As the international division of labour progressively develops,

[5] Current account liberalization also forces lower middle-income countries to experience competition from even lower-income countries. Tariff reduction thus concentrates job opportunities on one rung of the ladder of comparative advantage. Those with the appropriate skills benefit from the increase in demand; those without suffer until their skills can be upgraded or they move into the local service economy, the non-traded sector.

large wage inequalities could naturally be expected to emerge and persist.[6] Only when the adjustment process is fully played out, will the wage gap close.[7]

The wage inequality that results from trade liberalization is not necessarily undesirable.[8] High wages signal the need for the formation of human capital specific to the demand for labour for the expanding sectors, and vice versa for those that are contracting. Any policy initiative that seeks to reduce inequality of this kind may well be counterproductive to the extent that it impedes the formation of specific human capital. Indeed, Wood (1997) notes that the skilled labour premium declined in the Republic of Korea, Singapore and Chinese Taipei as the virtuous cycle of rising exports, improved access to education followed by an increase in supply of skilled labour, took hold. Lopez-Calva and Lustig's recent work on Mexico shows that wage differentials in Latin America have eroded over time as markets adjust, much to the surprise of most observers (Lopez-Calva and Lustig, 2010).

Policy-makers nevertheless often decry the wage inequality that arises from "efficiency wages" paid to the workers lucky enough to find jobs in the export sector that in part reflect the comparatively vast quantities of capital with which they work. Some of the economic literature has taken up the task of explaining wage inequality as it presents an economic as well as sociological problem. Rodrik (1997) is an early attempt to promote globalization by way of calling for stepped-up public sector intervention to resolve wage and, more broadly, factor price inequality that seems to be emerging. More than a decade ago, Rodrik pointed out that the trend toward increased openness would increase competition. In highly competitive markets, there is little or no ability of producers to pass on idiosyncratic cost increases. Consequently, the demand for labour in competitive industries could be expected to become more elastic under a globalized trading system. Rodrik points out that larger, more aggressive public sector intervention may be required in order to prevent a backlash by those who have been hurt by globalization, free-trade and current-ac-

[6] One response to rising competitive pressure is an increase in informality. Gibson and Kelley (1994) define the informal sector in a general equilibrium context as those who are forced to operate production processes that fail to return the average rate of profit when paying the going wage rate. These processes are defective in the sense that formal sector capitalists will not operate them. They nonetheless exist and can be utilized by those who have no other options. This conceptualization of informality is useful in analysing the impact of tariff reductions. Formal sector firms rendered unprofitable by tariff reduction fail and disappear, while informal firms simply adjust to the new competitive reality by accepting a lower rate of return, possibly negative, when evaluated at the market wage rate. Informality rises with import penetration.

[7] Feenstra and Hanson (1997), for example, find that US firms outsourced mostly labour-intensive jobs, which raises equality both at home and in the host country.

[8] Trade liberalization can also contribute to reducing wage inequalities. One way that wage *equality* can be brought about by trade policy is by reducing rents that accrue to firms and their workers in protected industries. As long-standing tariff protection is eliminated, unemployment in local labour markets rises, reducing the gap between the wages of experienced workers with significant learning-by-doing skills and those that have had little formal-sector experience. The wage inequality that had previously existed in this case would be reduced or eliminated by pro-trade policies. This "levelling from below" is rarely an attractive process to observe in reality, but can in principle be defended on the grounds of standard economic theory.

count openness. How much of a problem this is in practice is still a matter of dispute. Indeed, since Samuelson-Stolper (as well as the factor-price equalization theorem), there has been an unresolved tension between trade theorists, policy-makers and even some members of the economics profession.[9]

Nothing about globalization prevents a developing country from adopting the labour standards and associated transfers to shape their societies in ways they see fit. Stepped-up public sector intervention to resolve wage inequality is wholly consistent with mainstream economic theory, so long as: (1) the citizens of the country authorize the expenditure in the form of voting for the required tax increases; and (2) transfers are made in lump sums and do not disturb the prices or wages prevailing in the market. To the extent that planning was an attempt to circumvent these conditions, it would not be sustainable in the long run.

The extent to which government intervention is desired may depend on the nature of trade and also on the extent of the positive supply response following trade reform. It is, for instance, often pointed out that within-sector trade tends to winnow less productive, uncompetitive firms from the branch of production, allowing the fitter firms to enjoy a Darwinian prerogative.[10] Workers need not be reskilled to suit the expanding subsector, since they were recently discharged from the similar firms. Excess supply, local to the branch in question, will reduce wage demands, which will help to maintain competitiveness of the survivors. Since the losers are probably less competitive precisely because they are more labour intensive, an expanded role of the public sector may still be called for if sectoral employment falls. The scope and potential damage to macroeconomic variables, such as the public sector borrowing requirement (PSBR) to GDP ratio and subsequent exchange rate overvaluation, is less if the emerging sector is successful. Indeed, if exports rise rapidly, the budgetary implications will be positive. Wage inequality will certainly emerge, but it will be a marker of the success, not the failure, of the policy.

It also needs to be pointed out that poverty may decrease in developing countries even in the context of increasing wage inequality. Indeed, many economists would agree that the poor benefit from trade reforms because they rely on local industries for most of the goods they consume, industries that escape the cost-reducing effects of competition (Hertel and Winters, 2006). Real income of the poor increases with the rate of growth of their share plus the rate of growth of real GDP. If trade then accelerates GDP growth but causes the share of the poor to fall in the same proportion then the poor are no worse off as a result of trade liberalization, despite

[9] Samuelson himself has recently argued that trade may well damage the interests of US workers (Samuelson, 2004).

[10] In a closed economy, the rising concentration ratios might well raise market-power flags. Trade, however, brings the best of both worlds in that firms enjoy increasing returns to scale yet, at the same time, foreign competition ensures that the benefits of scale economies are passed on to consumers.

the deterioration in the distribution of income. In this context, an important elasticity is that of the income of the least well off with respect to the real wage. If this is greater than one, then higher wages will benefit the least well off. If it is less than one, higher wages work against their interests. Trade that brings lower wages will then work to their benefit. The key to understanding how the lowest strata fare when there is trade liberalization lies in evaluating this elasticity. If higher wages lead to slower growth of GDP because of a loss in competitiveness, and the share of the poorest segments remains constant, then they are clearly worse off. If lower wages causes a rise in the share of the poor, because the elasticity of substitution of labour for capital is greater than one, and low wages improve competitiveness, then the poor are absolutely better off with low wages. In this case, the average wage can fall without having any individual suffer a decline in his or her own wage.

While trade may well be important on a case-by-case basis for developing countries to escape the bonds of their own weak internal markets, the same does not appear to hold true for developed countries. Developed countries have a much bigger impact on LDCs than the other way around. Well-known papers have repeatedly made this point, Freeman and Katz (1991), Revenga (1992) and others broadly agree that skill-biased technical change explains much more of the skilled wage differential than does trade. Moreover, trade and technical change may be highly collinear in that many studies confirm that trade induces technical change.[11]

If policy-makers nevertheless chose to address inequality through, for instance, transfers, such policies should, as mentioned above, not upset prevailing wages in that they carry signals, often the only signals available, to guide the behaviour of individuals in the economy. Wage differentials that result from trade-induced investment and technical change provide a strong incentive for the unskilled to improve their education and training, while at the same time demonstrating that semi-skilled employment is within reach and significantly more remunerative.[12] High wages would then signal the formation of human capital specific to the demand for labour for the expanding sectors and vice versa for those that are contracting. Any policy initiative that seeks to reduce inequality of this kind may well be counterproductive to the extent that it impedes the formation of specific human capital. Public sector intervention, instead, that makes skill upgrading affordable to families can be considered highly desirable.

Another welcome effect from wage reductions is that they could have salutary effect on exports, propelling the economy down an export-led growth path (Gibson,

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[11] Trade and foreign direct investment (FDI) are widely recognized as the drivers of innovation. Abraham and Brock (2003) find that trade has induced changes in technology in the EU. Greenaway et al. (1999) indicate that open sectors in the UK tend to experience faster rates of technological change, and the same effect has been found for the US by Bernard and Jensen (1995).

[12] Feenstra and Hanson (1997) find this effect is strong along the Mexico-US border *maquiladora* zone in foreign affiliate assembly plants.

2005).[13] Indeed, why countries seem to believe that it is optimal to protect their low-skilled workers has been noted as a major "puzzle" by Hoekman and Winters (2005). Doing so effectively forces them to produce the "wrong" goods and, furthermore, effectively "protects" them from productivity-enhancing investment.

### *3.2.3 Which methodology?*

In the context of the modern globalized economy, top-down planning in the traditional sense may be a lost art (Gibson, 2008a). Davidson and Matusz's (2010) abovementioned work on trade with equilibrium unemployment, however, describes a more bottom-up approach. Models should be constructed with clear attention to the incentives and constraints a microeconomic agent faces. Policy can then be designed around these incentives and constraints rather than reacting to the macro-level properties that the interaction of the agents creates.

One of the major challenges economists face when building relevant models, and subsequently trying to assess the employment impact of trade, is to control for the impact of other variables on employment and to establish that observed changes in trade flows or policy have actually caused changes in employment. Indeed, much of standard macroeconomic empirical work of the post-war period, for example, has been subjected to the debilitating criticism that *all* macroeconomic variables tend to be correlated over time and thus imputed causality of established studies is in fact only a correlation.

The gold standard for distinguishing causality from correlation is the so-called randomized controlled trial. In this procedure, subjects are randomly allocated to either a "treatment" or "control" group. The key is that they are *randomly assigned* and the resulting samples are statistically equivalent. This does not imply that samples are exactly the same, only that the reasons they differ are purely random. The "treatment" sample is then exposed to the shock that is the subject of analysis. For the purpose of this chapter, the shock would be a change in trade policy. If the protocol is observed, no sophisticated statistical processing is then required to assess the employment effect of a change in trade policy. One would only need to calculate the employment level in the treatment cohort and compare it with that of the control group. It is not straightforward to artificially construct randomized controlled trials. But social scientists sometimes benefit from so-called "natural experiments", ones

[13] Imperfectly competitive product markets might well enhance the adjustment process and produce as a by-product even more wage inequality. Harrison and Hanson (1999) and Currie and Harrison (1997) note that firms may well reduce their profit margins to establish themselves in the global market. Firms may also hoard labour if forecast growth is strong and they are investing in more productive capital equipment. Artificial wage differentials are another matter. If the public sector promotes wage differentials that would not be validated by the private market, serious distortions may result. Paraguay's policy of subsidizing tertiary education and then finding it necessary to provide public-sector employment for graduates is a classic and unfortunate example. Wage differentials that arise in this way cannot be defended as a normal market-signalling mechanism, indeed, quite the reverse.

they did not arrange, but came about through serendipity. An example would be a natural event such as an earthquake that damages one school district but leaves a neighbouring one intact, or the introduction of some policy in one jurisdiction but not another. Unfortunately, opportunities to apply natural experiments are relatively rare.

Standard econometric models are used when randomized trials are not possible, too expensive or ethically questionable. To mimic the randomized trial methods, econometric models "control" for systematic differences in the treatment and control group characteristics that are *not* in fact randomly distributed between the two. Such "observational" studies work at a disadvantage: to properly impute causality, the controls must remove any and all variation in the two subsamples that might be correlated with either the treatment or the outcome. The discussion in box 3-1 reveals that this can rarely be fully achieved. Econometric approaches have, nevertheless, become the traditional workhorse of quantitative analysis although randomized controlled trials have been effectively and impressively conducted by Duflo and Banerjee and their group at the Poverty Action Lab at the Massachusetts Institute of Technology (Duflo et al., 2007).

**Box 3-1: Separating causality from correlation in econometric models.**

Econometric techniques that fit a regression line to a set of points by minimizing the sum of squares of the error term can only uncover correlation. To elevate correlation to causality requires a second movement, often subtle, delicate and frequently misunderstood. The two problems that stand in the way are "omitted variable bias" and "reverse causality", a problem revealed in the correlation between the regression's independent variable and its error term.

Without delving into the technical details, omitted variable bias can be conceived as the imputing to one coefficient in a multiple regression the impact of some unknown variable acting through the estimated coefficient. In addition to this "hidden actor" problem, reverse causality robs many regressions of their ability to establish causal links by ignoring the correlation between the independent variable and the error term. If the latter is systematically elevated with large values of the independent variable, chances are there is a reason for this.

All econometric models are designed to test an underlying theory, and most theories in economics, think supply and demand, involve simultaneous equations. All such models have bidirectional causality, running from the independent variable to the dependent variable and in reverse. This is evidently a fundamental problem that must be addressed using sophisticated methods, such as instrumental variables, as discussed in some examples below.

The vast literature on the effect of trade on employment is increasingly dominated by methods that have little to do with econometric estimation. These are computable partial equilibrium (CPE) or computable general equilibrium (CGE) models that are built on extensive databases and employ a simulation methodology. These methods attempt to mimic a randomized controlled experiment by building their own subjects (e.g. consumers, firms) in what has been called "generative social science" (Epstein, 2006). Essentially, the argument is that if the researcher can build a computerized society that has the same large-scale properties as the actual, legitimate experiments can be run "en silica", that is on computers. Here, realism is of the essence: if the model conforms to some erstwhile theory, itself the product of an oversimplified view of a social process, the simulation is of less value that one that more accurately replicates the measured properties in the real economy.

Simulation methods are widely used in virtually every branch of scientific inquiry. They escape the fundamental problems of econometrics of omitted variable bias and reverse causality by providing a more complete account of the object of analysis. On the other hand, the models have been criticized as "works of fiction" by philosophers of science. Finally, as seen in detail below, different models yield different results and it is therefore incumbent on policy-makers to make their own judgment about the relative realism of the models at their disposal.

### *3.2.4 Overcoming implementation obstacles*

As noted by Gibson (2008b), data in developing countries can be reliable, noisy and/or unreliable according to whether there are errors in the data collection process and whether these errors tend to cancel out.[14] Errors also result from changing definitions as well as the standard index number or aggregation problem. Populations tend to be more heterogeneous in developing countries and income is often badly distributed, leading to problems with aggregating rich and poor. Most fundamentally, aggregation problems are more likely to occur in developing countries because the social structure is rapidly changing.

Governments and non-governmental organizations (NGOs) often lack budgets to do an adequate job of collecting, cross-checking and validating data. The existence of a large informal or traditional sector also causes significant problems, especially in agriculture, which can make up more than half the economy. Auto-consumption and barter are perennial problems, of course, and investment in the informal sector is particularly difficult to track, often appearing in the national accounts as consumption (Taylor, 1979, p. 23). Employment data, especially when productive sectors are changing rapidly in response to trading opportunities, can be unreliable and tend to cover urban areas only. With technocrats in short supply, data gathering may be hampered by poorly trained or untrained field workers, especially for qualitative methods. Cost-minimizing sample design will lead to over-sampling of urban households (Deaton, 1995, p. 1790).

Gibson (2008b) lists specific sampling problems including: stratification and cluster bias; groups of individuals with similar unobservable characteristics, such as ability or entrepreneurship; weather; tastes; or prices. There is also selectivity bias,

[14] See the special issue of the *Journal of Development Economics* on data problems in developing countries. An overview is provided in Srinivasan (1994). There is no econometric test for unreliable data.

non-random reasons why some individuals enter a given sample. Uncertainty and inefficiency in tax laws may cause inaccurate reporting. There may also be principal-agent problems, in which respondents misrepresent their objective conditions when it is in their interest to do so.

Some data problems are specific to the models discussed in this chapter. Raw social accounting matrix (SAM) data, for example, is collected and processed by different agencies or ministries with different missions, budgets, effectiveness and capabilities. As noted in Gibson (2008b), most developing countries base their GDP estimates on the production rather than demand side. If the estimates are based on "flow of product" concepts, the underlying information will vary from sector to sector and reflect tax avoidance strategies.

Balance of payments data, necessary for trade analysis, may not agree with national accounts for exports and imports because of rapidly changing and distorted exchange rates, currency controls and import licensing. The ministry of interior or labour may handle household surveys with help from the World Bank, ILO or NGOs. Household surveys are often inconsistent with data for consumption in national accounts (Gruben and McLeod, 2002).

The two generally accepted methods of dealing with data problems in developing countries are cross-check and correlation. Correlation is a more elaborate process and integrates econometric methods into the process of consistent data generation, as for example is undertaken in the study cited above by Gruben and McLeod. Purchasing power parity (PPP) methods, which correct for the effect of asset demand on exchange rates, can be used for cross-country comparisons. Sequences of SAMs can be used to cross-check investment, depreciation rates and capital accumulation. Financial data from balance sheets from firms and central banks can also be used, although procedures are in their infancy. Data from agencies regulating financial practices, labour standards and environmental compliance may also be employed.

It must be borne in mind that models based on unreliable data are themselves unreliable, despite any other attractive properties they may possess. Unreliable data are data measured with error, but if the error is not random and does not cancel out, bias will result. Since data can be and often are produced by individuals who lack knowledge of proper sampling procedures, or indeed with political or self-interested motives, no corrective procedures are available.

## 3.3 ASSESSING THE EMPLOYMENT IMPACT OF TRADE: SIMULATION METHODS

Simulation methods of different levels of sophistication exist to evaluate the employment impact of trade. More sophisticated methods typically give a more complete picture of the employment effects of a change in trade policy or flows. Yet they also tend to be more difficult to use because they are more complex and tend to have ambitious data requirements. In the following, simulation methods are discussed in order of increasing level of sophistication.

### *3.3.1 Factor content and partial equilibrium methods*

#### 3.3.1.1 Looking at one market in isolation

The simplest trade model in economics is perhaps that of a single market in isolation. In such a model, the existence of other goods markets is ignored. How production factors, such as capital or labour, transit from one sector to the other is also not examined in detail. Instead, the outcome of the equilibration process in factor markets is taken as a given parameter, and the analysis focuses entirely on the market for the good in question. This partial equilibrium approach holds constant the effects of the changing price and quantity in the goods market of interest on factor markets and other goods. One of the ways in which the use of partial equilibrium models is justified is to say that competition in the factor markets equalizes factor returns. Any one market can only have a vanishing effect on this economy-wide equilibrium.

The advantage of using partial equilibrium model approaches is that it is significantly more straightforward than the use of a more complex and more accurate general equilibrium model. Indeed, partial equilibrium models represent probably one of the simplest models available for the analysis of the impact of trade on employment.

Trade models that look at one sector in isolation have often been used to quantify job losses due to import penetration. This is done by computing the "factor content" of displaced domestic production, i.e. the amount of capital and labour employed in production. When imports displace domestic production, the capital in the domestic sector is either retired or shifted to another sector. Partial equilibrium models do not account for this, but instead ask how much labour the domestic capital stock had employed in the import-competing sector. Displaced domestic production is then assumed to lead to displacement of workers and capital in the respective proportions. Not surprisingly, wiping out a labour-intensive sector will turn out to be worse for employment than wiping out its capital-intensive counterpart. Albeit the use of partial equilibrium models to evaluate employment impacts in import-

Table 3.1: Estimates of jobs lost when tariffs and quotas are removed

| **Sector** | **Jobs lost** | **Costs to consumers**[1] | | **Jobs lost** | **Costs to consumers**[1] |
|---|---|---|---|---|---|
| Ball bearings | 146 | 435,356 | Luggage | 226 | 933,628 |
| Benzoid chemicals | 216 | ≥ 1 mn | Machine tools | 1556 | 348,329 |
| Costume jewellery | 1,067 | 965,532 | Polyethylene resins | 298 | 590,604 |
| Dairy products | 2,378 | 497,897 | Rubber footwear | 1,701 | 122,281 |
| Frozen orange juice | 609 | 461,412 | Softwood lumber | 605 | 758,678 |
| Glassware | 1,477 | 180,095 | Women's footwear | 3,702 | 101,567 |

Source: Hufbauer and Elliott (1994).

Note 1: Per job.

competing sectors tends to lead to biased estimates, the use of partial equilibrium analysis has the great advantage of quickly and easily identifying the individuals who are likely to lose their jobs. The approach can thus be useful to provide guidance on the design of trade adjustment assistance, job retraining and other forms of transfers from the public sector.

One way to see what competition would do to employment is to ask the "dual" question of how tariffs protect jobs in a given sector. It follows that if tariffs were removed, the loss of jobs would be equivalent to those protected by the import tax. Removing a tariff is thus like a "natural experiment" and may provide the best partial equilibrium estimate of the employment-displacing effect of imports. Table 3.1 shows an estimate of the number of jobs saved by protection (tariffs and quotas) in the United States (US) in 1990.

#### 3.3.1.2 Competitive and non-competitive imports

The distinction between competitive and non-competitive imports, while not theoretically self-evident, makes a big difference in determining the effect of liberalization of any particular product market. Indeed, in order to estimate how much domestic production is replaced by imports, it is important to have an understanding of whether and to which extent imports compete with domestic production. In this context, "competitive" imports are imports that compete directly with domestic production and therefore directly subtract from GDP in the aggregate demand equation. "Non-competitive" imports, while imports just the same, do not compete and are not a direct substitute for any domestically produced good. In the US, only some agricultural goods, cobalt and other rare minerals are considered non-competitive, but in developing countries some 50-75 per cent of imports are not produced, nor have any close local substitutes.

The impact of trade on employment, for non-competitive imports, has the opposite sign of that of competitive imports. As raw materials, intermediate goods, fuel or other specialized inputs, a reduction in non-competitive imports will always reduce GDP and employment. This is not just a generalization: any good or service that is an input into domestic production with no viable substitute will reduce the ability of the economy to generate employment if removed.

It follows that any partial equilibrium analysis of imports and their job-destroying capacity must take careful account of the critical component in production plans into which the import enters either directly or indirectly. Moreover, before policy-makers take steps to reduce imports of *any* good for the purposes of raising the employment response, it is incumbent on the analyst to examine the precise nature of the import with respect to its feasible and likely substitutes.[15]

First generation partial equilibrium models tended to assume perfect substitution between domestically produced goods and foreign imports in *consumption*. Those

[15] There is nothing in partial equilibrium analysis that says that policy-makers cannot determine the answer to this question, but much of economy theory holds that this information is all but impossible for policy-makers to collect and use effectively.

**Box 3-2: Employment effects of trade: A partial equilibrium example.**

Imperfect substitution can be modelled by taking into account the elasticity of supply, demand and an estimated elasticity of substitution. Standard modelling techniques estimate an "Armington function" that essentially says that the demand for the domestic good $D$ to the import $D^*$ is given by

$$D = \frac{1-s}{s}\left(\frac{p}{p^*}\right)^{-\sigma} D^* \qquad \text{(i)}$$

where $s$ is the share of imports in domestic consumption, $p$ and $p^*$ are the domestic and foreign prices, respectively, and $\sigma$ is the Armington elasticity.[16]

Consider the following example: in light manufactured goods, the share of imports is given. Policy-makers are considering opening the market to imports but wish to know what the impact on local production and employment might be. It is known that demand for light manufactured goods, domestic or imported, is

$$C = p_c^{-\varepsilon} \qquad \text{(ii)}$$

while, for domestic production, it is

$$D = p^{\mu} \qquad \text{(iii)}$$

given that the consumer price is given by

$$p_c = (p^* D^* + pD)/(\mathrm{D}+D^*) \qquad \text{(iv)}$$

Consumers respond to the price difference, increasing their demand by the Armington in equation (ii) above. How much employment will one lose in this industry as import prices fall?

This computable partial equilibrium model can be solved in Excel as a function of the foreign price, $p^*$ (Sadoulet and de Janvry, 1995). The results are given in figure 3-1. Given its simplicity, the model is a "quick and dirty" method that can be of some use to policy-makers in assessing possible employment loss. Its main advantage is that it recognizes the interplay of demand and supply elasticities, which might well be estimated from a variety of other sources, in the determination of the employment response.[17]

The result shows that the elasticity of transmission of import price is less than 1, and depends on the Armington elasticity $\sigma$ as shown in Figure 3-1.

models therefore generated "worst-case scenarios" for two reasons: first, they focused on import-competing sectors and ignored the possibly positive employment effects on other sectors and industries; second, by assuming perfect substitution, even a small price advantage enjoyed by the import will, in theory, reduce the domestic industry to rubble.

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[15] There is nothing in partial equilibrium analysis that says that policy-makers cannot determine the answer to this question, but much of economy theory holds that this information is all but impossible for policy-makers to collect and use effectively.

[16] A particularly simple way of estimating this elasticity empirically is to take natural logs of both sides with the result that one has a linear equation in the coefficient $\sigma$.

[17] It is *extremely* simple in that the employment elasticity with respect to output is one.

Yet foreign products are not always able to satisfy consumers' preferences in precisely the same way that domestic production does. The point is that it is not really the same good for all consumers and so some are willing to pay the premium to "buy local" to keep domestic production viable. The imported and the locally produced goods are considered imperfect substitutes in this case, and two different prices will co-exist for the "same" good. The employment impact of tariff reductions will then crucially depend on the level of the so-called elasticity of substitution between imported and locally produced goods. This elasticity is called the "Armington elasticity" and is an important element of most trade-related simulation exercises. Box 3-2 provides details using the Armington elasticity to estimate the effect of cheaper imports on domestic employment.

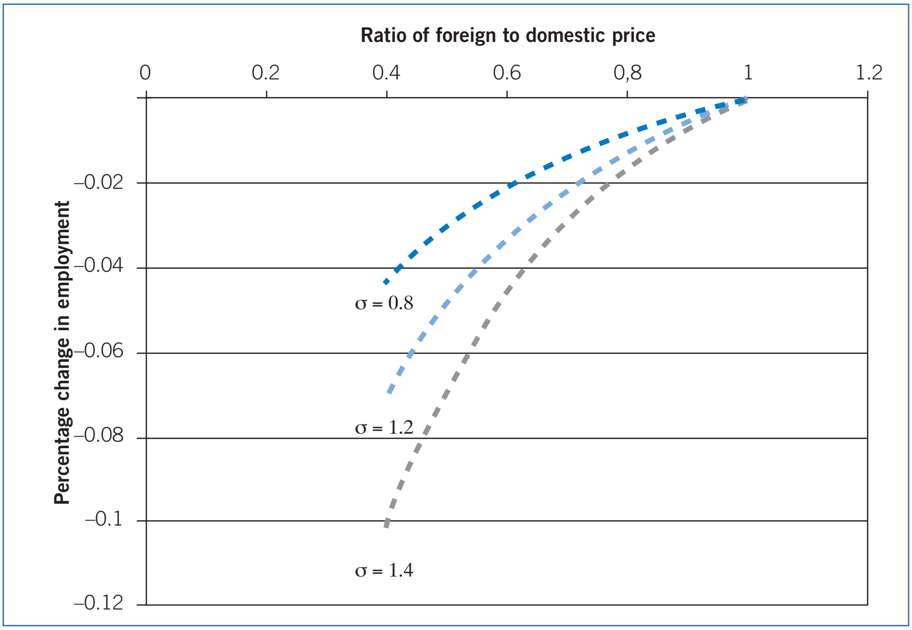
The greater the consumer attachment to domestic goods vis-à-vis their foreign rivals, the smaller the $\sigma$ and the less job loss will occur.[18] Figure 3.1 reflects simulation results of the employment response to changes in foreign prices. The horizontal axis depicts foreign prices relative to domestic prices. If foreign goods are cheaper than domestically produced goods, the relative price on the horizontal axis is smaller than one. The vertical axis shows employment losses generated by reductions in foreign prices. The three curves depicted in the chart reflect employment losses corresponding to different levels of import substitution. The higher the level of substitution, i.e. the larger the Armington elasticity $\sigma$, the larger the employment losses resulting from import competition.

Many comparative static exercises could be undertaken with this simple model: the jobs response also depends on the initial share of imports and the supply elasticity, $\mu$, both of which can be changed. For $\sigma > \varepsilon$ , job loss increases with the initial share of imports and decreases with the supply elasticity. Note the elephant in the room here: while there is job loss, the consumer price always *decreases*, leaving consumers better off than if trade barriers had not been lowered. This is the classic trade-off, captured in table 3.1 above, and now in this desktop CPE model.

Although partial equilibrium approaches have most frequently been used to assess the employment effects of increased imports, they can also be used to evaluate the employment effects of increased export opportunities. Not surprisingly, a focus on exporting sectors would tend to give an overly-optimistic picture of the employment effects of trade. As in the case of imports, the question of substitution between trade and domestically produced goods also arises in the case of exports. As noted in Sadoulet and de Janvry (1995), a bilateral choice model can be set up to extend to producers as well as consumers, as illustrated above. Exports in a world with competitive exchange rates may be very attractive for producers, but foreign markets also bear risks, many of which are absent in domestic markets. Quality control issues, forward markets for export earnings and other incentives may entice domestic producers to "sell local" when models with perfect substitution would suggest otherwise.

[18] Note that according to standard theory there is nothing inefficient whatsoever about this attachment.

Figure 3.1: Employment response as function of import price for various Armington elasticities (initial share of imports = $0.1,\ \mu=1,\ \varepsilon=1.2$)




Source: Author's calculations.

It follows that reducing export taxes may not produce the expected job gains for the same reason that consumer preferences mitigated job losses in the demand-side analysis. Again the magnitude of the Armington elasticity will be crucial to the size of this effect, and must be carefully estimated.

#### 3.3.1.3 Assessing the CPE method

An audit of costs and benefits of the CPE methods discussed in this section would conclude that the method could be implemented with minimal data and data-processing requirements, and relatively simple theoretical set-ups for local market structures. No teams or special clean rooms are needed, and all that is required is for policy-makers to think carefully about the applicability of framework to their economies.

The CPE method quickly and cheaply quantifies the effect of import competition, but its drawbacks as to the reliability of findings are significant. It certainly does not represent the end of the analysis of the effects of trade on employment. Why, for example, are computed job losses assumed not to affect the demand side of the model? Moreover, the lower price might not simply benefit consumers in this market but also *producers* in other markets. As those producers gain from cost savings, they might well expand, mitigating the job loss in the affected industry.

Finally, if there are many potential producers (and their consumers) who might benefit, the task of adding them all up becomes daunting.[19]

Note, however, that more lofty objectives in modelling see rapid escalation of data requirements as will become evident in the following sections. Policy-makers and experts will constantly face the trade-off between simplicity of the method and reliability of findings. Even stepping up from an assumption of perfect substitutability between imports and local products to a world of imperfect substitutability, as discussed above, requires substantially higher investment in the estimating of response elasticities. This is never easy or straightforward, and some policy-makers could be excused for substituting "sensitivity analysis", in which informal estimates of key parameters, such as response elasticities, are made and then are investigated for result robustness by simply varying the values within reasonable ranges. This is field dressing the model, but is clearly preferable in terms of reliability of outputs than taking fixed coefficients and calculating employment losses under the assumption of perfect substitutability.

### *3.3.2 Two-sector factor substitution models*

#### 3.3.2.1 Allowing for more than one market

When the economy opens to international trade, producers begin to respond to the demand from the world as a whole. In general, this will lead to changing the autarkic proportions of production. In the most extreme case, producers specialize in one good to the exclusion of the other, but in real-world economies complete specialization is rare. If production were undertaken with the fixed proportions discussed above, the movement from autarky to trade would be catastrophic for at least some individuals. If producers specialize in the labour-intensive good, for example, the rate of return to owners of capital will literally collapse, since the capital-intensive sector will have more capital to transfer to the labour-intensive sector than it can possibly use. The excess supply of capital will drive its price to zero, at least in theory.

Factor substitution models are based on the proposition that this unfortunate sequence of events never takes place. They tend to be based on the HOS theoretical framework that usually assumes two goods and two factors of production. As the labour-intensive sector expands, the price of capital falls and producers find it profitable to employ more capital per unit of labour. Factor proportions are adjusting here and it is a striking fact that the capital-intensity of *both* sectors will rise in the process. Note further that the demand for labour has increased. While the expanding firm sees too much capital arriving on the capital market, the contracting sector never used much labour in the first place. If the expanding sector is going to meet world demand, it will want to hire more labour than is available in the market. In

[19] For this reason, economists developed early on in the last century a comprehensive methodology to cut through the "fictitious rounds" of seemingly infinite interactions between sectors. See sections 3.3.3 and 3.3.4 on input-output and CGE models, respectively.

response, the expanding sector substitutes capital for labour and, in the process, the marginal *productivity of labour* increases. Workers have more capital to work with and thus firms can pay higher wages. Again, note that this occurs in both sectors. Rising world demand has increased wages at the expense of profits, but the latter do not fall to zero because of factor substitution.

#### 3.3.2.2 Elasticities of substitution matter yet again

It follows logically then, that the effect of trade on employment is crucially dependent on the possibilities of substitution. The elasticity of substitution is thus an important number to nail down empirically and must be done for each sector separately. The Cobb-Douglas production function, the workhorse of economic analysis for more than a century, is arguably of only limited use here. The elasticity of substitution is defined rather complexly as the percentage change in the capital-labour ratio with respect to the percentage change in the ratio of the cost of labour to the cost of capital. For the Cobb-Douglas case, it can be shown analytically that the elasticity is always equal to one for the constant returns to scale case.[20]

**Box 3-3: Why elasticities of substitution matter**

The elasticity of technical substitution is an important number to accurately estimate in simulations assessing the employment effects of trade. To see this, consider the following example. As trade starts to boom, the import-competing sector begins to contract, disgorging workers onto the labour market. In the expanding sector, labour demand increases, but there is a problem. Because of the low elasticity of substitution in the expanding sector, the capital per worker does not increase much, and therefore neither does the marginal productivity. Thus, real wages cannot rise and the incentives for labour to move, search out these newly emerging opportunities and obtain the skills necessary for the new job are all dampened. It is quite likely that skills will need some upgrading, since the expansion of the export sector will have attracted foreign capital with more advanced technology and higher demands on its workers. Retooling, as the sector expands, raises its elasticity of substitution and with it the marginal productivity of labour. Not as much labour is required, but those who do find jobs are well remunerated, at least comparatively. Slaughter (2001), for example, notes that changes in the elasticity of labour demand over time arise more from technological progress rather than trade itself.

After the Cobb-Douglas, the most popular production functions are constant elasticity of substitution (CES) production functions and translog, which closely approximates well-defined cost functions. These mathematical structures have elasticities of substitution that are different from one and can be estimated econometrically. All can be modified to use more than two factors so that, for example, the analysis

[20] For a Cobb-Douglas function of the form $Q = AK^{\alpha} L^{\beta}$, the elasticity of substitution is $1/(\alpha + \beta)$, where $Q$ is output, $A$ is scaling parameter and $\alpha$ and $\beta$ are the elasticities of $Q$ with respect to capital and labour $L$.

can include both skilled and unskilled labour or, indeed, as many labour categories as one wishes.[21]

If fixed coefficients is an excessively pessimistic foundation on which to analyse the effect of trade on employment, perhaps the Cobb-Douglas is at the other extreme. While fixed coefficient analyses implicitly assume an elasticity of substitution equal to zero, Cobb-Douglas production functions assume that factors can easily substitute one another. Ideally, one would want to pin down the "true" elasticity of substitution by collecting a sufficient quantity of relevant data and estimate either of the more sophisticated production functions mentioned above. An alternative to this relatively costly and time-consuming procedure would be to assume that the "truth" lies somewhere in the middle. This would correspond to running the simulation once under the assumption of fixed coefficients and once under the assumption of a Cobb-Douglas function. The generated employment effects would then arguably provide upper- and lower-bound estimates for the employment effects of trade.

A second point is time: like winter snows, the frozen elasticity of substitution in the fixed coefficients case will tend to melt away with time. Thus, a reasonable strategy might be to use the fixed coefficient model for small changes around the initial equilibrium, reserving the more sophisticated approaches for longer time frames and larger departures from the base data.[22] It has also been argued that the fixed coefficient case could provide estimates for economies characterized by low labour mobility.[23]

There is some evidence that for longer-term estimates in economies with sufficient labour mobility, Cobb-Douglas functions may actually represent good proxies for the actual elasticity of substitution. An early study of trade and employment in development was undertaken by Krueger and her associates for the NBER and published in a three-volume work (Krueger, 1983). Behrman (1983) in one chapter estimates a CES production for 70 countries for the period 1967-73. The total number of observations is increased by using data on 26 sectors per country, with a total $\eta$ = 1,723. The author finds, for this data set, that the Cobb-Douglas does indeed apply since the estimated CES elasticities of substitution are close to one. Behrman concludes that trade analysis based on fixed coefficients will be off the mark, as firms do actively substitute capital for labour as supplies of the latter dry up.

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[21] For the CES function of the form $Q = A[\alpha K^{-\rho} + (1 - \alpha) L^{-\rho}]^{-1/\rho}$, where $Q$ is output, $A$ is scaling parameter, the elasticity of substitution is $\sigma = 1/(1 + \rho)$ and $\alpha$ is the share of the return to capital in output. As $\rho$ goes to zero, the CES approaches the Cobb-Douglas. The translog function takes the form: $\ln Q = \ln \gamma_0 + \alpha_1 \ln K + \alpha_2 \ln L + \beta_1 (\ln K)^2 + \beta_2 (\ln L)^2 + \gamma_1 (\ln K)(\ln L)$, where the elasticity of substitution is $\sigma = -[(A + B) / Q,](A + B - 2\alpha_2 A / B - 2\beta_2 B / A - 2\gamma_1)^{-1}$ where $A = \beta_1 + 2\beta_2 \ln L + \gamma_1 \ln K$ and $B = \alpha_1 + 2\alpha_2 \ln K + \gamma_1 \ln L$.

[22] A subtle, but highly relevant, implication of the unitary elasticity of the Cobb-Douglas production function is the property that the total remuneration to a factor of production is constant with respect to changes in factor proportions. Thus, if the wage rate falls by $\varepsilon$ per cent, then employment increases by $\varepsilon$ per cent, and the wage bill remains fixed

[23] The issue of labour mobility is extensively discussed by Davidson and Matusz (2004; 2010). Labour mobility significantly affects the adjustment process following trade reform, as discussed in detail in Chapter 6 of this volume.

#### 3.3.2.3 Assessing the two-sector substitution model

The strength of the two-sector factor substitution models approach is its simplicity and clarity in regard to basic principles of economics.[24] Factor share models are relatively cheap and easy to implement: Cobb-Douglas equations can be easily estimated and factor shares deduced. Since the wage bill is constant, two-sector substitution models based on Cobb-Douglas production functions can predict whether there will be a large quantity of new jobs with low wages or the reverse, so long as workers are paid their marginal product. In non-competitive environments, studded with minimum wages and other labour-market distortions, the marginal product of labour may be scarcely relevant. It is still possible, however, to say that if demand shifts from a sector with a low share of labour to one with a high share of labour, workers in some form or other will probably benefit.

A weakness of the HOS-inspired labour share approach is that it does not often take into account inter-industry relationships as do the input-output models discussed below. A second weakness of this approach is that the whole of traditional trade theory in the mould of HOS seems to be at variance with what is observed in the current trading arena (Hertel and Keeney, 2005). A serious objection to the HOS view of the world is that sectoral reallocation along the lines predicted does not typically take place. Instead, a sector expands to meet an increase in export demand. In exchange, the home country receives an import from the same sector of the trading partner's economy. No factors are reallocated. Both sectors must either experience a rise in labour productivity or increased employment. Aggregate employment will then rise if there was slack in the labour market initially and wages will increase otherwise. Referring to the effects of the formation of the European Economic Community (EEC) and the US-Canadian auto agreement, Hertel and Keeney (2005) observe:

> "Little resource reallocation took place; instead, trade seems to have permitted an increased productivity of existing resources, which left everyone better off."

### *3.3.3 Input-output framework*

#### 3.3.3.1 Taking into account indirect employment effects

The next step is to introduce multi-market equilibria by way of an input-output framework, a halfway house to the full general equilibrium specification.[25] These

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[24] The HOS model does not allow for the possibility of intra-industry trade, i.e. the type of trade that typically takes place between industrialized countries. Although the bulk of trade still occurs between industrialized countries, trade between sectors with different capital labour ratios and radically different wages is still important and arguably increasingly so because of the increasing role of developing countries in global trade. The HOS model thus remains a valid instrument for trade analysis.

[25] These models have their roots in the model first described by the young Harvard graduate student W. Leontief just after the turn of the century.

**Box 3-4: Input-output models: Some technical details**

Input-output models are used to analyse the impact of a change in final demand, including *net exports* on the levels of production. The models assume fixed coefficients for labour, capital and intermediate inputs. Let $A = \{\alpha_{ij}\}$ be the *coefficient matrix* such that each $\alpha_{ij}$ describes the use of input $i$ for the production of one unit of output $j$ and $X = \{x_j\}$ be a column vector of gross outputs, including intermediate goods. So-called dual variables can also be defined and interpreted as prices, denoted here by row vector $P = \{p_i\}$. The equation dual to the material balance is then

$$P = PA + V_A$$

where $V_A$ is a row vector of value added, and may be disaggregated into wages, profits, imports, taxes and rents as needed.[26] *Final demand* is denoted by $F = \{f_j\}$, a column vector of outputs, and may be disaggregated into consumption, government spending, exports and imports as needed. The essential equation of input-output analysis, known as the *material balance*, is then

$$X = AX + F$$

One of the most basic measures of the effect of trade on employment comes from estimating *direct labour coefficients*, or the inverse of labour productivity. Census data provides measures of value added and employment by sector and thus an index of the number of workers employed by a unit of value added can be constructed.[27]

frameworks take into account backward linkages between trading sectors and the rest of the economy and therefore make it possible to assess the indirect employment impacts of trade reform or changes in trade flows. Economy-wide models of this type are usually based on either aggregate data from national income and product accounts or more disaggregated input-output tables. Regional models may link regional input-output matrices, analogous to the way international trade models link countries. The informal sector can also be treated in the same way, operating alongside the formal economy and trading with it.

Lydall's (1975) classic study for the ILO assumed that an increase in imports by a developed country of one of 12 different final processing ISIC industries, produced by a developing country, would replace an equal *value* (US$1 million at factor cost) of production in the developed economy. The question addressed was then: what is the effect of this replacement in the importing and exporting countries, respectively? The Lydall study takes into account not only the direct impact of the trade on producing sector employment but also the indirect employment effects by way of input-output analysis. These are the so-called "backward linkage" effects. These indirect effects naturally include the impact on the balance of other tradable goods.[28]

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[26] Factors of production, labour, $L$, and capital, $K$, are treated separately, usually with fixed coefficients under the assumption that factor prices remain unchanged.

[27] The "unit" has to be in common currency and this presents problems of its own. Previous studies have used the official or prevailing exchange rate to convert value added to a common currency, usually US$.

[28] A recent study on the employment effects of changes in trade flows during the Great Recession (Kucera et al., 2010) finds that indirect employment effects may be about equal in size to the direct employment effects of a trade shock.

The input-output approach is still widely used. Revenga (1992), for example, looked at 38 US manufacturing industries for 1977-87 and found a fall in price of 1 per cent caused only a small loss in employment, between 0.24 and 0.39 per cent. She found almost no impact on nominal wages, and concluded that labour mobility prevented a significant decline in wages due to import penetration, despite job loss. This implies that the direct and indirect factor content of industries that contract is approximately the same as that of expanding industries, at least for the US data.

Box 3.5 illustrates using a hypothetical example of how trade-induced employment changes can be calculated on the basis of the input-output approach.

### Box 3-5: Using input-output methods to compute trade-induced changes in employment: a hypothetical example

The effect of trade on employment can be studied with the help of an input-output matrix, which shows the quantity of intermediate goods and services (both imported and domestically produced) required for the production of one unit of output. This is known as the Leontief matrix and is denoted by $A$:

| | **Agriculture** | **Industry** | **Services** |
|---|---|---|---|
| Agriculture | 0.1 | 0.1 | 0.15 |
| Industry | 0.2 | 0.25 | 0.12 |
| Services | 0.1 | 0.2 | 0.24 |

Source : Author's calculations.

If $X$ is a column vector of gross outputs of the three sectors shown, then total intermediate demand is given by the vector product $AX$. Labour demand per unit of output ($L$) is written as a row vector and, for this example, is

| | **Agriculture** | **Industry** | **Services** |
|---|---|---|---|
| Labour demand | 0.4 | 0.2 | 0.3 |

Source : Author's calculations.

Final demand is made up of three column vectors, domestic demand, $Y_d$, exports, $E$, and imports, $M$

| | $Y_d$ | **Exports** | **Imports** |
|---|---|---|---|
| Agriculture | 40 | 30 | 10 |
| Industry | 45 | 5 | 15 |
| Services | 60 | 10 | 20 |

Source : Author's calculations.

**Box 3-5: Using input-output methods to compute trade-induced changes in employment: a hypothetical example** *(Continued)*

Note that when all prices are equal to one, trade is balanced in this example. Gross output ($X$) would then be equal to

$$X = AX + Y_d + E - M,$$

which can be solved

$$X = (I\text{-}A)^{-1} (Y_d + E - M)$$

Here, I is the identity matrix, with ones on the diagonal and zero elsewhere. Computing $X$ can be done easily by way of Excel's array functions.[29]

| | $X$ |
|---|---|
| Agriculture | 93.3 |
| Industry | 87.7 |
| Services | 101.1 |

Source : Author's calculations.

Total employment is then $LX = 85.2$.

On the basis of this exercise, a 1 per cent increase in imports in all sectors will lead to an employment level of 84.94, a decline of 0.26, since total output contracts. A 1 percent increase in exports, instead, will increase employment by 0.27 as output expands. Since trade was initially in balance, a 1 per cent change in both exports and imports has no effect on the total gross value of production but does change its structure.

The Leontief multiplier analysis emphasizes the need to count intermediate production, both direct and indirect, in order to assess employment effects. It assumes that wages are fixed and that the economy adjusts to changes in final demand, both in aggregate and structure, through proportional adjustments in employment levels *for each sector*. In this structuralist approach (see box 3-7), exports from sectors that are more labour intensive, directly *and* indirectly, cause employment to rise faster.

The methodology can be easily extended to assess the impact of productivity increases, which simply take the form of lower labour coefficients. If, however, lower employment leads to lower wages, and if profit-maximizing firms respond by hiring more labour, the linearity of the Leontief model is inappropriate and a more complex model is required.

An approach similar to that summarized in box 3-5 has been applied in the OECD (Baldwin, 1994) to assess employment changes following changes in trade flows for eight industrialized countries. Table 3.2 reports the findings of the exercise. Canada, as is seen, experienced a 2.38 per cent increase in employment from 1971

[29] One can use the command: "=MMULT(MINVERSE(I-A),Yd+E-M)", to compute $X$ with $I$, $A$, $Yd$, $E$ and $M$ all defined as ranges.

to 1986. This was due to a 3.56 per cent change in gross output, itself the product of a rise in domestic demand of 3.48 per cent and a rise in exports of 1.85 per cent. This was offset by a rise in imports of 1.58 per cent, a reduction in intermediate use of 0.19 per cent, as well as a change in productivity of 1.19 per cent. The latter enters with a negative sign since productivity reduces employment.

The table shows that import penetration slows employment growth most in the Netherlands, followed by Canada. The data for the US is broadly consistent with Revenga (1992). Table 3.3 combines the information of columns 4 and 5 of table 3.2. There it is seen that Japanese employment benefits from trade the most, with a change in employment growth of 0.71 per cent for the indicated period. Only the US and the UK seem have lost to trade, and this by small margins.

The exercise is consistent with the partial equilibrium models discussed above in that competition from abroad causes domestic prices and thus employment to fall. The same is true in input-output multi-sectoral environment. What is added is the *interactions* of the sectors and with it the possibility that jobs lost in one sector

Table 3.2: Decomposing the causes of employment growth

| | **Employment growth** | **Change in gross output** | **Domestic final demand** | **Export growth** | **Import growth** | **Intermediate growth** | **Labour productivity** |
|---|---|---|---|---|---|---|---|
| Canada[1] | 2.38 | 3.56 | 3.48 | 1.85 | –1.58 | -0.19 | –1.19 |
| Denmark[2] | 0.71 | 2.36 | 1.68 | 1.69 | –1.03 | 0.02 | –1.64 |
| France[3] | 0.03 | 2.3 | 2.15 | 0.95 | –0.71 | –0.09 | –2.27 |
| Germany[4] | 0.34 | 1.51 | 1.28 | 1.1 | –0.79 | –0.08 | –1.16 |
| Japan[5] | 0.66 | 4.2 | 4.38 | 1.13 | –0.42 | –0.81 | –3.52 |
| Netherlands[6] | 0 | 3.2 | 2.62 | 1.96 | –1.78 | 0.4 | –3.21 |
| UK[7] | –0.2 | 2.41 | 2.45 | 0.84 | –1.13 | 0.25 | –2.61 |
| US[3] | 1.96 | 2.8 | 2.82 | 0.35 | –0.46 | 0.09 | –0.84 |

Source: Baldwin (1994). Notes: 1. 1971–86. 2. 1972–88. 3. 1972–85. 4. 1978–86. 5. 1970–85. 6. 1972–86. 7. 1968–84.

Table 3.3: Net change in employment due to growth imports and exports

| | **Canada** | **Denmark** | **France** | **Germany** | **Japan** | **Netherlands** | **UK** | **US** |
|---|---|---|---|---|---|---|---|---|
| Imports | –1.58 | –1.03 | -0.32 | –0.79 | –0.42 | –1.78 | –1.13 | –0.46 |
| Exports | 1.85 | 1.69 | 1.02 | 1.31 | 1.13 | 1.96 | 0.84 | 0.35 |
| Imports and exports | 0.27 | 0.66 | 0.64 | 0.31 | 0.71 | 0.18 | –0.29 | –0.11 |

Source: Baldwin (1994).

through import penetration could be made up for, at least in part if not wholly, by jobs gained in a range of other sectors. Baldwin notes that when applied to manufacturing alone, the results are not as favourable in the above example. Canada, France, the UK and the US all suffer a net decline in manufacturing employment growth. The main point of this analysis, however, seems to echo the conventional wisdom: trade in the long run has mostly a small but positive impact on national employment growth.

#### 3.3.3.2 Assessing input-output methods

As a result of the assumed linear production technology, input-output models are relatively inexpensive and easy to formulate and run. They can be made dynamic if investment, *I*, is first disaggregated from final demand, *F*, and then used to determine the time path of the capital stock.[30] Still, input-output models lack an internally consistent demand system and thus an endogenous balance of savings and investment. Productivity-enhancing trade flows may well kick up this investment in fully specified general equilibrium models, but for now that link is ignored. It follows that one would expect a reduced impact of trade on employment when using an input-output approach compared to partial equilibrium, but less than CGE models.

The disadvantages of input-output analysis mostly derive from the implicit assumption that factor content remains fixed over a long period of time and is therefore impervious to changes in policy, tastes or indeed any other behavioural variables. Moreover, the analysis takes the level of productivity as exogenously given, when a number of studies have shown that productivity growth rises with trade, both imports and exports.

As in partial equilibrium models, input-output does not track individuals to find out what they do when they are displaced from their jobs. In the short run the answer might be "nothing". This answer is not, however, plausible when one takes a longer historical view. In developing countries, the concentration of income due to trade or any other force opens up new areas of consumer goods that might not have been demanded in the past, or were seen as out of reach. In developing countries, transition from an agrarian-based economy to one based on manufacturing and ultimately services had to have begun with individuals "losing their jobs" in agriculture. Nobody wants to be the one to make the first move but, as Chamley (2004) notes in his work on rational herds, even penguins will push an unfortunate colleague into icy, orca-infested waters to test whether it is safe for the rest of the flock.

[30] This is done by way of the stock-flow equation $K_t = K_{t-1}(1-\delta) + I$, where $\delta$ is the depreciation rate. Consistent forecasts of intermediate demand, foreign exchange requirements and associated employment, for example, could then be made, contingent on a forecast for investment. The framework just presented is the *open Leontief model*, but a closed version is available in which all elements of final demand and value added are made dependent on gross output *X*. It was left to von Neumann to show that a maximum rate of sustainable growth is well defined by the model.

**Box 3-6: Linear programming: Another approach to assess the employment effects of trade**

Linear programming models are an extension of input-output models that essentially allow for multiple processes to produce the same good. Policy-makers lucky enough to have detailed data on options that do not yet exist can add the technological coefficients to the input-output matrix and ask a program such as LINDO (or even Excel if the problem is small enough) for the "best" combination of sectors to maximize some objective function.

Dorfman et al. (1958), the classic reference in the field, would use GDP as the welfare function to be optimized. But it may occur to an enterprising policy-maker that she could ask the program to maximize employment. She will be sorely disappointed, however, since the program will almost certainly produce a nonsensical solution. It is obvious why: employment was maximized when 100 per cent of the labour force was occupied in agriculture or, for that matter, in hunter-gatherer activities.

Still, linear programming analysis can be highly useful for practical trade analysis in the hands of skilled analysts and a relatively skilled data processing team. They must be crafted for highly specific problems with well-defined constraints. The real value of the approach comes not in solving the primal problem, the allocation of labour for example, but in the duality theorem: the dual variable associated with a constraint that fails to bind in the primal is always zero.

Consider an example in which a lengthy list of occupational categories is included in the employment database. Calculate the primal solution that maximizes some agreed-upon objective function. The dual variable is known as the shadow value because it measures the change in the objective function, if some small additional amount of the binding resource could be found. If it turns out that the shadow value of the *i*th skill category is zero, then there is no reason to design policy to increase its supply, at least in the short run. This idea of complementary slackness, the relationship between the primal constraint and the value of the associated dual variable, is one of the most profound in economics. It explains why factors get the returns they do, their shadow values, in an economy that obeys the laws of perfect competition. To the extent that the economy differs from the competitive ideal, some additional constraints would have to be built in.

Linear programming has an illustrious history since it was first used by the US Army in its operations research. Its glory has faded somewhat as vastly more sophisticated programs such as the General Algebraic Modelling System (GAMS) have become available. This programming language, used extensively in CGE modelling, handles linear programming as a special case and as a result has relegated the method to use in problems of such extreme dimensions that the non-linear counterpart fails.

## *3.3.4 Social accounting matrices and computable general equilibrium (CGE) models*

### 3.3.4.1 An introduction into CGE modelling

As intimated above, CGE models are computer-based simulations capable of constructing counterfactual scenarios that have been found to be very useful in policy discussions.[31] A counterfactual is the state of the world in which current policies are not in force but some others are. The plausibility of the counterfactual depends on:

[31] See Ginsburgh and Keyzer (1997), Dervis et al. (1982) and Taylor (1990) for some general examples of this literature. Of special interest on closure is Dewatripont and Michel (1987).

(1) the adjustment mechanisms built into the model; and (2) the data on which the counterfactual is based. CGE models can be static, designed for one period, and used for comparative static exercises, or they can be full-fledged dynamic models, similar to time series econometric models.[32]

**Box 3-7: Assumptions about the functioning of markets in different types of CGE models**

One adjustment mechanism used in economic models is that of perfectly competitive markets. CGE models based on perfect information, and perfect foresight in the dynamic versions, however, are usually unconvincing to policy-makers. *Structural CGE models*, on the other hand, are often more realistic, building in country-specific rigidities, such as foreign exchange constraints, parallel-market premia, informal sector and labour market rigidities, among others.

Structural models are often highly linearized with labour demand functions that are based on fixed labour coefficients, that is, labour demand functions that do not depend on the real wage. This is considered theoretically unrealistic, but is not necessarily a bad approximation for small changes. Certainly, models with fixed wages overestimate the damage done to employment by imports. If wages are flexible, then not all the adjustment to trade reform will take place through quantities (employment) and this is why economists usually back measures to increase labour-market deregulation.

Both structuralist and standard CGE models are typically calibrated to so-called social accounting matrices (SAMs) that extend I-O tables with a savings-investment balance and, as such, are simply dressed up input-output frameworks. It follows that they can be used in the same way, inverses calculated and direct and indirect variables computed, but in fact they are much more useful as simply databases to which CGE models are calibrated. Table 3-4 shows a simplified

Table 3.4: SAM for Chile, 1992

| | Agric | Non-Ag | HH | Invest | Govt | Expts | Total |
|---|---|---|---|---|---|---|---|
| Agriculture | 2016 | 2174 | 1924 | –215 | 0 | 2373 | 8272 |
| Non-agriculture | 1718 | 9024 | 9645 | 2160 | 1454 | 2242 | 26243 |
| Households | 3318 | 8618 | | | 1162 | 125 | 13224 |
| labour skilled | 980 | 3045 | | | 908 | 43 | 4976 |
| labour unskilled | 314 | 861 | | | 254 | 83 | 1511 |
| Capital | 2024 | 4713 | | | | 0 | 6737 |
| Savings | | | 1101 | | 1236 | 2054 | 4391 |
| Government | 656 | 2626 | 277 | | | 425 | 3984 |
| Tariffs | 78 | 392 | | | | | 470 |
| Imports | 562 | 3801 | 276 | 2447 | 132 | | 7219 |
| Total | 8272 | 26243 | 13224 | 4391 | 3984 | 7219 | |

Note: Millions of 1992 local currency units (LCU).

[32] See Gibson and van Seventer (2000) and Gibson (2003) for some methodological details.

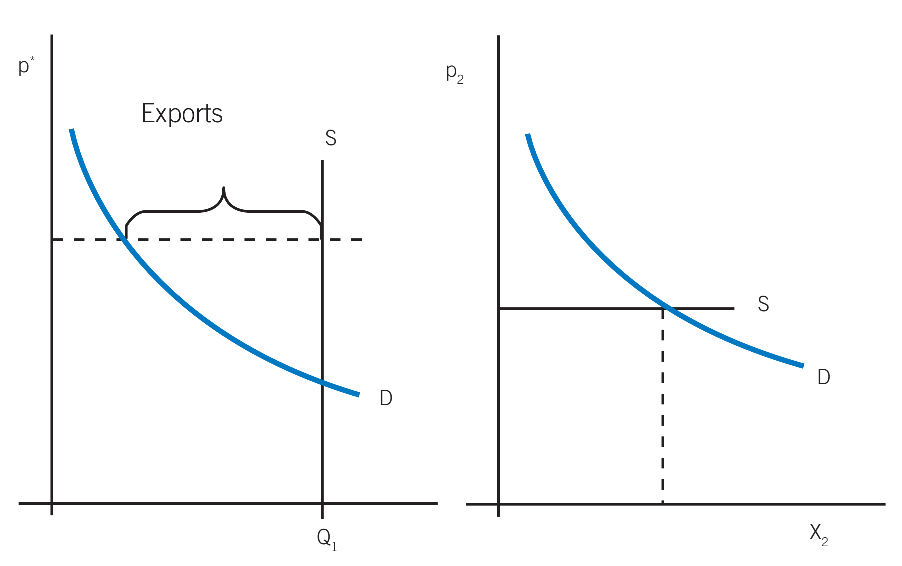
social accounting matrix adapted from the 1992 SAM for Chile. The full-sized SAM from which the table was taken has five household categories and a more complex system of domestic and foreign transfers than that shown here.

A SAM is not, formally speaking, a model inasmuch as it has no behavioural equations. It is rather a snapshot of economic activity on a given date, in this case 1992. A wide variety of models can be calibrated to the same SAM.[33] Desktop CGE models can be easily calibrated to SAMs of this size and then solved in Excel with limited need for advanced computer skills. More sophisticated software and stronger computer skills are necessary to calibrate CGEs to larger datasets. Decaluwe and his associates have, for instance, shown that CGE models can be merged with household survey data to provide a rich mosaic for policy analysis (Decaluwe and Martens, 1988). Households need not be aggregated at all and models with large numbers of household units, sometimes numbering into the thousands, can be handled in the CGE programming framework. Thus, the impact of trade policy can be finely disaggregated. Issues concerning both the size and functional distribution of income can be investigated and the impact on employment assessed. Since CGE models are typically multi-sectoral, one can easily examine the impact on workers of a certain skill category in a given sector of the economy.

CGE models need to make assumptions regarding the behaviour of consumers, firms and the government. The current account balance is also taken into account. One typically uses a linear expenditure system (LES) for the consumption function although other demand systems can also be used (Sadoulet and de Janvry, 1995). The addition of the LES closes the essential circular flow of income and it is left to the model builder to supply equations for other components of aggregate demand. Investment, for example, might be taken as a function of capacity utilization, the profit rate, or even the interest rate if a monetary side of the model were added. Government is usually taken as an exogenous policy variable on which to run comparative static exercises. For the purposes of this chapter, the net export function is key: net exports should rise with the real exchange rate, $ep^*/p$, where $e$ is the nominal exchange rate, $p^*$ is the foreign price and $p$ is the domestic price level, usually the GDP deflator or some other aggregate. Net exports should also fall with the level of income, according to some marginal propensity to import. Most models adhere to a version of the Marshall-Lerner condition, which ensures that a devaluation will not increase the *value* of imports in local currency so much that they more than offset the export response. The price level for each sector can either be determined by a flexible price that balances supply and demand at full capacity utilization or a markup on unit costs, including intermediate, wage and import costs. Indirect or value-added taxes are also added in.

[33] The simplest is perhaps a structuralist model in which aggregate demand determines the level of capacity utilization in a given period, with investment increasing capital stock in the next. The key to this kind of model is the distinction between investment by origin, that which contributes to aggregate demand, and investment by destination that causes an increase in productivity and capacity utilization for the next period.

Figure 3.2: Market structure in the sample CGE model




### 3.3.4.2 CGE simulations: A simple example

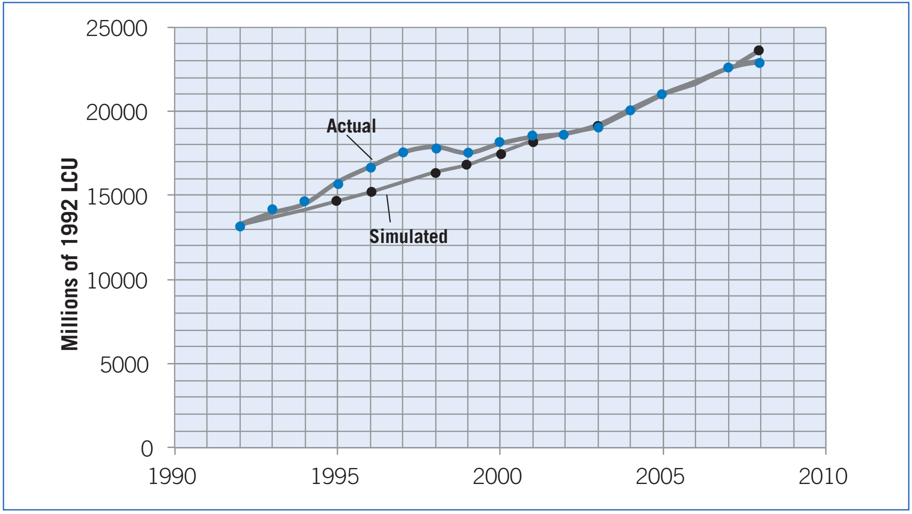
The sample model has the configuration in shown in figure 3.2 with export clearing in the agricultural sector, including mining and fix-price in the non-agricultural sectors. In this model, the nominal exchange rate continuously adjusts to keep the foreign and domestic prices of the first sector equal.[34]

Figure 3.3 provides an indication of the degree to which the model can be made to fit actual data. The figure depicts the actual evolution of GDP in Chile during the period 1992–2008. It also illustrates the predicted GDP evolution as simulated with the CGE model in our example. The crudeness of the model is evident in that the model undershoots and then overshoots the actual GDP path for the Chilean economy. The model nevertheless fits the actual data pretty well.

Having thus double-checked that the base model provides an adequate reflection of the actual economy, the model can now be used to estimate how small changes in trade policy might affect employment outcomes. One simple experiment that can be run in this kind of model is opening the economy to trade by reducing tariffs. The effect will not be large since tariffs are already extremely low in Chile, around 10 per cent of government revenue, as can be seen from the SAM in table 3.4.

[34] The spreadsheet for replication purposes is available at http://www.uvm.edu/~wgibson/. Further information is available in appendix 3.B of this chapter.

Figure 3.3: The base run of the small CGE for Chile



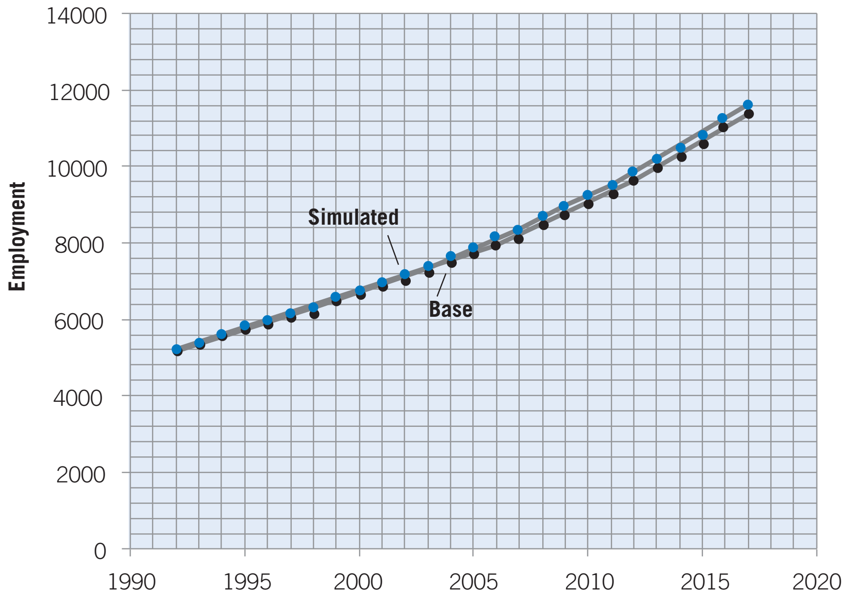

The results are shown in figure 3.4. Lowering tariffs only raises employment marginally, by about 2.3 per cent at the end of the simulated period. Real wages are the same in both simulations.

As is evident from the diagram, the impact of the tariff reduction is not large. The gain in employment amounts to a little more than 2.3 per cent at its maximum and that only after 25 simulated periods. The principal benefit of CGE models of this simple sort lies not in their predictive power, but rather in their elucidating the interactions of often complex mechanisms. In this case, the employment gain is due to the expansionary effect of lower tariffs, which after all, are just taxes. Thus, a tariff cut is likely to be expansionary simply because it amounts to an increase in net injections from the public sector.

This experiment is designed to do nothing more than illustrate how the CGE models can be used. Many alternative assumptions about how the model is configured are possible. Hammouda and Osakwe (2006), for example, note that CGE models are often designed to prevent revenues from falling, although the realism of this assumption is subject to question.

Perhaps the most important aspect of CGE modelling of the impact of trade on employment is due to accounting for the effect of productivity growth on investment. Models that examine the partial equilibrium impact of trade are useful but ultimately biased against trade openness because they can only "see" the negative impact. Not only is trade beneficial to consumers by lowering prices of goods directly and indirectly, it also stimulates productivity growth. This raises either wages, profits or both. If the productivity growth is captured by labour, demand will rise and increments in output will follow as capacity utilization rises. If profits increase, then investment is likely to rise as well. In both cases, the demand for labour will increase.

Figure 3.4: The impact of tariff reduction on employment




### Box 3-8: Trade and employment: The role of productivity

Gibson (2009) shows in a simple model that the relationship between trade and employment is essentially a relationship between productivity that reduces the demand for labour, *ceteris paribus*, and growth, which increases the demand for labour. The relationship between productivity and investment is a difficult one to measure with any precision, but one can be fairly sure that a rise in productivity will spur a rise in investment, output and *ultimately* the demand for labour.

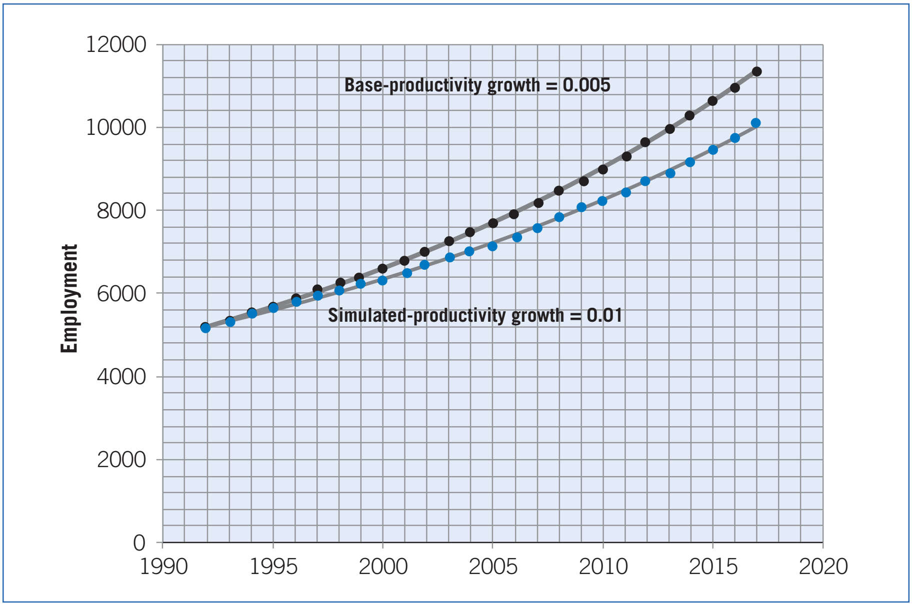
Productivity gains are certainly lethal to employment in demand-driven models with fixed investment. The reason is obvious from the structure of demand that depends largely on consumption. Since consumption depends, for the most part, on labour incomes, a reduction in employment quickly drives down aggregate demand. When there is quantity clearing only, the effect can be quite strong, as shown in figure 3.5. There, employment in the Chile CGE for the base run is compared to a simulation with twice the base level productivity gain, from 0.5 per cent per year to 1 per cent. No other change is made. In particular, it is seen that the level of employment increases much less rapidly as a result of this small loss. There is much less inflation, of course, but the real wage for both skilled and unskilled labour remains fixed. Interestingly enough, real GDP in this simple model does not change. The country is producing exactly the same quantity of output but with less labour. Where does it go? There might well be re-distributional consequences, of course, but in reality, some of the output will filter down through the informal sector to the rest of the economy. Total labour hours will likely be the same or higher. This distribution of productive activity will be highly skewed, of course.

### 3.3.4.3 Labour market assumptions in CGE models

CGE models combine the logic of various partial equilibrium models into one, and so the process of profit maximization that is used to derive the demand for labour appears in both. Some combination of prices (in this case the wage rate) and quantities (employment) bring about an equilibrium. Structuralist CGE models, such as the prototype discussed in the example of Chile, typically assume fixed real wages and take investment as the independent variable of the system (Gibson, 2009; Polaski, 2006).[35] If the economy is demand driven, a rise in exports will increase employment, despite the rise in imports.[36] Structuralist models generate much higher employment multipliers than do standard CGE models, primarily because of the assumption of excess supplies of labour.

Kurzweil (2002) notes that the standard approach to modelling the labour market in a CGE model is based on the distinction between factors and goods. In the simplest framework, labour is a homogeneous factor of production and is used as an input into a production function that takes a Leontief (fixed coefficients), Cobb-Douglas, CES or translog form as discussed above. In static models, the supply of labour is usually taken as a given parameter but, in dynamic models, assumptions about the labour force participation rate can be combined with population forecasts to determine the supply endogenously.

Figure 3.5: Increasing the productivity growth rate by 0.5 per cent




[35] Investment is often determined by "animal spirits" or some other exogenously specified variable.

[36] This shifts the focus to what determines investment and this is, of course, a notoriously difficult question as noted above.

The model may admit a wide range of labour types, degrees of mobility, forms of segmentation, costs and randomness of search depending on the assumptions deemed appropriate by the author.[37] Models with large numbers of labour categories are not uncommon and significant wage differences are often assumed, because of the assumption that skilled labour can compete with unskilled labour but not vice versa. This may be somewhat unrealistic, but skill categories are nonetheless useful ways of demarcating contours of labour mobility within a given sector.

Efficiency wage theory has also occasionally been integrated into applied models (Shapiro and Stiglitz, 1984). In LDCs, many firms pay workers higher than a market-clearing wage. Efficiency wage models explain this stylized fact by noting the principal-agent problem facing employers as workers may elect to work with less intensity than specified in the employment contract. One solution is monitoring, but this is expensive. Instead, workers are paid more to elicit higher productivity. This raises the cost of job loss to the worker and reduces shirking and turnover, attracts the best workers in the labour market and improves morale and productivity of workers happy to have a "really good" job.

In LDCs, efficiency wages may also have a biological component as caloric intake actually improves energy and effort and at the same time reduces absenteeism due to illness. While providing a theoretically cogent argument for high unemployment rates in developing countries, efficiency wage theory has not shown particular empirical strength. Since the optimal incentive wage is taken as a function of the unemployment rate, a rate that is very high when informal workers are considered unemployed, the efficiency wage premium is probably very small in LDCs.

Many structural CGE models do use a form of the Beverage curve, or wage curve, that relates search time to vacancies of employers (Gibson and van Seventer, 2000; Guichard and Laffargue, 2000). The curve serves to define the path of nominal wages in labour-market adjustment. When the rate of unemployment is higher than usual, nominal wage growth slows, and vice versa. In most CGE models, the agents (workers, firms and government) only control nominal variables, while general equilibrium essentially converts these nominal values into real, setting the stage for a reaction to the outcome in the next period. Reasonable paths for nominal variables are then required, which implies something like a Beverage curve for each segment of the labour market. Nothing prevents spillover here, such that unemployment in the skilled labour market reduces the rate of nominal wage growth for unskilled workers. It is also easy to build in a minimum wage option and then turn it on and off to see what the effects on employment and other variables, such as poverty, might be.

One innovative modelling technique in dynamic models is to use "complementary slackness", a term borrowed from the linear programming framework, as discussed above. Here, the labour constraint is written where

[37] Given the degree of aggregation at which most CGE models operate, it is not necessary to assume that any firm can substitute labour for capital, yet, for the sector as whole, it appears that substitution has taken place due to the changing patterns of aggregation.

$$(w / \overline{w})(\overline{L} - L) = 0 \qquad (3\text{-}5)$$

$w$ is the nominal wage and $L$ is employment. Bars indicate a floor for the wage and full employment for labour. Thus, if there is slack in the labour market such that $\overline{L} - L > 0$, then the complementary condition holds as an equality, $w - \overline{w} = 0$, and vice versa. This approach can be used to model the boundary between full and less than full employment scenarios.

Another innovative example is to introduce labour unions in the labour market specification. Workers and firms can explicitly bargain over wages or employment levels, with the union setting the wage and firms making the employment decision. Unions may also decide to maximize employment subject to a minimum acceptable wage. A simple approach is to set up a monopoly model to endogenously define wage differentials to reflect union power as in Thierfelder and Shiells (1997).

Structuralist models are useful for the analysis of labour market deregulation and its effects on wages, employment and incomes of the economy as whole. The fine structure of these models is unhappily beyond the scope of this chapter, but note in passing there is a fundamental property of CGE models that can be at seen as both a strength and weakness. Supporters of living wage, fair trade, better factories and decent work initiatives can use CGE models to quantify the costs of these programmes in terms of the well-being of those left out of such programmes. Partial equilibrium models ignore the plight of rejected workers, but economy-wide models should not and often do not. Whether they fill the informal sector, return to school to acquire human capital, or enjoy their leisure time, these agents should be accounted for in the CGE. This may raise the cost of reformist policies to an unacceptable level, or the reverse, enable the political classes to make informed decisions about the cost of closing down "sweat shops" and the like.

The above illustrates that labour markets can be modelled in a variety of ways. One of the main attractions of CGE models is that they can incorporate a wide variety of adjustment mechanisms in markets, ranging from the extremes of pure price or quantity-clearing markets to rationing, monopoly pricing, administered or foreign border prices. In any given model, a number of these adjustment mechanisms can happily coexist, although subsequent interpretations of results can become somewhat opaque. It is, therefore, important to carefully chose labour market assumptions in accordance with the reality in the economy that is represented in the model.

Making the right choice is particularly important in dynamic models. The impact on employment of trade depends on the assumptions made and, since the effects are cumulative in dynamic models, there is a risk of creating a cumulative implausibility. The choice of CGE model also matters. The original CGE models were all one-period set-ups for which comparative static changes (derivatives) could be computed. Many standard CGE models remain static owing to the great technical difficulty of inserting (many simultaneous) intertemporal optimization models into a common framework. Once these formidable challenges have been met, however, they may still fail the test of plausibility, simply because their assumptions seem so unreal. Structuralist models deal with this problem by assuming simple stock-flow relationships, often linear, and then calibrating the model to actual data as shown in the simple CGE for Chile above.

#### 3.3.4.4 Evidence based on SAM-CGE models

The largest impact of trade reform on employment seems to be from the effect that liberalization has on investment. Earlier CGE studies found that the gains from NAFTA-generated trade in Canada, Mexico and the US were small, less than 3 per cent of GDP over a decade. But standard CGE models do not typically address the inducement to invest in a dynamic context. The typical model has a neoclassical closure in which wages adjust to excess supply in the labour market and savings drive investment. With flexible product prices and elastic supply curves, an increase in the demand for exports can have a very small effect on wages and employment.

The Global Trade Analysis Project (GTAP) model is one of the most innovative CGE frameworks to appear in recent years (Hertel, 1997). The model's realism is enhanced by non-homothetic constant difference of elasticity (CDE) household preferences. It also incorporates international trade and transport margins as well as a banking sector that links system-wide savings and investment. Trade is modelled using bilateral trade matrices based on Armington elasticities. Factors include skilled and unskilled labour, capital, land and natural resources.

Kurzweil (2002) examines three specifications of the labour market in the GTAP model using the GTAP 5 database. The first is a "plain vanilla" trade liberalization experiment in which agricultural trade barriers are removed in the European Union (EU) by 50 per cent for African products. The second has the same tariff cut but low-wage workers in the EU are protected by a fixed real wage for unskilled labour in both low- and middle-income countries as well as in the EU. The third reduces the mobility of labour relative to the base GTAP assumption of perfect in-country labour mobility. Finally, a portmanteau simulation combines all the effects, liberalization, fixed real wage and labour mobility into one.

Kurzweil finds that the cut of the European tariffs on agricultural commodities raises welfare for the African regions. There is a slight decline in EU welfare. The different labour market extensions modify these results in various ways. Not surprisingly, the effect of labour immobility diminishes the impact of trade reform while the fixed real wage produces a large increase in welfare.

Note that this is the conjugate of the effect discussed above: when quantities adjust in the labour market rather than prices, that is wages, the employment effects are much more obvious. With the fixed real wage eliminated, employment gains in the formal sector are not as great as wages rise.

Kurzweil (2002) notes that "it becomes obvious that the characteristics of a country's labour market have a significant influence on the outcome of a trade liberalization scenario", but it would seem that the labour market structure is not what she is really getting at here. The difference in her simulations is how the model is closed, that is, with Keynesian demand-driven labour markets or with a more standard neoclassical flexible wage that eliminates excess demand or supply of labour. This point is fundamental to all CGE modelling: the nature of the closure is essential to

Table 3.5: Overall welfare gains from removal of all trade barriers in various CGE models

| Study | GTAP data | Sectors/ regions | Static/ dynamic | Returns to scale | Competition: perfect (PC) or monopolistic (MC) | Welfare gains ($US bn) |
|---|---|---|---|---|---|---|
| OECD[1] | 5 | 10/10 | Static | CRS | PC | 173.60 |
| Cline[2] | 5 | 22/25 | Static | CRS | PC | 227.80 |
| Anderson et al.[3] | 4 | 4/19 | Static | CRS | PC | 263.50 |
| Anderson et al.[4] | 6 | 25/27 | Dynamic | CRS | PC | 264.80 |
| Francois et al.[5] | 5 | 17/16 | Dynamic | Ag: CRS | Ag: PC | 367.30 |
| | | | | Mfg: IRS | Mfg: MC | |
| Brown et al.[6] | 4 | 18/20 | Dynamic | Ag: CRS | Ag: PC | 2154.50 |
| | | | | Mfg: IRS | Mfg: MC | |

Source: Piermartini and Teh (2005).

Notes: 1. OECD (2003); 2. Cline (2004); 3. Anderson et al. (2001); 4. Anderson et al. (2005); 5. Francois et al. (2003); 6. Brown et al. (2003).

the size and even direction of the results. There are fundamental differences between economies with surplus labour and those without (cyclical fluctuations notwithstanding) and it is this difference rather than the specific details of the labour market that must be pinned down before a model is ready for use in policy discussions.

Table 3.5 shows a summary of model structures and results for a number of models surveyed recently. As an example of how results from CGE models may vary with the database, structure of the models and the exact simulations undertaken, consider the information in table 3.5. The results of the studies in the table are presented as the total overall welfare gains from the removal of trade barriers, in the right-most column. From the table, the estimated gains range from a low of US$173.6 billion to a high of US$2,154.5 billion, with four of the six studies in a narrower range from US$227.8 billion to US$367.3 billion. The size of the gains increases as the models move from static to dynamic. Note also the assumptions about competition are altered in some studies to allow for imperfect competition, in the form of monopolistic competition. The effect is restricted to the manufacturing sector alone.

The table shows that structure makes a difference and this certainly irks some observers. Ackerman and Gallagher (2002) note that "the results of these models are typically reported as if they were hard, objective facts, providing unambiguous numerical measures of the value of liberalization". This could be a complaint made only by those with the most fleeting association with economic models of any kind and their use in modern political discourse. While it is possible to imagine that model results are sometimes presented in this way, there is certainly no shortage of scepticism in the eyes of the viewing public about virtually all models in virtually all disciplines. The picture illustrated in this table is that of a vigorous competition between modellers who believe that different aspects of an economy are of greatest importance. It is then up to the policy-maker, not the analyst, to choose the model deemed most appropriate to the policy question at hand.

Winchester (2008a) reviews 11 CGE studies of trade and wage inequality, including Cline (2004). Despite a wide variation in factors, sectors and regions, as well as trade scenarios considered, the models speak with one voice: the effect of trade liberalization on the relative skilled/unskilled wage is generally 5 per cent and often much less. The one outlier is Winchester (2008b), whose models claims a 27 per cent decrease for New Zealand in the skill premium. This is the product of an unusual experiment in which New Zealand returns to its agricultural roots, its true comparative advantage, and in the process requires much more unskilled labour. Ten of the 11 studies assume perfect competition and most have used an Armington function to distribute demand between imports and domestically produced goods. The changes are often quite large in these models: Theirfelder and Robinson (2002), for example, cut the price of imports by half, and Cortes and Jean (1999) double the size of emerging economies. Both get only a 1 per cent change in the skill premium.

In a particularly clear example of how large-scale structure can make an enormous difference in the way an economy responds to import penetration, Sadoulet and de Janvry (1992) use a CGE to study two archetypal low-income economies. In African countries, they note, cereal imports are non-competitive whereas in rice-producing Asian countries they are competitive with domestic production. The competitive/non-competitive import distinction was identified above as crucial to the impact of trade liberalization on employment. The authors use the same model (same closure and numéraire) with balanced fiscal intervention. Private and public investment has a long-run effect on total factor productivity. The models consider a 20 per cent increase in the price of cereals and animal products. In the African case, the price elasticity of the demand for cereals is, on net, less than one, leading to an increase in the import bill. Demand for local production falls and with it employment. To restore macroeconomic balance, a real devaluation is introduced, which reallocates labour to the agro-export sector. The devaluation steers resources to larger farmers who are the most capable of producing agro-exports. As a result, the distribution of income deteriorates, but a signal is sent to smaller farmers that producing food crops for domestic production is now a less viable option.

The Asian scenario is entirely different in that the rising cereal price benefits all farmers. There, cereal imports fall and macro-balance is achieved by way of a revaluation of the exchange rate. Since both countries depend on export taxes as the means to finance public-sector investment, the long-run effects are also the opposite. The Asian countries lose output and employment as budgets shrink, while the African countries, with rising trade taxes, have the resources to dedicate to public investment. The employment outlook is thus more positive for Africa relative to Asia in this simulation.

### 3.3.4.5 Assessing the CGE approach

One of the main weaknesses of the CGE approach is that the level of aggregation is very high and so it is not possible to identify where, when and for whom job loss will become a problem. Ackerman and Gallagher (2002) make three additional points when criticizing the use of CGE models to predict the gains from trade: First, in light of the fact that the projected benefits of liberalization of merchandise trade are small, especially for developing countries, and given the limited scope for future reduction, trade liberalization is unlikely to help reduce poverty significantly. Second, the assumptions and structures of first-generation CGE models are undergoing serious modification and divergent results are undermining the minimal consensus there had been. Third, employment effects of liberalization, while of fundamental concern to policy-makers, are “excluded by design” from most CGE models. Models based on more realistic assumptions about how markets actually function would produce an auditing of winners and losers from trade that would differ from the standard results. In short, the authors make the case that trade liberalization is essentially over and that any future benefits will be on a margin that is seriously diminished.[38]

Table 3.6: Benefits of complete liberalization: GTAP versus LINKAGE

| Liberalizing sector | High income | | Developing | | World | |
|---|---|---|---|---|---|---|
| | GTAP | LINKAGE | GTAP | LINKAGE | GTAP | LINKAGE |
| Total Amounts[1] | | | | | | |
| Agriculture | 42 | 128 | 12 | 54 | 56 | 182 |
| Textiles | 1 | 16 | 9 | 22 | 10 | 38 |
| Other | 17 | 57 | 1 | 10 | 19 | 67 |
| Total | 60 | 201 | 22 | 86 | 84 | 287 |
| Per capita[2] | | | | | | |
| Agriculture | 40 | 126 | 3 | 11 | 9 | 30 |
| Textiles | 1 | 16 | 2 | 4 | 2 | 6 |
| Other | 16 | 56 | 0 | 2 | 3 | 11 |
| Total | 57 | 199 | 5 | 17 | 14 | 47 |
| Percentage of GDP[3] | | | | | | |
| Agriculture | 0.16 | 0.38 | 0.24 | 0.50 | 0.18 | 0.44 |
| Textiles | 0.01 | 0.05 | 0.18 | 0.20 | 0.03 | 0.09 |
| Other | 0.07 | 0.17 | 0.03 | 0.09 | 0.06 | 0.16 |
| Total | 0.23 | 0.60 | 0.44 | 0.80 | 0.27 | 0.70 |

Source: Ackerman and Gallagher (2002).

Notes: 1. US$ billions. 2. US$ per person. 3. For LINKAGE, estimate for year 2015.

[38] Greenspan notes that the limits to the growth of benefits of globalization were already beginning to be felt in his administration as Chairman of the Federal Reserve (Greenspan, 2007).

World Bank economists have estimated global gains as much as US$520 billion with two-thirds of it going to developing countries. In the context of a US$50 trillion world economy, this is just over 1 per cent, observable, but not game-changing. Similarly, some 140 million people have escaped poverty due to trade liberalization according to World Bank economists. This effect is relatively larger; there are around 1 billion people in poverty worldwide, depending on how poverty is defined. Nothing in these numbers changes the general view that trade has only a peripheral impact on employment.

The discussion offered by Ackerman and Gallagher (2002) also highlights the role of data in the debate, weighing in against previous tales about how underlying SAMs to which CGE models had been calibrated were inadvertently switched, but with no perceptible effect on the outcomes of the simulations! The larger effect of liberalization observed in the GTAP 5 database seems to have diminished indeed. The GTAP 6 database describes the year 2001 and incorporates trade agreements reached through 2005, including China's entry into the WTO, the expansion of the European Union in 2004, and the end of the Multi-Fibre Agreement (Anderson et al., 2005; van der Mensbrugghe, 2007). The more up-to-date data incorporate the gains from previous tariff reductions, of course, but at the same time permit smaller gains from future reductions.[39]

On a more theoretical level, Hammouda and Osakwe (2006) note three sources of weakness in CGE models: the theoretical framework or structure; database availability and accuracy; and the distinction between model parameters and endogenous variables. The authors join Taylor and von Arnim (2006) in identifying the Armington function and its estimated elasticities, as a central vulnerability. In this view, policy recommendations seem to hinge on a parameter that cannot be estimated with great accuracy.[40]All CGE model critics note that strategic considerations, power relations, regional hegemony and other local rigidities are entirely left out of the model specification. To the extent that these models are guided by the spirit of the Walrasian general equilibrium system, they miss some of the features central to the development process, such as restricted or entirely absent credit markets, uncertainty around property ownership and title, asymmetric information problems and general coordination issues. Adjustment costs, too, are often left out of the models. Many of these criticisms can be addressed using agent-based methods, but that work remains in its infancy (Epstein, 2006).

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[39] It is important to see, however, that tariff changes can happen in both directions, so the model is still useful in predicting what would happen, hysteresis aside, were some backtracking to occur. The tone of the critics notwithstanding, it is difficult to see the relevance of the critique of their CGE methodology as anything more than the recognition that diminishing returns to trade liberalization are setting in. The World Bank's LINKAGE model predicted, for example, a gain for developing countries of US$539 billion in 2003 but by 2005 the impact had fallen to US$86 billion. Hertel and Keeney (2005) use the GTAP model to estimate the benefits available from removal of all remaining barriers to merchandise trade, some US$84 billion, mostly from the liberalization of agriculture.

[40] The desktop CGE elaborated above can certainly be used to test this hypothesis. Raise the import price and lower the level of import growth: the model then mimics the presence of an Armington, without the computational complexity.

By far the most controversial assumption built into many CGE models is that of full employment. On the one hand, developing economies do have full employment: virtually everyone in an LDC is doing something all the time, especially in countries that provide no social safety net (Gibson and Kelley, 1994). Gibson (2005) uses a CGE model to incorporate the informal sector and this model effectively assumes full employment, just not all in the formal sector. The idea–implicit in full employment models–that wages would drop to the point that all those willing to work would find jobs in the formal sector is clearly a different kind of assumption and it is the one to which most critics most strenuously object.

The database critique does seem to have some validity. When CGE models are based on the MAcMAP or GTAP database, including vintage and MIRAGE models, many countries are left out.[41] Only 11 of the 48 in Sub-Saharan Africa are included in the GTAP 6 database (Hammouda and Osakwe, 2006).[42] The lacunae might or might not be pertinent to a specific policy issue but, at a minimum, should remind policy-makers that having a small pilot or desktop CGE for use in evaluating "black box" models linked to unrepresentative databases might be an investment well worth making. Models, for instance, that assume a common crop structure across an otherwise highly heterogeneous agricultural sector cannot hope to predict the effect of trade liberalization on employment in countries specialized in a limited number of agricultural products. This does not mean that CGE models are always wrong or of no use, but rather that they must be suited to both local rigidities and calibrated to relevant time scales.

### *3.3.5 Comparing different simulation methods*

These and other criticisms frame the question of which is the more appropriate model, partial or general equilibrium. ATPC (2005) notes that computable partial equilibrium approaches, such as the World Integrated Trade Solution (WITS/SMART), are flexible enough to assess country- or sector-specific employment losses or gains associated with trade liberalization. The data for these models are certainly less synthetic than for SAMs and CGE models and thus present a higher resolution image of the sector in question. Moreover, CGE models are singularly unwilling to identify firms whose workers are in immediate need of trade

[41] The MIRAGE model has some interesting features: FDI flows are explicitly described, vertical product differentiation is introduced, by distinguishing two quality ranges, according to the country of origin of the product and trade barriers. These are described by the MAcMaps database, which also provides ad-valorem tariffs, ad-valorem equivalents of specific tariffs, tariff quotas, prohibitions and anti-dumping duties at the bilateral level for 137 countries with 220 partners. Preferential agreements are taken into account in a quasi-exhaustive way (Bchir et al., 2002).

[42] The Michigan model, on the other hand, is based on its own database and was used to analyse the employment effect of the Tokyo Round of Multi-lateral Trade Liberalization in 29 sector models of 18 industrialized and 16 developing countries (Deardorff and Stern, 1986.). This model was extended to include imperfect competition and some aspects of "new trade theory" for the analysis of the US-Canada free trade agreement (Brown et al., 2005).

adjustment assistance. Indeed, CGE models are all but blind to any but the largest contributors to GDP. The general rule of thumb is that sectors smaller than "1 per cent of GDP" do not matter and show up only as rounding error. The 1 per cent rule is hardly an adequate foundation on which to make policy except at the most aggregate level. In this important sense, partial and CGE models do not directly compete with but rather complement each other in any comprehensive policy analysis.

The large-scale optics of CGE models are made worse by the tendency of some modellers to regard their code as a commercial secret. There are two levels on which modellers can infringe. The first, mentioned by Hammouda and Osakwe (2006), is the obscurity with which model equations are described. Sensitivity testing of key assumptions is lacking too frequently, although in much of the professional literature it has become practically a requirement to post data and models on one's web page for replication purposes. In the case of some of the large CGE models, this certainly can present a practical problem.

Critics also complain that authors seem to be devoted to discussing the specific equations of their work without giving an overview of how the equations interact so that model results can be compared across various modelling approaches. For this reason, meta-studies are rare and not always of high value. The authors of the commercially available MIRAGE model, for a particularly egregious example, do not even supply a listing of their code, creating a box that is truly black.

As suggested above, data requirements of CGE are very different from those that feed econometric models. In addition to a base SAM, standard CGE models require elasticities of substitution between labour and capital, the income and price elasticities of household consumption demand, the elasticity of substitution for the Armington and an elasticity of transformation. These four key sets of elasticities cannot be estimated directly from the SAM and must, therefore, be derived from econometric or other sources (Sadoulet and de Janvry, 1995).[43]

## 3.4 ASSESSING THE EMPLOYMENT IMPACTS OF TRADE: ECONOMETRIC METHODS

Just articulating the nature of the problem that econometrics is designed to tackle unveils the difficulty in testing the hypothesis that trade liberalization causes employment to rise. The first problem that has plagued all econometric research is the nature of the subject. In principle, the subject should be an individual agent, rather than a country. Were all countries of the same size, it would be possible to renormalize

[43] "Other sources" include "guesstimation", i.e. educated guesses, but as Sadoulet and de Janvry (1995, p. 354) point out, "luckily, experience has shown that the empirical results obtained from simulations with CGEs are quite insensitive to specific values of all these elasticities ...". They go on to identify the Armington as one of the crucial parameters for which the proper "order of magnitude" must be obtained.

to the country unit without affecting the results. In the imagined randomized trial, most subjects will be from the large countries, randomly assigned to one group or the other.[44]

In the following, the discussion is structured around three types of regressions that have typically been conducted when analysing the relationship between trade and employment. The first subsection discusses an exercise in which sectoral information is explored to analyse how import penetration has affected sectoral employment within one single country. In the second subsection, the relationship between trade and the wage premium is discussed, a relationship that has been the object of a large body of econometric work. Last, but not least, a cross-country analysis is presented.

**Box 3-9: Econometrics: A reminder of the basics**

To evaluate the econometric work done on the issue of trade and employment, it is best to keep in mind several basic ideas about what the method entails:

- First, all econometric models are (or should be) designed to mimic a randomized controlled trial. Hence, pick a group of country subjects, randomly assign them to two groups. Let one trade and the other not and then measure the employment response after a determinate length of time.
- Second, when working with observational data, the default interpretation of the results should be that the observations are correlated and that no causal relationship can be imputed. This "guilty until proven innocent" approach is the recommended way to avoiding type I errors, failing to reject a false hypothesis. This is because the overwhelming majority of theories in economics involve simultaneous causality.[45]
- Third, econometric tests can never "prove" anything. All that is possible is to fail to reject a theory that seems correct.
- Fourth, econometric methods cannot distinguish between theories since any given set of observations is likely to fail to contradict some theory. Data do generate theories, and working backward from data to theory ensures that the data will fail to contradict the theory and so will be of no intellectual value.
- Fifth, econometric models can test a theory "all up" in the sense of the overall direction of causality between independent and dependent variables, or it can test a component of a theory that is necessarily true if the theory as a whole is to work.

[44] Sometimes this can be done, or approximately so. Consider the coastal cities of China that are heavily involved in world trade. The rural counterpart is not, so in some sense there is a natural experiment. On closer inspection, the example fails, however, since the assumption that coastal and rural Chinese are statistically identical is obviously problematic. When subjects can self-sort into one of the two groups, control or treatment, the results are subject to "selection bias" and are generally not valid. See Kennedy (1998) for a non-technical discussion of selection bias.

[45] Paraphrasing Kennedy (1998), for any given set of variables some researcher is hoping that there will be a discernible relation between one and the others, while some other is hoping that there will not be (because of multi-collinearity).

### *3.4.1 Trade and sectoral employment*

Consider first a naive regression, say the impact of imports on the industrial employment of some developing country. Could it be said that the imports "caused" the decline in employment, either quality or quantity of jobs, in that sector? Intuitively, the answer is yes. Even this simple relationship, however, is quite difficult to corroborate with empirical data.

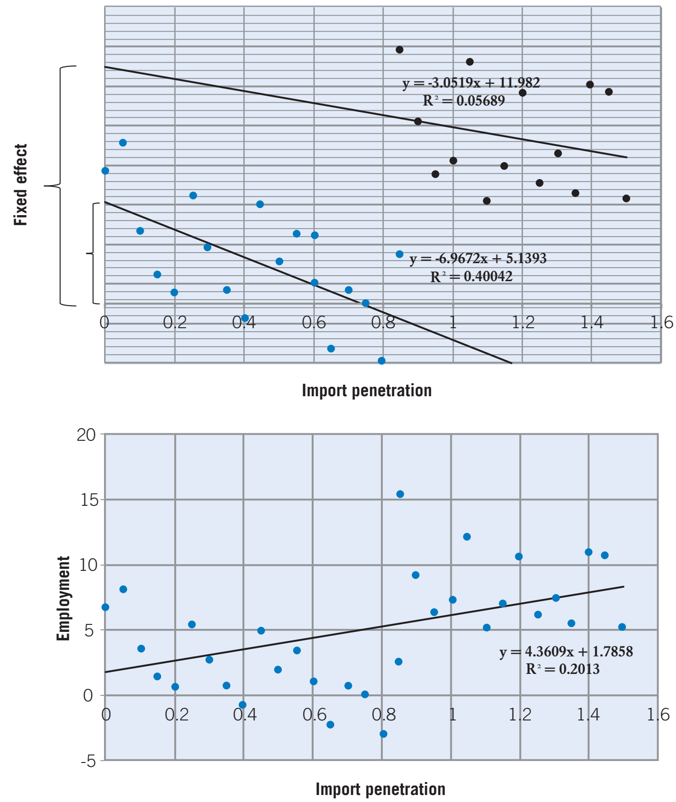
A simple example is provided by Galiani and Sanguinetti (2003). The authors note that Argentina underwent a substantial liberalization beginning in 1990 that transformed the industrial sector. The tariff reductions resulted from multi-lateral negotiations at the General Agreement on Trade and Tariffs (GATT). Tariff barriers were reduced to an average level of 10 per cent and all import licences were eliminated. This was an impressive across-the-board liberalization, reducing protection from an average level of 45 per cent in 1988 to around 12 per cent in 1991.

During the next decade, total trade almost quadrupled, increasing its share in GDP from some 10 per cent to 18 per cent, with import penetration in manufacturing rising from 5.7 per cent in 1990 to 19 per cent in 1999. This was, then, a classic case of trade liberalization and it did lead to a reduction of employment in manufacturing. Here the "treatment" is the import penetration, which varies from sector to sector. The control group consists of the sectors with low or zero import penetration.

Do these sectors differ systematically? If so, then strictly speaking, any empirical results are meaningless since it will be uncertain whether the imports caused the decline in employment or it was some other unaccounted for factor. Surely the special circumstances of each of the industrial sectors must matter, how much capital they employ, the degree to which labour can be substituted for capital and what local labour rigidities might impinge on employment decisions. Even if there is no information about these and other factors, might it still be possible to apply the control group method?

The answer is broadly yes. The critical assumption is that the unobserved factors remain constant over the time frame for which the regression is run. If so, then it is possible to split the data set up into subsets, cancelling out the systematic difference between the two. Figure 3.6 shows how this is done. Let there be two sectors in the data set for some arbitrary country. Running a regression amounts to fitting a straight line through the data points as is done in the left-hand side of the panel. The regression slope there is positive as shown in the figure. In the right-hand panel, the data set is split into two, one for the first and one for the second sector. Now regressions are run for the two data sets separately and the difference in intercepts amounts to the "fixed effect" or sector-specific determinants of employment. Now the slopes have reversed their signs, as seen in the figure, so that an increase in import penetration shows a declining level of employment. Does the left-hand-side diagram contradict the theory that increased imports reduce employment? No, it does not, since the experimental design does not hold everything else but the treatment constant. On the other hand, the diagram on the right fails to contradict the hypothesis that higher imports lead to lower employment.

Figure 3.6: Fixed effects regressions




The coefficients on import penetration may nonetheless be incorrect if the unobserved factors held constant by way of splitting the data set are not, in fact, constant over time. If not, then there is omitted variable bias. What if, for example, employment were falling in all sectors over time as resources were reallocated from industry to services, a trend that seems to take place in most economies as they mature? The tendency for industrial employment to fall on its own would then "pile on" to the effect of trade liberalization, increasing the apparent effect of the latter. The improper attribution of time effects onto the import coefficient causes bias in the latter that will disappear even in large sample sizes. It is a fundamental defect of the experimental design.

Appendix table 3.A-1 shows data for Argentinean employment for 22 industrial sectors for the years 1994, 1996 and 1998. There are also data for imports as a percentage of valued added in those sectors for selected years from 1993 to 1998. Running a simple regression of employment on import penetration (IP) yields the regression in the first column of table 3.7. While the sign is what might be expected, the coefficient is not significantly different from zero.[46] Regression 2 does not split the regression but nonetheless has a significant coefficient on import penetration lagged with a negative and *positive* and significant coefficient on lagged imports. The last two regressions sharpen the estimate a bit, effectively checking for the possibility of fixed sectoral effects (regression 3) and fixed time effects (regression 4). The general similarity of results suggests that these effects are not large in this sample. The quite negative effects of the year dummies show that *all* sectors are experiencing a decline in employment. Thus, the regression that seems most accurate is the last with fixed effects in both sector and time. It has the smallest coefficient for the import penetration variable.

Table 3.7: Dependent variable: Employment

| | Regression | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| IP | –0.022 | –0.242*** | –0.271*** | –0.163** |
| | (0.013) | (0.030) | (0.052) | (0.050) |
| IPL | | 0.227*** | 0.179* | 0.238*** |
| | | (0.024) | (0.067) | (0.058) |
| 1994 | | | | . |
| | | | | . |
| 1996 | | | | –9.594*** |
| | | | | (1.298) |
| 1998 | | | | –9.110*** |
| | | | | (1.776) |
| Constant | 86.306*** | 89.114*** | 92.829*** | 90.895*** |
| | (2.606) | (1.381) | (2.571) | (0.826) |
| $R^2$-adjusted | –0.009 | 0.081 | 0.253 | 0.68 |
| $R^2$ | 0.040 | 0.109 | 0.276 | 0.702 |
| Observations | 22 | 66 | 66 | 66 |
| F-stat | 2.562 | 49.166 | 14.007 | 20.771 |

Source: Galiani and Sanguinetti (2003).

Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Notes: 1.The dependent variable is the employment (1990 = 100).

2. The variable IP is the import penetration as a percentage of value added.

3. The variable IPL is the import penetration lagged one year.

[46] Running the regressions one at a time shows that, indeed, the coefficient on IP varies from positive to negative but is never significant.

What is remarkable about these regressions is that they seem to support the idea that imports destroy jobs in the current period, but build them back up in the second year.[47] Why might this be so? One answer is what the general equilibrium theories suggest above. Competitive imports do indeed reduce employment in the sectors with which they compete, but then the lower import prices also *raise* the profitability of import-using sectors. If and when these sectors expand in response to higher profitability, the demand for labour would then increase.

### *3.4.2 Trade and the wages of skilled and unskilled workers*

Galiani and Sanguinetti (2003) show the effect of trade liberalization on the wages of skilled and unskilled workers. Import penetration will affect unskilled labour more if it is relatively immobile. Skilled workers may or may not have sector-specific skills, but to the extent that their skills are applicable in the expanding sectors, they will suffer less from import penetration.

Prior to liberalization, unskilled and semi-skilled workers kept pace with skilled workers in that the skill premium was relatively constant. After 1990, the premium began to accelerate. The premium is certainly correlated with the rise in imports as just discussed, but did liberalization *cause* the wage gap to rise?

All manufacturing wages were rising during the 1990s, skilled, semi-skilled and unskilled. Wages will rise with age and experience, so the researchers used information on these variables to control for the impact on wages. They then ask the question: holding the skill, experience and age of a worker constant, would an increase in import penetration raise the *slope* of the regression line more for semi-skilled and skilled workers relative to their unskilled counterparts? To analyse this question, the authors use an interaction term

$$w = \beta_o + \sum_{j=1} \beta_j C_j + \beta_w C_s I \qquad (3\text{-}6)$$

where $\beta_o$ is a constant and $\sum_{j=1}\beta_j C_j$ the sum of the control variables multiplied times their coefficients $\beta_j$. The last term factors in the level of import penetration with the variable $I$. Note that it is multiplied times $C_s$, which is the variable to control for skills or education. The key to understanding this approach is to note that $C_s$ is *already included in the sum of controls*. So the effect of skills is not counted twice, once by itself and then multiplied by the import penetration variable. The change in wage with respect to skill is just the slope coefficient on the skilled variable but now it consists of *two* parts, a base slope and then, potentially, an addition for the fact that the worker is working in an industry with high import penetration. This extra boost on the *slope* coefficient is only "potential" because it might not be significantly different from zero. If so, then there is no difference in the skill premia

[47] This may be an interesting theory, but it is not tested by the data in table 3.8, simply because the idea emerged from the data. To check this theory further, some additional regressions would have to be run.

for workers in penetrated industries versus those in others. Return to figure 3.6 and consider that the interaction of the skilled premium with import penetration must there change the *slope* of each of the separate regressions in the right-hand panel.

Galiani and Sanguinetti (2003) find that the interaction terms are indeed significant but not large enough to explain the more than about 16 per cent of the skilled labour premium. This is certainly an interesting result and this methodology could easily be applied in a number of different countries. One important point to mention, however, is that since import penetration does not explain much of the rising skilled-labour premia, something else must. When the unknown effects are fully accounted for then perhaps it will be seen that import penetration suffers from omitted variable bias. Further research would be needed to answer this question definitively.

It should not come as a surprise that trade liberalization leads to an increase in the skilled-labour wage rate relative to the unskilled wage rate. As old sectors contract and new sectors expand, workers with greater mobility, non-specific creative abilities and generally higher levels of education will be in short supply, and even more so than in times of more balanced growth. The wage premium therefore reflects the reality that change requires adaptive talent, and the signal sent to those without that adequate human capital is that all the incentives are pointed in the direction of taking greater advantage of the educational system. Indeed, if skill bias in wage growth did not appear, one could be appropriately sceptical that any change was actually taking place in the economy.

### *3.4.3 Trade, productivity and employment*

The previous section conveyed a story of rising demand for labour, but with a lag, as liberalization proceeds. Wage inequality sends a powerful signal that new opportunities for significantly better living standards are present if one takes the proper steps to prepare. This is an optimistic scenario and a reality that not all countries have experienced. The transition to openness might begin with significant import penetration, job loss, but then lack the investment necessary to open new branches of production with an export orientation.

Might it be possible to determine empirically the slope of the implied relationship between employment and productivity? The problems with a project of this nature are legion, however, in that one must deal with simultaneity (the correlation between the independent variable and the error term) as well as the usual problems of data reliability and comparability. Above all, there is the problem of lack of data on productivity and employment. Both have to be manufactured from existing data sources before any attempt at estimation can be made.

A second major estimation problem comes in the weighting of the data. Is it really possible to take one observation of a country the size of China and India along with states a micro-fraction of their size and deduce anything of scientific value? Finally, there is the problem faced by most time-series studies that spurious correlation must be removed by way of co-integration or other techniques. Despite these difficulties, it might be worthwhile to consult some data for an opinion as to the slope of the long-term relationship between trade, productivity and employment.

If trade is intended to promote higher levels of employment, it must do so through the mechanisms discussed above, notably, either that the economy must grow in a balanced fashion with no change in factor prices or, if growth is unbalanced, any subsequent rise in the aggregate labour coefficient should not offset the growth in output. So far, the empirical literature has not spoken with a consistent voice on the relationship between trade policy and employment. As noted, there are severe problems of endogeneity, with employment policy as a determinant of trade policy as much as the other way around.

Indeed, even *openness* itself is difficult to measure. Sachs and Warner's influential index of openness included a range of variables that would seem to be important (Sachs and Warner, 1997). It is a binary variable with a value of zero for a closed economy and one for an open economy. To qualify as closed, the economy must satisfy *only one* of the five following criteria: (1) average tariff rates exceed 40 per cent; (2) non-tariff barriers on more than 40 per cent of imports; (3) an explicitly socialist economic system; (4) a state monopoly on its major export; (5) a black-market premium on the exchange rate that exceeds 20 per cent during either the 1970s or 1980s.

A closed economy is thus defined somewhat subjectively, but this is more than a typical portmanteau regression variable in that economies can qualify as closed in a variety of ways, and introducing them separately may not yield stable *t*-scores due to their high levels of multicollinearity. The Sachs-Warner dummy has a high and robust coefficient when inserted into growth regressions and was subjected to exhaustive sensitivity analysis, including more than 58 potential determinants of growth.

Rodriguez and Rodrik (1999) point out that the variable actually measures *macroeconomic mismanagement*, especially around the real exchange rate, a key measure of competitiveness. This is, of course, broadly consistent with the major message of this chapter: employment, and derivatively, the quality of employment depends not on trade but rather on how well trade is managed. Rodriguez and Rodrik (1999) conclude that the Sachs and Warner indicator serves as a proxy for a wide range of policy and institutional differences and thus it yields an *upwardly biased* estimate of the effects of trade restrictions alone. Edwards (2002), correcting in various ways for heteroskedasticity, substitutes another linear combination, more heavily weighted toward even more subjective conceptions of openness, including an index compiled by the Heritage Foundation. Rodriguez and Rodrik are critical, noting numerous instances of judgment bias in sample selection and lack of counterparty robustness (robust in own but not other studies). They conclude that the relationship between trade and growth enjoys sketchy support at best and, while the econometric literature fails to soundly *reject* the null, it provides a weak foundation for policy advice (Rodrik, 1997).

As noted, a second major problem is simultaneity: in regressions of output per worker and employment, greater productivity can cause higher employment as easily as higher employment causes higher productivity. Recent attempts to solve this problem have instrumented employment by changes in labour taxes since the latter should be unaffected by changes in productivity. Several authors have found a strong *negative* relationship between productivity and employment, Beaudry and Collard (2002), among others.[48]

A casual conversation with the data does not lead to the same conclusion. Since reliable data for world employment are not readily available, a work-around is necessary. One approach is to replace employment with the labour force, a variable widely reported, under the assumption that there is no trend in unemployment rates over time. This proxy certainly reduces the variability of the dependent variable and leads to inflated *t*-statistics as reported below. Whether the resulting upward bias in reported *t*-ratios is sufficient to create a false impression of significance is a judgement left to the reader.

To counteract spurious correlation, the regressions below use time fixed effects as discussed above. Country fixed effects partially compensate for the endogeneity, since what would be a large error associated with a large value of the independent variable $\rho$ is absorbed into the dummy variable or constant term. The results of the regression are presented in table 3.8.

Table 3.8: Dependent variable: Employment

| | Regression | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| ln ipc | 0.307*** | 0.009 | 0.307*** | 0.285*** |
| | (0.013) | (0.008) | (0.013) | (0.018) |
| Trade | | | | 0.001*** |
| | | | | (0.000) |
| cons | 11.707*** | 14.641*** | 11.707*** | 11.779*** |
| | (0.130) | (0.088) | (0.130) | (0.176) |
| Observations | 4.568 | 4.568 | 4.568 | 3.536 |
| $R^2$ | 0.127 | 0.000 | 0.127 | 0.123 |
| $R^2$-adjusted | 0.127 | 0.000 | 0.127 | 0.123 |

Source: Author's calculations based on World Bank (2009).

Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Notes: 1. The dependent variable is the log of the labour force.

2. The variable ln ipc is the log of income per capita.

3. The variable trade is the sum of exports and imports divided by GDP.

[48] This work would suggest that protection is the right way to save jobs since protection reduces productivity and therefore increases employment.

In table 3.8, regression 1 includes only *country* fixed effects while regression 2 has only *time* fixed effects. Regression 3 is estimated using two-way fixed effects, that is there as a dummy variable for every year and every country.[49] In both regressions 1 and 3, the coefficient on the measure of productivity (in log form in the equations) is positive and significant. Note that the time-only fixed effects model (regression 2) does not show a significant coefficient on the productivity variable.

The significance and positive sign of the coefficient on the productivity variable continue to hold for regression 4, which uses two-way fixed effects and includes the variable trade to measure openness in the economy (the ratio of the sum of imports and exports to GDP). Including trade in the model reduces slightly the coefficient on the productivity variable but it remains significant at the 1 per cent level. The coefficient on the trade variable itself is also positive and significant.

These simple regressions can only be suggestive, but they lend support to the notion that there is a positive relationship of labour productivity and trade with employment.

**Box 3-10: Structuralist and standard CGE models: Not that different after all?**

It was argued above that the full employment assumption underlying much of the research in CGE models seems inappropriate for countries with significant open unemployment and large informal sectors. Most of the standard CGE models assume that savings drives investment and that wages cannot remain in disequilibrium forever, and will eventually have to fall to the point that the labour market will clear. Structuralist models, as was seen above, are based on the reverse relationship, that investment drives savings and, moreover, that the long run is simply a sequence of short-run equilibria.

The difference in views of how the world works may not be as momentous as it first appears. Structuralist models assume that the independent variable of the system, investment, is driven over time by capacity utilization and profitability. Therefore, if trade brings technological change, which in turn causes productivity to rise faster than real wages, profits will have to rise. If it is institutionally possible for investment to increase, then indeed the structuralist model will come to resemble the standard model more closely. In other words, if productivity rises with trade liberalization, and investment rises with productivity, the employment must rise eventually.

The simple regression findings presented in the main text lend support to the notion that there is a positive relationship of labour productivity and trade with employment. This implies that the gulf between the standard and structuralist CGE models might not be as large as it seems.

## 3.5 ASSESSING THE EMPLOYMENT IMPACTS OF TRADE: QUALITATIVE METHODS

Qualitative methods in the social sciences start from the premise that the critical factor in understanding the world is *context*. This general point expresses concern about several specific features of quantitative analysis that, taken together, are seen as stripping away the necessary context (Chabal and Daloz, 2006). The first of these foundations of qualitative methods is the view that non-quantitative dimensions of experience and behaviour are ignored in quantitative techniques discussed in section

[49] Fixed effects models are voracious consumers of degrees of freedom, but the World Bank's development indicators database has (incomplete) data for a large number of countries back to the 1960s.

3.3 and 3.4 above. In discussions of trade, for example, deeply entrenched and powerful but difficult to measure factors such as gender and other social norms may limit the mobility of labour, retarding the employment response to trade liberalization. Similarly, critics of quantitative methods argue that randomized controlled experiments, as discussed above, are *not* possible. All the factors comprising the history of the agents acting in formal models cannot be captured as explanatory variables: quantitative studies can only give a partial and static snapshot in time.[50] Lacking the contextual detail leaves us with what critics of quantitative methods call "universalist and culture-free approaches to social phenomena" (Hantrais, 1995, p. 1), Therefore, quantitative methods are inherently "thin", only skimming the surface of social reality, whereas "thick" description admits a complex set of phenomena, themselves complexly superimposed and interrelated (Ryle, 1971).

What adds *thickness* to the alleged thinness of quantitative methods varies. The first of the two main positions holds that the most important context is the social nature of science itself as it is embedded in specific historical and cultural contexts. To do social science, this view believes, one must understand the "rhetoric of scientific authority" (Weinberg, 2002, p. 12).[51] A second main strand looks not only at the cultural imperatives of the researcher but also at the detailed histories of the studied population, with an eye toward identifying the multiple realities as seen by various members of the population and assigning meaning to the differences. The point then is to explore and interpret social phenomena for their meaning rather than to search for a covering law to confirm by way of standard hypothesis testing (Geertz, 2000).

Specific qualitative methods derived from these principles include participant observation, direct observation, unstructured interviewing and case studies. The last two are the most relevant for economic analysis and define clearly the difference between qualitative and quantitative methods. Unstructured interviewing is explicitly not based on survey instruments or protocols to be administered uniformly across the sample subjects, for example. Rather, open-ended questions, which can go in any direction the interviewees desire, form the basis of the qualitative study. Its results are not data that can be quantified or made comparable across respondents, but rather field notes that include enough detail, thick description, to account for what the researcher considers the most salient information (Trochim, 2006). Case studies in the same way are *sui generis*, with each case a reality in itself.

A good example of this methodology applied to the impact of trade on employment is a study of the lives of female factory workers in an export processing city in China (Chang, 2008). From interviews with workers, visits to their home villages and information from the author's family history, a complex portrait of the various strands of influence on the lives of factory workers is painted. Ancestral norms and expectations limit first the mobility of the women and then, once they break free of the village and migrate to urban employment, their decisions about acceptable

[50] The well-known "Hawthorne effect" eliminates the possibility of randomized controlled trials in context since the context is, by definition, made artificial by the presence of the study.

[51] See also McCloskey (1988).

forms of employment. At the same time, the new norms of the urban environment affect their experience by influencing how they spend their wages, the extent to which they invest in upgrading their skills and whether they maintain their ties to the village, including decisions about remittances. These decisions, in turn, seriously affect the evolution of their home communities in complex and contradictory ways that no formal model could predict.

Case studies of firms also look at the complexity of firm-level responses to trade liberalization. A good example of comparative case studies is D'Costa (2004), which examines the institutional features of automobile firms in India to assess the reasons some succeed and others fail to remain competitive. Consistent with thick description methods, the study incorporates but does not either quantify or attempt to rank formally the importance of a wide variety of institutional influences. These include factors external to the firm, such as cooperation between suppliers and buyers, the location of suppliers, partnership arrangements in the industry and government trade and industrial polices. Internal factors also play important roles, including the degree of worker participation and protection of worker rights, the form of innovation and the scale of operation. The point is that presence or absence of the *set* of institutions and their interaction, as a whole, is implicated in successful response to competition from imports. No one factor or subset is sufficient to capture the complex reality of the requirements for competitiveness. Moreover, what leads one firm to introduce an innovation such as worker participation is directly linked to the cultural history of the area in which the firm operates. Some firms are more tradition-bound than others by virtue of their location and heritage. In the original areas of India's industrial development, for example, firms are far more path dependent than in the call centres of Bangalore. While the narrative of qualitative analysis can capture these subtleties, they are often overlooked in formal models.

Both the strength and the weakness of qualitative methods lie in the degree to which cataloguing the richness and variety of individual experience is the goal of research. Unravelling the intertwined strands of experience to make any assessments of causal links is both difficult conceptually and subjective, based on the judgment of the participants and the researcher. By their nature, such studies cannot be replicated because the precise context cannot be reproduced, as noted above. It is left to the researcher to determine how thick the description must be to "account for the ever-changing context within which research occurs" (Trochim, 2006). An important weakness of qualitative methods is, therefore, that policy-makers are left with no firm ground on which to decide whether a particular case can be generalized as the basis for policy formulation.

## 3.6 CONCLUSIONS

As Jansen and Lee (2007, p. 20) observed, "due to a combination of methodological and data problems, it has been more difficult to provide robust empirical evidence for the relative impact of trade liberalization and other domestic policies on employment changes and economic growth". These authors conclude that the preponderance of studies do seem to show a consistent relationship between trade and growth in income per capita. An outward orientation does seem to be superior to an inward, self-sufficient course of growth. This seems to be the message of the models and literature reviewed in this chapter, but with some substantial caveats.

Given the complexity of the nature of the relationship between trade and employment, it is hardly a surprise to observe that the literature wanders somewhat aimlessly. One of the aims of this chapter has been to provide an overview of existing methods to evaluate the employment effects of trade. The methods discussed in this chapter and their respective characteristics are summarized in appendix table 3.A-2. Another aim of this chapter has been to narrow the field of possible methods to the point that they can converge to a common conclusion. While this chapter privileges no particular methods, several key points emerge as to the proper way to model the relationship between trade and employment:

(1) An economy-wide model is necessary to study the complex interaction produced in a trading regime. Even the earliest ILO studies recognized this and it remains true today. Partial equilibrium accounts that conclude that the interests of some sectors have been damaged can lead to an anti-trade bias. This is simply because the partial equilibrium approach fails to see how seemingly unrelated sectors might benefit from the same trade policy that is so destructive to the sector in question.

(2) Calibrated models, even if economy-wide, are not likely to produce good policy if there are inadequate micro-foundations. The reason a solid micro-foundation is necessary is that all policy must ultimately act on people, providing incentives that real-world agents can presumably understand and incorporate into their decisions. Policy directed at aggregate indicators is rarely successful; it must be directed to the people themselves. Many of the models surveyed in this chapter are properly micro-founded.

(3) The data from econometric models should be used to test theories to the extent possible, but should not be used to build the theories. This will preclude the data from having any self-serving comment on the validity of the theory. What the data seem to show is that trade is important to virtually every country that has experienced large increases in employment. While openness is not sufficient to drive up employment, it does seem to be necessary for poor countries to break out of the cycle of poverty, low levels of human capital and large informal sectors.

(4) It is important to note that people and not firms suffer adjustment costs. Standard economic theory suggests that policy should follow this logic, that is, direct assistance to individuals should be preferred to bailing out firms or sectors of the economy. This may be a difficult policy recommendation to follow in the real world, despite its pedigree among economists.

## APPPENDIX 3.A: TABLES

Appendix table 3.A-1:

Argentinean employment for 22 industrial sectors for the years 1994, 1996 and 1998.

| | Employment | | | Imports as share of value added | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sector** | **1994** | **1996** | **1998** | **1993** | **1994** | **1996** | **1997** | **1998** |
| Food | 100 | 91.1 | 88 | 2.9 | 2.4 | 3.0 | 3.4 | 3.7 |
| Tobacco | 89.9 | 72.5 | 67.2 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 |
| Textile | 90 | 83 | 81.2 | 13.6 | 11.5 | 15.1 | 16.9 | 18.7 |
| Apparel | 92.1 | 77.9 | 78.9 | 11.9 | 7.7 | 9.9 | 11.0 | 12.1 |
| Leather | 97 | 85.2 | 85.2 | 7.7 | 6.7 | 9.1 | 10.3 | 11.5 |
| Wood | 98.8 | 86.9 | 92.9 | 11.8 | 12.5 | 16.7 | 18.7 | 20.8 |
| Paper | 100.5 | 93.6 | 83.3 | 20.9 | 20.7 | 27.0 | 30.2 | 33.3 |
| Printing | 100.3 | 94.1 | 91.2 | 4.4 | 5.2 | 7.4 | 8.5 | 9.6 |
| Petroleum | 73.3 | 69.1 | 66.8 | 2.9 | 3.2 | 4.1 | 4.5 | 4.9 |
| Chemical | 97.4 | 94.6 | 93.4 | 25.3 | 29.9 | 36.4 | 39.6 | 42.8 |
| Rubber | 96 | 97.9 | 102.5 | 18.1 | 17.9 | 24.0 | 27.1 | 30.1 |
| Mineral | 95 | 84 | 83.9 | 7.3 | 7.3 | 9.2 | 10.2 | 11.2 |
| Basic metal | 96.3 | 93 | 93 | 15 | 15.4 | 19.6 | 21.6 | 23.7 |
| Metal products | 97 | 86.4 | 98.8 | 11.5 | 14.3 | 19.7 | 22.4 | 25.1 |
| Machinery | 95.9 | 89.2 | 90 | 60.5 | 55.5 | 72.6 | 81.1 | 89.7 |
| Computer | 97 | 92 | 76.3 | 308.5 | 259.1 | 324.9 | 357.8 | 390.7 |
| Engines elect | 94.9 | 82.2 | 84.6 | 44.2 | 43.4 | 56.9 | 63.7 | 70.5 |
| Audio | 89.1 | 64.8 | 66.2 | 83.7 | 71.8 | 89.8 | 98.8 | 107.7 |
| Instruments | 94.6 | 89 | 85.3 | 100.4 | 100.6 | 129.9 | 144.5 | 159.2 |
| Motor veh. | 103.5 | 85.8 | 91 | 28 | 27.4 | 36.8 | 41.6 | 46.3 |
| Transport | 87 | 73 | 83.3 | 99.4 | 97.8 | 140.5 | 161.8 | 183.2 |
| Furniture | 93.9 | 80.4 | 87 | 29 | 25.7 | 32.6 | 36.1 | 39.5 |

Source: Galiani and Sanguinetti (2003).

# APPPENDIX 3.A: TABLES

Appendix table 3.A-2: Methods matrix

| Model | Factor-content substitution | Partial equilibrium | Input-output LP | General equilibrium | Structural CGEs | Agent based | Econometric models | Social assessment | Qualitative approach |
|---|---|---|---|---|---|---|---|---|---|
| Description | Distinguishes L-K intensive processes | Single market equilibrium | Multi-market Supply-side | Multi-market Supply-Demand | Multi-market with structural constraints | Multi-market with structural constraints | Ex-post testing of existing theory | Survey methods with qualitative assessment | Case study anecdotal |
| Strengths | Consistency with first principles | Can be adapted to country-specific constraints | Compute direct plus indirect labour equirements | Full integration of demand side data | Realistic: calibrated to time series | Heterogenous agents bounded rationality | Inferential hypothesis testing possible | Additional detail captured | Highly detailed |
| Weaknesses | Ignores stylized facts | Good for small sectors only | Linear; good for small changes only; aggregated can only see sectors >1% of GDP | Comparative static exercises Dynamic results often unrealistic. For sectors >1% of GDP | Rigid | Emergent properties difficult to discern | Ambiguous causality due to OVB and simultaneity | Difficult to generalize | Highly difficult to generalize |
| Internal validity | High | High | Medium | High | Medium | Very high | Variable | Variable | Variable |
| External validity | Low | High | Medium | Low-medium | Medium-high | Low-medium | Variable | Medium-high | Low |
| Data requirement | Low | Low | Medium | Very high | Very high | High | Medium-high | Very high | Medium-high |
| | Low | Medium | Medium | High | High | High | Medium | High | |

## APPPENDIX 3.A: TABLES

Appendix table 3.A-2: Methods matrix *(Continued)*

| Model | Factor-content substitution | Partial equilibrium | Input-output LP | General equilibrium | Structural CGEs | Agent based | Econometric models | Social assessment | Qualitative approach |
|---|---|---|---|---|---|---|---|---|---|
| Complexity | Staff requirement: 1 person | Staff requirement: 1-2 persons | Small team for gathering date; requirements low | Specialized professional staff needed; requires SAM, data-processing requirements hig | Specialized professional staff needed; requires SAM, data-processing requirements hig | Professional programmers required; multiple data sources | Small staff needed; requires professional analyst | Large staff of interviewers required; data-processing requirement higt | Small staff interviewers or individual |
| Programming | Excel, MatLab, Mathematica | Excel, MatLab Mathematica | Excel, Java, C or LINDO | GAMS, GTAP, Proprietary (MIRAGE) | GAMS, GTAP, DADS | Excel, Java, C or NetLogo | Stata, SPSS SAS | Excel | None |
| Policy relevance | Medium | Medium | High | Medium | Medium-high | Medium | High | Low-medium | |
| Labour market | Low | High | Medium/High | High | Rigid labour markets; fixed wages | Very high | High | High | |
| Main conclusions | HOS, Stolper-Samuelson | Biased against trade; overstates employment loss | Trade less damaging to employment | Trade effects small | Trade effects larger | Trade effects variable | Trade effects variable | Trade effects variable | |

## APPPENDIX 3.B

### Model specification used for simple CGE simulation

The equations of the model used for the simulations in section 3.4.2 are first the consumption function (an LES) with $Y_j$ as household income for the $j$th income category

$$C_{ij} = C_{ij}(Y_{dj})$$

where $Y_{dj}$ is disposable income. The material balance is

$$X_i = \sum_{j=1} A_{ij} + C_{ij} + I_i + G_i + E_i$$

where government expenditure, $G_i$, and net exports, $E_i$, are taken from the base SAM and grow at an exogenous rate in the non-agricultural sector. For the agricultural sector, exports are determined as a residual from this same equation with

$$X_1 = Q(K_1 L_1)$$

where the production function is Cobb-Douglas. Investment, $I_i$, by destination is given by

$$I_i / K_i = I + \alpha_\mu u_2 + \alpha_r r$$

where $u_2 = X / Q_2$ and $r$ is the rate of profit. Household income is given by the value added in production plus domestic and foreign transfers.

## REFERENCES


Abraham, F.; Brock, E. 2003. "Sectoral employment effects of trade and productivity in Europe", in *Applied Economics*, Vol. 35, No. 2, pp. 223-235, Jan.

Ackerman, F.; Gallagher, K.P. 2002. "The shrinking gains from global trade liberalization in computable general equilibrium models: A critical assessment", in *International Journal of Political Economy*, Vol. 37, No. 1, pp. 50-77, Apr.

Anderson, K.; Dimaranan, B.; Francois, J.; Hertel, T.; Hoeckman, B.; Martin, W. 2003. "The cost of rich (and poor) country protection to developing countries", in *Journal of African Economies*, Vol. 10, No. 3, pp. 227-257.

Anderson, K.; Martin, W.; van der Mensbrugghe, D. 2005. "Agricultural trade reform and the Doha development agenda", in *Market and welfare implications of the Doha reform scenarios* (World Bank).

ATPC. 2005. *The economic and welfare impacts of the EU-Africa economic partnership agreements*, Briefing 6 (African Trade Policy Centre, Economic Commission for Africa).

Baldwin, R.E. 1994. "The effect of trade and foreign direct investment on employment and relative wages", in *OECD Economic Studies*, Vol. 23, pp. 7-54.

Bchir, H.; Decreux, Y.; Guérin, J-L.; Jean, S. 2002. "MIRAGE, a computable general equilibrium model for trade policy analysis", *CEPII Working Paper* No. 2002-17.

Beaudry, P.; Collard, F. 2002. "Why has the employment-productivity tradeoff among industrialized countries been so strong", *NBER Technical Report* No. W8754.

Behrman, J.R. 1983. "Country and sectoral variations in manufacturing elasticities of substitution between capital and labor", in O.E. Krueger (ed.): *Trade and employment in developing countries, Vol. 2: Factor supply and substitution* (NBER).

Bernard, A.B.; Jensen, J.B. 1995. "Exporters, jobs, and wages in U.S. manufacturing: 1976-1987", in *Brookings Papers on Economic Activity*, Vol. 1995.

Brown, D.K.; Deardorff, A.V.; Stern, R.M. 1995. "Expanding NAFTA: Economic effects of accession of Chile and other major South American nations", in *The North American Journal of Economics and Finance*, Vol. 6, No. 2, pp. 149-170.

Brown, D.K.; Deardorff, A.V.; Stern, R.M. 2003. "Multilateral, regional and bilateral trade-policy options for the United States and Japan", in *The World Economy*, Vol. 26, No. 6, pp. 803-828, June.

Chabal, P.; Daloz, J-P. 2006. *Culture troubles: Politics and the interpretation of meaning* (University of Chicago Press).

Chamley, C.P. 2004. *Rational herds: Economic models of social learning* (Cambridge University Press).

Chang, L.T. 2008. *Factory girls: From village to city in a changing China* (Spiegel & Grau).

Clerides, S.K.; Lach, S.; Tybout, J.R. 1998. "Is 'learning by exporting' important? Micro-dynamic evidence from Colombia, Mexico and Morocco", in *Quarterly Journal of Economics*, Vol. 113, No. 3, pp. 903-960, Aug.

Cline, W. 2004. *Trade policy and global poverty* (Institute for International Economics).

Cortes, O.; Jean, S. 1999. "Does competition from emerging countries threaten unskilled labour in Europe? An applied computable general equilibrium approach", in P. Brenton; L. Pelkmann (eds): *Global Trade and European Workers* (Macmillan), pp. 96-122.

Currie, J.; Harrison, A.E. 1997. "Sharing the costs: The impact of trade reform on capital and labor in Morocco", in *Journal of Labor Economics*, Vol. 15, No. 3, pp. S44-S71, July.

Davidson, C.; Matusz, S.J. 2004. *International trade and labor markets: Theory, evidence, and policy implications* (Upjohn Institute for Employment Research).

Davidson, C.; Matusz, S.J. 2010. *International trade with equilibrium unemployment* (Princeton University Press).

D'Costa, A.P. 2004. "Flexible practices for mass production goals: Economic governance in the Indian automobile industry", in *Industrial and Corporate Change*, Vol. 13, No. 2, pp. 335-367, Apr.

Deardorff, A.V.; Stern, R.M. 1986. *The Michigan model of world production and trade: Theory and applications* (MIT Press).

Deaton, A. 1995. Data and econometric tools for development analysis", in H. Chenery; T.N. Srinivasan (eds): *Handbook of development economics (Vol. 3A)*, Ch. 33 (Elsevier).

Decaluwe, B.; Martens A. 1988. "CGE modeling and developing economies: A concise empirical survey of 73 applications to 26 countries", in *Journal of Policy Modeling*, Vol. 10, No. 4, pp. 529-568.

Dervis, K.; de Melo, J.D.; Robinson, S. 1982. *General equilibrium models for development planning* (Cambridge University Press).

Dew-Becker, I.L.; Gordon, R.J. 2005. Where did the productivity growth go? Inflation dynamics and the distribution of income", *NBER Working Paper* No. 11842.

Dewatripont, M.; Michel, G. 1987. "On closure rules: Homogeneity and dynamics in applied general equilibrium models", in *Journal of Development Economics*, Vol. 26, No. 1, pp. 65-76.

Dorfman, R.; Samuelson, P.A.; Solow, R.M. 1958. *Linear programming and economic analysis* (McGraw-Hill).

Duflo, E.; Glennerster, R.; Kremer, M. 2007. "Using randomization in development economics research: A toolkit", *CEPR Discussion Paper* No. 6059.

Edwards, S. 2002. "Openness, trade liberalization, and growth in developing countries", in International Library of Critical Writings in Economics, Vol. 140, No. 3, pp. 78-116.

Edwards, S.; Edwards, A.C. 1996. "Trade liberalization and unemployment: Policy issues and evidence from Chile", in *Cuadernos de Economia*, Vol. 33, No. 99, pp. 227-250.

Epstein, J.M. 2006. *Generative social science: Studies in agent-based computational model* (Princeton University Press).

Feenstra, R.C.; Hanson, G.H. 1997. "Foreign direct investment and relative wages: Evidence from Mexico's maquiladoras", in *Journal of International Economics*, Vol. 42, No. 3-4, pp. 371-393, May.

Francois, J.; van Meijl, H.; van Tongeren, F. 2003. "Trade liberalization and developing countries under the Doha round", *CEPR Discussion Paper* No. 4032.

Freeman, R.B.; Katz, L.F. 1991. "Industrial wage and employment determination in an open economy", in J.M. Abowd; R. Freeman (eds): *Immigration, trade and the labor market* (University of Chicago Press).

Galiani, S.; Sanguinetti, P. 2003. "The impact of trade liberalization on wage inequality: Evidence from Argentina", *Working Paper* No. 011 (Department of Economics, Universidad Torcuato Di Tella).

Geertz, C. 2000. *Thick description: The interpretation of cultures: Selected essays* (Basic Books).

Gibson, B. 2003. "An essay on late structuralism", in A. Dutt; J. Ros (eds): *Development economics and structuralist macroeconomics: Essays in honor of Lance Taylor*, Ch. 2, pp. 52-76 (Edward Elgar).

Gibson, B. 2005. "The transition to a globalized economy: Poverty, human capital and the informal sector in a structuralist CGE model", in *Journal of Development Economics*, Vol. 78, No. 1, pp. 60-94, Oct.

Gibson, B. 2008a. "Economic planning in developing economies", in A. Dutt; J. Ros (eds): *International Handbook of Development Economics (Vol. 2)*, Ch. 57, pp. 341-355 (Edward Elgar).

Gibson, B. 2008b. "Data Problems and Empirical Modeling in Developing Economies", in A. Dutt,; J. Ros (eds): *International Handbook of Development Economics*, pp. 83-96 (Edward Elgar).

Gibson, B. 2009. *Trade and employment* (University of Vermont). Available at: http://www.uvm.edu/~wgibson/ (accessed 9 June 2011).

Gibson, B.; Kelley, B. 1994. "A classical theory of the informal sector", in *The Manchester School*, Vol. 62, No. 1, pp. 81-96, Mar.

Gibson, B.; van Seventer, D.E. 2000. "A tale of two models: Comparing structuralist and neoclassical computable general equilibrium models for South Africa", in *International Review of Applied Economics*, Vol. 14, No. 2, pp. 149-171, May.

Ginsburgh, V.; Keyzer, M. 1997. *The structure of applied general equilibrium models* (MIT Press).

Greenaway, D., Hine, R.C.; Wright, P. 1999. "An empirical assessment of the impact of trade on employment in the United Kingdom", in *European Journal of Political Economy*, Vol. 15, No. 3, pp. 485-500, Sep.

Greenspan, A. 2007. *The age of turbulence* (Penguin Press).

Gruben, W.; McLeod, D. 2002. *Choosing among rival poverty rates*. Available at: http://dallasfed.org/research/claepapers/2003/lawp0301.pdf (accessed 9 June 2011).

Guichard, S.; Laffargue, J-P. 2000. "The wage curve: The lessons of an estimation over a panel of countries", *CEPII Working Paper* No. 2000-21.

Hammouda, H.B.; Osakwe, P.N. 2006. "Global trade models and economic policy analyses: Relevance, risks, and repercussions for Africa", *ATPC Work in Progress* No. 47.

Hantrais, L. 1995. "Comparative research methods", *Social Research Update* No. 13 (University of Surrey).

Harrison, A.E.; Hanson, G.H. 1999. "Who gains from trade reform? Some remaining puzzles", *NBER Working Paper* No. 6915.

Hertel, T.W. 1997. *Global trade analysis: Modeling and applications* (Cambridge University Press).

Hertel, T.W.; Keeney, R. 2005. "What's at stake? The relative importance of import barriers, export subsidies and domestic support", chapter in *Agricultural trade reform and the Doha development agenda* (World Bank).

Hertel, T.W.; Winters, L.A. 2006. *Poverty and the WTO: Impacts of the Doha development agenda* (Palgrave Macmillan and World Bank).

Hoekman, B.; Winters, L.A. 2005. *Trade and employment: Stylized facts and research findings* (World Bank).

Hufbauer, G.C.; Elliott, K.A.1994. *Measuring the costs of protection in the United States* (Peterson Institute for International Economics).

Jansen, M.; Lee, E. 2007. *Trade and employment: Challenges for policy research* (ILO).

Kennedy, P.E. 1998. *A guide to econometrics* (MIT Press).

Keynes, J.M. 1936. *The general theory of employment, interest and money* (Palgrave Macmillan).

Krueger, A.O. 1983. *Trade and employment in developing countries, Volume 3: Synthesis and conclusions* (University of Chicago Press).

Kucera, D.; Roncolato, L.; Von Uexkull, E. 2010. Trade contraction in the global crisis: Employment and inequality effects in India and South Africa, in *ILO Employment Sector Working Paper* No. 54

Kurzweil, M. 2002. "The need for a 'complete' labor market in CGE modeling", in *Landbauforschung Völkenrode*, Vol. 52, No. 2, pp. 107-119.

Lopez-Calva, L.F.; Lustig, N.C. 2010. *Declining inequality in Latin America: A decade of progress?* (Brookings Institution Press and UNDP).

Lydall, H.F. 1975. *Trade and employment: A study of the effects of trade expansion on employment in developing and developed countries* (ILO).

Matusz, S.J.; Tarr, D. 1999. "Adjusting to trade policy reform", *World Bank Policy Research Paper* No. 2142.

McCloskey, D.N. 1988. "Thick and thin: Methodologies in the history of economic thought", chapter in *The Popperian legacy in economics* (Cambridge University Press).

van der Mensbrugghe, D. 2007. *Modeling the impact of trade liberalization: A structuralist perspective?* (World Bank).

OECD. 2003. *The Doha development agenda: Welfare gains from further multilateral trade liberalization with respect to tariffs*.

Piermartini, R.; Teh, R. 2005. "Demystifying modelling methods for trade policy", *WTO Discussion Paper* No. 10.

Polaski, S. 2006. *Winners and losers: Impact of the Doha round on developing countries* (Carnegie Endowment for International Peace).

Revenga, A.L. 1992. "Exporting jobs? The impact of import competition on employment and wages in U.S. manufacturing", in *Quarterly Journal of Economics*, Vol. 107, No. 1, pp. 255-284, Feb.

Rodriguez, F.; Rodrik, D. 1999. "Trade policy and economic growth: A sceptic's guide to the cross-national evidence", *CEPR Discussion Paper* No. 2143.

Rodrik, D. 1997. *Has Globalization Gone too Far?* (Peterson Institute for International Economics).

Romer, P.M. 1986. "Increasing returns and long run growth", in *Journal of Political Economy*, Vol. 94, No. 5, pp. 1002-1037, Oct.

Romer, P.M. 1990. "Endogenous technological change", in *Journal of Political Economy*, Vol. 98, No. 5, pp. S71–S101, Oct.

Ryle, G. 1971. *The thinking of thoughts: What is 'le Penseur' thinking?* (Hutchinson).

Sachs, J.D.; Warner, A.M. 1997. "Fundamental sources of long-run growth", in *American Economic Review*, Vol. 87, No. 2, pp. 184-188, May.

Sadoulet, E.; de Janvry, A. 1992. "Agricultural trade liberalization and low income countries: A general equilibrium-multimarket approach", in *American Journal of Agricultural Economics*, Vol. 74, No. 2, pp. 268-280, May.

Sadoulet, E.; de Janvry, A. 1995. *Quantitative Development Policy* (Johns Hopkins University Press).

Samuelson, P.A. 2004. "Where Ricardo and Mill rebut and confirm arguments of mainstream economists supporting globalization", in *Journal of Economic Perspectives*, Vol. 18, No. 3, pp. 135-146.

Shapiro, C.; Stiglitz, J.E. 1984. "Equilibrium unemployment as a worker discipline device", in *American Economic Review*, Vol. 74, No. 3, pp. 433-444.

Slaughter, M.J. 2001. “International trade and labor-demand elasticities”, in *Journal of International Economics*, Vol. 54, No. 1, pp. 27-56.

Solow, R.M. 1956. “A contribution to the theory of economic growth”, in *The Quarterly Journal of Economics*, Vol. 70, No. 1, pp. 65-94, Feb.

Srinivasan, T.N. 1994. “Data base for development analysis: An overview”, in *Journal of Development Economics*, Vol. 44, No. 1, pp. 3-27, June.

Taylor, L. 1979. “Macro models for developing countries”, *Economic Handbook Series* (McGraw-Hill).

Taylor, L. 1990. *Socially relevant policy analysis: Structuralist computable general equilibrium models for the developing world* (MIT Press).

Taylor, L.; von Arnim, R. 2006. *Modelling the impact of trade liberalisation: A critique of computable general equilibrium models* (Oxfam International Research Report).

Thierfelder, K.; Shiells, C. 1997. “Trade and labor market behavior”, chapter in J.F. Francois; K.A. Reinert (eds): *Applied methods for trade policy analysis: A handbook* (Cambridge University Press).

Trochim, W.M. 2006. *Qualitative research methods* (Web Center for Social Research Methods).

Weinberg, D. 2002. *Qualitative research methods* (Blackwell Publishers).

Winchester, N. 2008a. “Trade and rising wage inequality: What can we learn from a decade of computable equilibrium analysis?”, chapter in *Globalisation and labour market adjustment* (Palgrave MacMillan).

Winchester, N. 2008b. “Searching for the smoking gun: Did trade hurt unskilled workers?”, in *Economic Record*, Vol. 84, No. 256, pp. 141-156, June.

Wood, A. 1997. “Openness and wage inequality in developing countries: The Latin American challenge to East Asian conventional wisdom”, in *World Bank Economic Review*, Vol. 11, No. 1, pp. 33-58, Jan.

World Bank. 2009. *World Development Indicators 2009* (Washington, DC).