Guide to Growth, Employment and Productivity Analysis

I. BACKGROUND

1.1. Why this guide?

It is widely acknowledged that economic growth is a main driving force behind poverty reduction over the long run, and that labor markets provide the main transmission channel for this process, because the poor depend on labor income. Understanding how and to what extent economic growth is shared through the labor market is therefore a necessity to understand the growth-poverty links.

Because of these links, job creation, and increasing the job intensity of growth, tends to take priority on policy makers agenda. Indeed, "job-less growth" is often seen as a major concern and has been blamed for slow progress on poverty reduction in many countries. However, there are two problems with focusing only on job creation and growth. First, many developing countries face rapidly growing work forces which may parallel or outpace high job creation. High job creation can thus be consistent with worsening unemployment. Second and more importantly, developing country labor markets are not lacking in jobs per se, but in jobs which offer higher earnings.[1] Applying this logic to the dynamic analysis, it follows that mere job creation will not be sufficient to improve the lot of the poorest workers and their families. Poverty improvements require instead (i) an increase in the share of jobs with higher earnings and destruction of low earning jobs (ii) that the poor can access jobs which offer higher earnings.

Thus, the analysis must focus on capturing changing job quality rather than net job creation or the capacity of growth to create jobs (employment elasticities). Labor productivity growth is an important alternative indicator of the potential for sustained earnings increases. In a second step, the analysis must also link growth and labor markets to poverty and address how and if the fruits of growth are distributed to the poor. The present guide focuses on the first step, namely links between growth and labor markets while an accompanying guide, Guide to Employment, Low Pay and Poverty Dynamics, analyzes the specific impact on the poor's earnings and employment. The methodology proposed below helps analysts answer four principal questions.

- Is growth in per capita value added due to demographic changes or changes in the level of growth? For example, if growth per capita has increased, is this because population growth has slowed down or because economic growth has increased? The demographic factor may be particularly critical in low income countries where, in the past, rapid

[1] The issue of quality vs. quantity of jobs is discussed in more detail in two accompanying guides, Introduction to the Employment Lab Guides and Performing Labor Market Diagnostics in developing countries.

population growth and high dependency rates have eaten away much of aggregate output gains.

- Is growth correlated with increases in the quantity of jobs or in the quality of jobs? Put differently, is growth reflected in job creation or increased productivity of existing jobs? The answer is important to understand the quantity and quality aspects of job creation.

- Are the changes in output per worker due to changes within sectors, or due to shifts of workers from low productivity to higher productivity sectors, i.e. changing employment structure? Is productivity changing within sectors, or are higher productivity sectors simply creating more jobs than lower productivity sectors? Should worker sector transitions or productivity improvements be encouraged?

- What are the sources of any increases in output per worker within sectors? Are they related to increases in Total Factor Productivity (TFP) due to innovation (better use of existing resources)? Or are they due to increases in the ratio of capital to labor in firms (adding more resources)? This is important because over the long run, TFP is a critical factor for economic growth and relying only on resource accumulation is not likely to be a sustainable approach for productivity increases.

Of course, the above analysis – like most country economic work – should be preceded by a succinct presentation of the overall economic framework, including major trends in value added, main sources of growth including the role of external versus domestic demand, and major economic reforms undertaken in recent years.

1.2. Why do we care about the labor market contributions to per capita income growth?

The purpose of the decompositions outlined below is to identify the different impact of various components on per capita income, which in turn will indicate the potential for poverty reduction through increased labor earnings. The guide provides the basis for the analytical developments around labor market and poverty links, but leaves the explicit discussion of earnings distribution and worker heterogeneity these to the Guide to Employment, Low Pay and Poverty Dynamics. The different steps presented below are thus focused on linking changes in *average* per capita income to labor market factors – including both the quality and quantity of jobs as measured by labor productivity and employment rates – and separate these out from factors unrelated to labor market changes over the short term, namely the change in the share of dependents which affects how many people have to share labor income from one person, which is not immediately affected by policy aimed at increasing quality and quantity of jobs.

Labor market dynamics are also driven by growth patterns at the disaggregate level, such as productivity developments within different sectors (agriculture, industry, etc.) and the move of workers between sectors. While it is clear that increasing labor productivity will be important for sustained labor earnings as well as for per capita income growth, the way in which it increases will also matter for how this affects the poor who are generally limited to a few sectors and occupations.

For example, country work suggests that the labor income of the poor have generally benefited from specific patterns of increases in labor productivity: increases of labor productivity in low productivity sectors, and shifts of workers from low productivity to higher productivity sectors, even when the higher productivity sectors have seen productivity drops (see World Bank 2008a, 2008b, 2008c, and Cichello and Sienaert, 2009). A drop in productivity in the non-agricultural sectors may imply more labor intensive production, meaning that unskilled and low paid workers have accessed higher productivity jobs – raising their own productivity - although average productivity is dropping.

All of this matters, because the information can improve the targeting of economic and social policy – both labor market policy, industrial policy, and policies for skills development. As will be seen in the case of Nicaragua, higher job creation in low productivity sectors like agriculture results in lower overall productivity and is very likely to imply falling earnings for those additional workers. Thus, encouraging job creation in higher (though not necessarily high) productivity sectors, and productivity growth in low productivity sectors, is likely to be the most efficient way of increasing productivity overall.

1.3. Data requirements, software and overall approach

To address the questions outlined above, data on value added by sector (from national accounts), employment by sector (from labor force or household surveys), and population by age (census) is needed, for two periods. Since the focus is on real growth, data on output should be in constant currency.

Population data may be inconsistent with data from household surveys. It is often the case that the expansion weights used in household surveys rely on old population census, while population projections may be updated according to new census. In these cases it is important to re-weight or re-scale the household survey data so that it is consistent with the latest population projections.

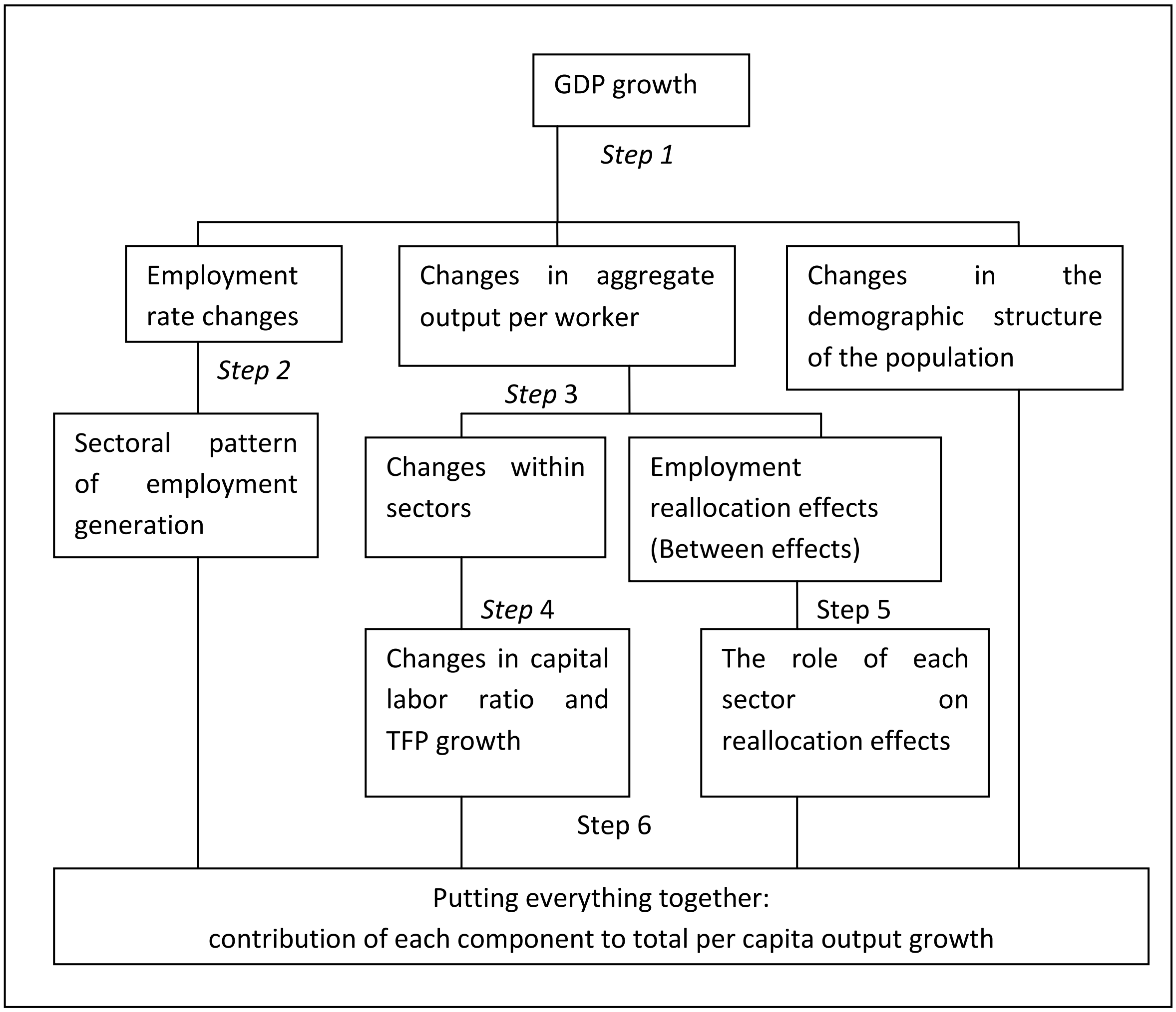
In addition, in order to provide the specific decomposition of the role of TFP vs. capital-labor ratios in driving labor productivity changes, data on capital stocks are needed. These are often difficult to come by, however. In all, the analyst will have to choose how far to go, depending on data availability and policy relevance.

The **Job Generation and Growth (JoGGs) decomposition tool**[2] is an Excel-based macro-spreadsheet which enables the decomposition of GDP growth using several consecutive steps

[2] The JoGG-files can be downlowded at http://www.worldbank.org/employmentlab

along these lines (Box 1). Although there are several techniques for decomposing changes in GDP, the methodology presented here uses Shapely decompositions. This methodology has the advantage of being a relatively simple additive method, meaning that the total change in per capita GDP can be described in terms of the sum of the growth attributed to each of its components, of presenting a unified way of looking at all the components (employment, capital, TFP and sectoral relocation of labor) and of being very modest in terms of data requirements.

Box 1. Stepwise decomposition approach (JoGG)



Each step goes further in answering the above questions, allowing analysts to tailor the depth of the investigation according to data availability and the most pertinent policy questions.

Step 1 creates a profile of growth in per capita GDP by decomposing it into changes in the employment rate, productivity and demographics.

Step 2 decomposes changes in the employment rate into changes in employment by sectors.

Step 3 decomposes changes in productivity into changes into variations in output per worker within sectors and movement of workers between sectors.

Step 4 considers the role of capital and TFP as sources of changes in output per worker at the aggregate level.

Step 5 helps to further understand the role played by each sector in the overall change in output per worker.

The **sixth and final step** puts all the elements together, to see how each factor affected total per capita growth. While steps 1, 2, and 3 can be performed independently, steps 4 and 5 require step 3 as a preliminary step.

The remainder of this guide describes the method employed for each step, using data for Nicaragua. All tables and graphs are the output of the JoGGs decomposition tool. Definitions for all the terms used here are provided in the Introduction to the Employment Lab Guides.

II. DECOMPOSING GROWTH PROCESS IN NICARAGUA – A PRACTICAL APPLICATION OF JOGGS.

2.1. Step 1: Understanding the aggregate employment and productivity profile of growth

To understand how growth has translated into increases in productivity and employment at the aggregate level and by sectors (or regions), note that per capita GDP, *Y/N=y* can be expressed as:

$$\frac{Y}{N} = \frac{Y}{E}\frac{E}{A}\frac{A}{N}$$

Or:

$$y = \omega * e * a$$

where Y_i is total Value Added E is total employment, A is the total population of working age and N is total population. In this way Y/E=ω is total output per worker, E/A is the share of working age population (i.e. the labor force) employed and A/N is the labor force as a fraction of total population. We will refer to *e*, as the employment rate[3].

Thus per capita GDP growth can be decomposed into growth associated with changes in output per worker, growth associated with changes in employment rates and growth associated with changes in the relative weight the working age population. Details of the formulas for the Shapley decomposition can be found in the Annex. Since the decomposition is additive, the total change in per capita GDP will be the sum of the growth attributed to each of its components, *ω*, *e*, and *a*. Thus if we let $\bar{\varpi}$, $\bar{e}$ and $\bar{a}$ denote the fraction of growth linked to each component then the growth can be expressed as:

$$\Delta y = \bar{\varpi} * \Delta y + \bar{e} * \Delta y + \bar{a} * \Delta y$$

In this way the percentage growth between two periods can be expressed as follows:

$$\frac{\Delta y}{y} = \bar{\varpi}\frac{\Delta y}{y} + \bar{e}\frac{\Delta y}{y} + \bar{a}\frac{\Delta y}{y}$$

$\bar{\varpi} * \Delta y$ will reflect the amount of growth that would be consistent with a scenario in which the employment rate *e* and the share of population of working age *a* stayed constant. In the same way $\bar{e} * \Delta y$ will be the amount of growth consistent with a scenario in which output per worker ω, and the share of population of working age *a*, had remained 'unchanged'. The amount of per capita growth linked to demographic changes will be $\bar{a} * \Delta y$.

Table 1 presents the main data used for the aggregate decomposition: Output, employment and populations, as well as employment shares, output per worker, and share of population of working age. Nicaragua registered a growth rate of 7.1% in per capita value added between 2001 and 2005. Growth was accompanied by a decrease in output per workers (-1.8), and increases in the population of working age (12.5%) and in employment rates (3.6%).

[3] Strictly speaking the employment rate is measured as the share of population of working age that 'participates' in the labor market, which is employed. Where participation is defined as all those looking for a job or already employed. As we will argue below for low and middle income countries this distinction of who is participating and who is not is rather blurred. Nevertheless, the methodology can be easily extended to include the effects of higher participation rates.

Table 1: Employment, Output, Productivity and Population: Nicaragua 2001-2005

	2001	2005	% change
Y. GDP (value added) (in constant millions)	25,765	29,495	14.5
N. Total population (thousands)	4,812	5,142	6.9
A. Total population of working age (thousands)	2,699	3,035	12.5
E. Total number of employed (thousands)	1,635	1,906	16.5
GDP (value added) per capita (Y/N)	5,354	5,736	7.1
Output per worker (Y/E)	15,757	15,477	-1.8
Employment rate (E/A)	61	63	3.6
Share of population of working age (A/N)	56	59	2.9

Source: Table obtained using JoGGs Decomposition tool with value added data from Nicaragua's Central Bank, population data from the Statistical Office (INEC) and employment data from Nicaragua's Household Surveys (Encuesta de Medición del Nivel de Vida EMNV).

Using this information, results from the decomposition of aggregate per capita growth are presented in Table 2. In Nicaragua, a major share of the changes in per capita (74 percent) was associated with changes in the structure of the population. In other words, had productivity levels and employment rates been the same in 2001 as in 2005, the fact that the share of dependent children and elderly relative to working age population dropped would have generated a growth equivalent to 74 percent of the actual observed growth. Changes in the employment rate were also important, accounting for some 51 percent of observed growth. Had productivity levels and demographics remained constant, the higher rate of employment would have generated a growth of 3.6 percent. However, productivity did not remain constant, but acted in the opposite direction. Had productivity not changed, observed growth would have been 9 percent, but decreases in productivity meant that growth was 1.6 percentage points lower. Growth in Nicaragua was thus far from "job-less" but the quality of jobs is likely to have fallen, since labor productivity growth overall fell.

Table 2: Decomposition of Growth in per capita Value Added. Nicaragua 2001-2005

	In 1994 Córdobas	As percent of total	Contribution in percentage points
Total Growth in per capita GDP (value added)	382	100	7.1
Growth linked to output per worker	-99	-26	-1.8
Growth linked to changes in employment rate	197	52	3.7
Growth linked to changes in the share of population of working Age	284	74	5.3

Source: See Table 1

2.2. Step 2: Understanding the role of each sector in employment generation

To understand the way in which sectors contributed to employment generation and to total per capita growth, employment (rate) increase (Δe) can be decomposed by sectors:

$$\Delta e = \sum_{i=1}^{s} \Delta e_i$$

Where $\Delta e_i = \Delta \frac{E_i}{A}$ is just the change in employment in sector *i* as a share of total working age population. This gives a simple measure of which sector contributed more to changes in the employment rate.

Table 3 presents the data on employment by sector. All sectors except Mining and Utilities and Construction registered absolute growth in the number of employed, but only Agriculture, Manufacturing and Government Services increased their share of employment.

Table 3: Employment by Sectors of Economic Activity, Nicaragua 2001-2005

	--------Total employment-------			Employment/pop. of working age		
	2001	2005	% change	2001	2005	% change
Agriculture	518	625	20.6	19.2	20.6	7.3
Mining and Utilities	21	19	-12.4	0.8	0.6	-22.1
Manufacturing	196	277	41.1	7.3	9.1	25.4
Construction	86	86	-0.2	3.2	2.8	-11.2
Commerce	374	415	11.0	13.9	13.7	-1.3
Transport	64	71	9.7	2.4	2.3	-2.4
Government Services	49	60	23.4	1.8	2.0	9.7
Other	326	353	8.3	12.1	11.6	-3.7
Total	1,635	1,906	16.5	60.6	62.8	3.6

Source: See Table 1

Table 4 shows the results of the decomposition. The first column of the table is simply the difference between columns five and four in Table 3 above. The total employment rate increased in absolute terms by 2.20 percentage points, reflecting increases in employment and in the working age population. The first column of the table shows how the absolute change in the employment rate was distributed among the different sectors. Manufacturing and Agriculture are responsible for most of the increase. The decomposition highlights how, small percent changes in a sector or component, can have big impacts if its relative size is large – agriculture grew at a much slower rate than manufacturing or government services but increased most in absolute terms and had the second largest contribution to increases in the employment rate after manufacturing.

Table 4: Contribution of sectors to total change in employment rate

	Contribution to change in total employment rate (percent points)	Percent contribution of the sector to total employment rate growth
Agriculture	1.4	63.5
Mining and Utilities	-0.2	-8.0
Manufacturing	1.9	84.2
Construction	-0.4	-16.3
Commerce	-0.2	-8.2
Transport	0.0	-2.6
Government Services	0.2	8.0
Other	-0.4	-20.5
Total employment rate	**2.2**	**100.0**

Source: See Table 1

Combining step one (contribution of changes in total employment rate, total output per worker and dependency changes to total per capita output growth) with step 2 (disaggregated sector contribution to changes in total employment rate) logically gives the contribution of sectoral employment changes to growth in total per capita output. The contribution of each sector is simply

$$\left(\frac{\Delta e_i}{\Delta e}\right) * \bar{e} * \Delta y$$

Where the last term was shown in table 1 to amount to 52%*$382, i.e. $197 Córdobas. Of the $197 Córdobas registered in per capita output, manufacturing contributed with $166 Córdobas and agriculture with $125 Córdobas, assuming, as before, that output per worker and the share of working age population had been the same throughout. All other sectors saw diminishing shares of employment (even if absolute employment numbers increased). As a result, they contributed negatively to per capita output growth from the employment perspective (Table 5).

As before this can be interpreted as the per capita growth consistent with a counterfactual scenario, in which all else (productivity, demographics, and employment in the remaining sectors) had remained unchanged, and the only change had been the observed employment growth in sector.

Table 5: Contribution of employment structure changes to per capita value added
Nicaragua 2001-2005

	Contribution to change in per capita value added 1994 Córdobas	Percent of total change in per capita value added
Agriculture	125.2	32.8
Mining and Utilities	-15.7	-4.1
Manufacturing	166.1	43.5
Construction	-32.2	-8.4
Commerce	-16.2	-4.2
Transport	-5.2	-1.4
Government Services	15.7	4.1
Other	-40.5	-10.6
Total contribution	197.3	51.6

Source: See Table 1

2.3. Step 3: Decomposing changes in output per worker by sectors and between and within components

Changes in output per worker can be decomposed into sectoral employment shifts and changes in output per worker by sectors by noting that:

$$\frac{Y}{E}=\sum_{S}\frac{Y_i}{E_i}\frac{E_i}{E}$$

or equivalently:

$$\omega=\sum_{i=1}^{S}\omega_i s_i$$

where Y_i is value added of sector $i = 1…S$, E_i is employment in sector i, and E is total employment. This means that $\omega_i=\frac{Y_i}{E_i}$ will correspond to output per worker in sector i and $s_i=\frac{E_i}{E}$ is the share of sector i in total employment. This equation just states that changes in output per worker are the weighted sum of changes in output per worker in all sectors, where the weights are simply the employment share of each sector.

Again using the Shapley approach, changes in aggregate output per worker can thus be decomposed as:

$$\Delta\omega=\underbrace{\Delta\omega_1*\left(\frac{s_{1,t=0}+s_{1,t=1}}{2}\right)+\Delta\omega_2*\left(\frac{s_{2,t=0}+s_{2,t=1}}{2}\right)+\ldots+\Delta\omega_i*\left(\frac{s_{i,t=0}+s_{i,t=1}}{2}\right)}_{\Delta\omega_w}+\underbrace{\sum_{i=1}^{S}\Delta s_i*\left(\frac{\omega_{i,t=0}+\omega_{i,t=1}}{2}\right)}_{\Delta\omega_B}$$

$\Delta\omega_i * \left(\frac{s_{i,t=0} + s_{i,t=1}}{2}\right)$ is the change in output per worker which can be linked to changes in output per worker in sector *i.* Together they add up *to* $\Delta\omega_w$ which corresponds to total changes in output per worker net of relocation effects. This is the changes in output per worker within sectors, assuming no changes in employment shares over time.

$\Delta\omega_B$ is the change in output per worker due to intersectoral employment changes (i.e., between sectors). Employment movement from low-productivity sectors to high-productivity sectors increases total output per worker, and the flows from high-productivity sectors to low-productivity sectors should reduce aggregate output per worker. If this last term is negative, the reallocation of employment by sectors has been detrimental to overall productivity growth.

The fraction of aggregate output per worker growth that can be linked to growth in output per worker in sector *i* can then be denoted as

$$\overline{\omega}_i^{\omega} \equiv \Delta\omega_i * \left(\frac{s_{i,t=0} + s_{i,t=1}}{2}\right) / \Delta\omega$$

where the bar denotes contribution, and the supraindex denotes the fact that it is a contribution to aggregate output *per worker* growth ω, rather than to output *per capita* growth *y.*
Similarly,
$\overline{\omega}_w^{\omega} \equiv \Delta\omega_w / \Delta\omega$ is the contribution of within-sector productivity growth and
$\overline{\omega}_B^{\omega} \equiv \Delta\omega_B / \Delta\omega$ the contribution of intersectoral shifts

Table 6 shows the changes in total output per worker by each sector. As seen earlier, aggregate output per worker fell in the Nicaraguan economy, with a negative impact on growth. The sectors that experienced high inflows of workers (agriculture and manufacturing, to some extent government services) also saw significant drops in labor productivity.

Table 6: Changes in Output per Worker by Sectors. Nicaragua 2001-2005.

	2001	2005	Change	Change %
	----------1994 Cordobas -------			
Agriculture	10,973	9,988	-985	-9.0
Mining and Utilities	43,097	55,364	12,268	28.5
Manufacturing	25,032	21,097	-3,934	-15.7
Construction	14,701	15,393	692	4.7
Commerce	12,505	13,005	501	4.0
Transport	28,418	31,084	2,667	9.4
Government Services	37,223	32,239	-4,984	-13.4
Other	14,308	15,643	1,335	9.3
Total output per worker	**15,757**	**15,477**	-280	-1.8

Source: See Table 1

The decomposition of the total drop in within sector productivity changes, vs. intersectoral shifts, is displayed in Table 7. As a practical application of the formulas, the agricultural sector's share of employment in 2001 was 31.7% (518/1635 as per Table 2), and increased to 32.8 percent in 2005. Output per worker fell by 985 Cordobas in real terms. The "within sector" component for Agriculture was thus -985*[(31.7%+32.8%)/2] = 318 Cordobas.

As seen the drop in productivity in agriculture and manufacturing respectively were the major contributing factors to the drop in overall output per worker. The higher absorption of workers into manufacturing and government services which remain higher productivity activities had a positive effect, however.

Table 7: Decomposition of Output per Worker into Within Sector Changes in Output per Worker and Inter-sectoral Shifts. Nicaragua 2001-2005.

	Contribution to Change in 1994 Cordobas	**Contribution to Change in %)**
Within sector total	-347	
Agriculture	-318	114
Mining and Utilities	140	-50
Manufacturing	-521	186
Construction	34	-12
Commerce	112	-40
Transport	102	-36
Government Services	-153	55
Other	257	-92
Inter-sectoral shift	67	-24
Total change in output per worker	**-280**	100

Source: See Table 1

2.4. Step 4: Understanding the sources of changes in output per worker net of intersectoral shifts

Increases in output per worker can come from three different sources: (i) increases in the capital-labor ratio, (ii) increases in TFP, and (iii) relocation of jobs from bad jobs sectors (low productivity) to good jobs sectors (high productivity). The role of intersectoral shifts were analyzed above. To see the first two sources, note that under constant returns to scale, if output is a function of capital and labor and productivity,

$$Y_t = \Phi_t f(E_t, K_t)$$

where K_t is the capital stock and Φ_t a technological parameter also know as Total Factor Productivity (TFP), then output per worker can be expressed as

$$Y_t/E_t = \Phi_t f(1, K_t/E_t).$$

Note that the relationship may also capture cyclical behavior of output: firms operating in economic downturns may have underutilized capital, so when the demand rises again it will be reflected as rise in output per worker.

For example, if the production function is assumed to be Cobb-Douglas, then:

$$\frac{Y}{E} = \Phi\left(\frac{K}{E}\right)^{1-\alpha}$$

In competitive markets, 1-α is the share of payments to capital in total value added. It is usually available from national accounts data or, if there are enough time series, then it can be estimated by taking logs and estimating:

$$\ln\frac{Y}{E} = \ln\Phi + (1-\alpha)\ln\left(\frac{K}{E}\right) + t + \mu$$

where t is an (optional) time trend capturing technological change and μ is a residual. Using α, changes in output per worker can be decomposed, net of intersectoral shifts, into changes in total factor productivity and changes in the capital-labor ratio.

TFP is calculated as a residual. In the first period it will be:

$$\left(\frac{Y}{E}\right)_{t=0} / \left(\frac{K}{E}\right)_{t=0}^{(1-\alpha)} = TFP_{t=0}$$

In the second period, however, part of the change in output per worker may have been a consequence of relocation shifts. TFP in the second period thus has to be calculated as:

$$\left[\left(\frac{Y}{E}\right)_{t=1} - \Delta\omega_B\right] / \left(\frac{K}{E}\right)_{t=1}^{(1-\alpha)} = TFP_{t=1}$$

The term in square brackets is just output per worker in the second period (t=1) net of relocation effects.

Table 8 summarizes the data used for the TFP estimates and the subsequent decomposition of within sector output per worker. As seen TFP fell between the two years, while the capital labor ratio increased.

Table 8: Data used for Decomposition of Output per Worker, Capital Stocks, Capital Labor Ratio and Share of Capital in Total Income. Nicaragua 2001-2005

	2001	2005	% change
Share of Capital in Total Income (%)	29%	29%	0.0
In 1994 Córdobas			
Capital	77,183	95,278	23.4
Total output per worker	15,757	15,477	-1.8
Output per worker net of inter-sectoral shifts	15,757	15,410	-2.2
Capital Labor Ratio	47,202	49,996	5.9
TFP residual net of inter-sectoral shifts	660	635	-3.8

Source: See Table 1

With TFP estimates for both periods, it is possible to calculate whether changes in output per worker net of relocation effects, are the result of increases in capital per worker or in TFP, using the following formula:

$$\Delta\omega_w = \Delta k^{1-\alpha}\frac{(TFP_{t=0} + TFP_{t=1})}{2} + \Delta TFP\frac{(k^{1-\alpha}{}_{t=0} + k^{1-\alpha}{}_{t=1})}{2}$$

where *k* is simply the capital-labor ratio. The first term in the right-hand side is the contribution of changes in the capital-labor ratio to growth in output per worker net of relocation effects, and the second term is the contribution of changes in TFP.

Changes in within-sector output per worker can then be expressed as the sum of changes in TFP, changes in the capita-labor ratio, and intersectoral shifts:

$$\Delta\omega = \underbrace{\Delta k^{1-\alpha}\frac{(TFP_{t=0} + TFP_{t=1})}{2} + \Delta TFP\frac{(k^{1-\alpha}{}_{t=0} + k^{1-\alpha}{}_{t=1})}{2}}_{\Delta\omega^w} + \Delta\omega_B$$

Then,

$\bar{k}^{\omega} \equiv \Delta k^{1-\alpha} \dfrac{(TFP_{t=0} + TFP_{t=1})}{2} / \Delta\omega$ denotes the share of changes in within sector output per worker that can be linked to changes in the capital labor ratio, and

$\overline{TFP}^{\omega} \equiv \Delta TFP \dfrac{(k^{1-\alpha}{}_{t=0} + k^{1-\alpha}{}_{t=1})}{2} / \Delta\omega$ denotes the share that can be linked to TFP changes

The results of the decomposition of output per worker, including the intersectoral shifts, are presented in Table 9. The positive impact of increasing capital-labor ratios was more than counteracted by a strong negative contribution from TFP.

Table 9: Decomposition of within sector and total output per worker

Total within sector output per worker	**-347**
Capital Labor Ratio	264
Total Factor Productivity	-611
Inter-sectoral shift	**67**
Total productivity	**-280**

Source: See Table 1

2.5. Step 5: Understanding the role of each sector in intersectoral shifts

Changes in the employment structure, i.e. movements of labor force shares from low-productivity sectors to high-productivity sectors, is an important factor behind growth. Increases in the share of employment in sectors with above-average productivity will increase overall productivity and contribute positively to the intersectoral shift term which captures the relocation effects $\Delta\omega_B$. By the same token, increases in the share **of** employment in sectors with below-average productivity should reduce growth, while a reduction in the share **of** employment in sectors with below-average productivity should contribute positively to growth.

As shown above, the intersectoral term can be written as:

$$\Delta\omega_B = \sum_{i=1}^{S} \Delta s_i \left(\frac{\omega_{i,t=0} + \omega_{i,t=1}}{2} - \frac{\omega_{t=0} + \omega_{t=1}}{2} \right)$$

The term in parenthesis is the difference between a sector *i*'s productivity (averaged between the two periods), $\dfrac{\omega_{i,t=0} + \omega_{i,t=1}}{2}$, and the average productivity of all the economy (averaged over the two periods; note there is no sectoral subindex), $\dfrac{\omega_{t=0} + \omega_{t=1}}{2}$. The contribution of sector *i* to the intersectoral shifts term will be:

$$\Delta s_i \left(\frac{\omega_{i,t=0} + \omega_{i,t=1}}{2} - \frac{\omega_{t=0} + \omega_{t=1}}{2} \right)$$

Thus, if sector *i* has productivity below the average productivity, and reduces its share s_i, its contribution will be positive (because both terms above will be negative), that is outflows from the low productivity sector have contributed to increase output per worker. If on the other hand the low productivity sector sees an increase in its share, output per worker will fall and thus have a negative effect on the intersectoral shift term. The magnitude of the effect will be proportional to: i) the difference between the sector's productivity and average productivity and ii) the magnitude of the employment shift.

The share of intersectoral shift that is explained by sector *i* can be denoted as:

$$\overline{s}_i^{\omega_B} = \Delta s_i \left(\frac{\omega_{i,t=0} + \omega_{i,t=1}}{2} - \frac{\omega_{t=0} + \omega_{t=1}}{2} \right) / \Delta \omega_B$$

The decomposition results for the impact on productivity changes through the intersectoral shifts are presented in Table 10. The table shows that productivity was negatively impacted by inflows of workers into the low productivity agricultural sector, and from outflows of workers from the higher productivity mining and transports sectors. On the other hand, overall productivity benefited from the inflow of workers into manufacturing and government services, and from the outflow of low productivity sectors like construction, commerce, and "other".

Table 10: Understanding the Role of Inter-Sectoral Employment Shifts. Nicaragua 2001-2005

	Average Output per Worker[1] (1994 Cord.) ω_i	**Change in employment share (percentage points) Δs_i**	**Sectoral contribution to inter-sectoral shift component (1994 cord)**
Agriculture	10,481	1.1	-57
Mining and Utilities	49,230	-0.3	-109
Manufacturing	23,065	2.5	188
Construction	15,047	-0.8	4
Commerce	12,755	-1.1	31
Transport	29,751	-0.2	-32
Government Services	34,731	0.2	33
Other	14,975	-1.4	9
Aggregate	**15,617**		**67**

Source: See Table 1. Note: 1. Average of output per worker in 2001 and 2005.

Step 6: Putting it all together.

Table 11, finally, brings together all of the information in one synthesis table, disaggregating the different contributions to the absolute change in value added per capita of 382 Córdobas in real terms. For illustration, the value for agriculture in the first column that relate to within sector productivity is derived as follows: The total contribution to within-sector productivity changes of

-$318 Cordobas, as per Table 7, is multiplied by the ratio of the total contribution of output per workers to value added per capita (-$99, as per Table 5) over the total change in output per worker (-$279, as per Table 7), resulting in -$318*[-$99/-$280]=-113 Cordobas.

To sum up, then, the increase in value added per capita was largely associated with (i) a fall in dependency rates, as output per worker had to be shared among fewer people (ii) an increase in employment rate as more adult people were employed and (iii) the positive productivity effect of shifts of workers into the higher productivity manufacturing sector in particular. However, these effects were largely undone by a major fall in within-sector productivity. As shown in Table 9, the within-sector productivity decline was entirely due to the fall in total factor productivity, as capital-labor ratios actually increased over the same period. These sharp drops in TFP may be cause for concern as TFP is considered a major driver of economic growth over the long run.

Table 11: Growth Decomposition. Contribution to Total Growth in GDP (value added) per capita, Nicaragua 2001-2005

	Within sector changes	**Changes in Employment**	**Inter-sectoral Shifts**	**Total**
Sectoral contributions				
Agriculture	-113	125	-20	-8
Mining and Utilities	50	-16	-39	-5
Manufacturing	-185	166	67	48
Construction	12	-32	2	-19
Commerce	40	-16	11	35
Transport	36	-5	-12	19
Government Services	-54	16	12	-27
Other	91	-40	3	54
Subtotals	*-123*	*197*	*24*	*98*
Demographic component	-	-		284
Total change in value added per capita				382

Source: See Table 1.

Annex 1.

A simple way of understanding how growth has translated into increases in productivity and employment at the aggregate level and by sectors (or regions) is to perform a simple decomposition of growth in per capita GDP. To do so, we use the fact that per capita GDP, *Y/N = y* can be expressed as

$$\frac{Y}{N} = \frac{Y}{E}\frac{E}{A}\frac{A}{N}$$

or:

$$y = \omega * e * a$$

where Y is total value added, E is total employment, A is the total population of working age, and N is total population. In this way, Y/E = ω is total output per worker, E/A = e is the share of working-age population (i.e., the labor force) employed, and A/N = a is the labor force as a fraction of total population.

Thus, *changes* in per capita value added can be decomposed into *changes* in output per worker, *changes* in employment rates, and *changes* in the share of the labor force. The term Y/E can be augmented to include hours of work, in which case productivity is measured by output per hour worked Y/H and the average hours of work per employed person H/E also needs to be included. The relationship can be used to explore how changes in the components of per capita growth vary with changes in per capita growth itself. The Shapley[4] decomposition approach is based on the marginal effect on the value of a variable or indicator, of eliminating each of the contributory factors in a sequence. The method then assigns to each factor the average of its marginal contribution in all possible elimination sequences (see Shorrocks 1999)[5]. Using the Shapley decomposition, total changes in per capita value added will be equal to:

$$\Delta y = \Delta\omega\left[\frac{e_{t=1}a_{t=1} + e_{t=0}a_{t=0}}{3} + \frac{e_{t=1}a_{t=0} + e_{t=0}a_{t=1}}{6}\right] + \Delta e\left[\frac{\omega_{t=1}a_{t=1} + \omega_{t=0}a_{t=0}}{3} + \frac{\omega_{t=1}a_{t=0} + \omega_{t=0}a_{t=1}}{6}\right] + \Delta a\left[\frac{\omega_{t=1}e_{t=1} + \omega_{t=0}e_{t=0}}{3} + \frac{\omega_{t=1}e_{t=0} + \omega_{t=0}e_{t=1}}{6}\right]$$

The first term in the summation will be the contribution of changes in output per worker, the second term the contribution of changes in the employment rate, and the third term the contribution to changes in the demographic component.

[4] See Shorrocks, A., 1999: "Decomposition Procedures for Distributional Analysis: A Unified Framework Based on the Shapley Value." Mimeo, University of Essex, Colchester, U.K.

[5] Shapely decomposition packages for STATA are readily available.

This information can be used to present aggregate growth in terms of each of these components, where:

$\bar{\omega} \equiv \Delta\omega \left[\frac{e_{t=1}a_{t=1} + e_{t=0}a_{t=0}}{3} + \frac{e_{t=1}a_{t=0} + e_{t=0}a_{t=1}}{6} \right] / \Delta y$ will be the fraction of growth that can be linked to changes in output per worker,

$\bar{e} \equiv \Delta e \left[\frac{\omega_{t=1}a_{t=1} + \omega_{t=0}a_{t=0}}{3} + \frac{\omega_{t=1}a_{t=0} + \omega_{t=0}a_{t=1}}{6} \right] / \Delta y$ will be the fraction of growth that can be linked to changes in the employment rate, and

$\bar{a} \equiv \Delta a \left[\frac{\omega_{t=1}e_{t=1} + \omega_{t=0}e_{t=0}}{3} + \frac{\omega_{t=1}e_{t=0} + \omega_{t=0}e_{t=1}}{6} \right] / \Delta y$ will be the fraction of growth that can be linked to changes in the share of total population that is of working age,

and where the bar denotes the fraction of growth explained by the component. In this way percentage growth between two periods can be expressed as follows:

$$\frac{\Delta y}{y} = \bar{\omega}\frac{\Delta y}{y} + \bar{e}\frac{\Delta y}{y} + \bar{a}\frac{\Delta y}{y}$$

The decomposition provides a first step towards understanding, first, the role played by different sectors in changes in employment, and second, the role of capital, total factor productivity (TFP), and intersectoral shifts in explaining changes in output per worker, both at the aggregate level and by sectors. This amounts to doing a stepwise decomposition, first decomposing aggregate growth into employment and productivity changes, and then decomposing employment and productivity changes by sectors.