



Thinking Ahead  
for the Mediterranean

## WP 8 - Scenario building and impact assessment

# Economic and Structural Database for the MEDPRO Project

Leonidas Paroussos, Stella Tsani and Zoi Vrontisi

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### Abstract

This report presents the economic and structural database compiled for the MEDPRO project. The database includes governance, infrastructure, finance, environment, energy, agricultural data and development indicators for the 11 southern and eastern Mediterranean countries (SEMCs) studied in the MEDPRO project. The report further details the data and the methods used for the construction of social accounting, bilateral trade, consumption and investment matrices for each of the SEMCs.

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Unless otherwise indicated, the views expressed are attributable only to the authors in a personal capacity and not to any institution with which they are associated.

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# Economic and Structural Database for the MEDPRO Project

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## 1. Introduction

The aim of this report is to provide an overview of the economic and structural database compiled for the MEDPRO project. The research team at the E3M Lab, ICCS, has developed an extensive database, which includes figures on governance, development indicators, infrastructure, finance, the environment, energy and agriculture for the 11 southern and eastern Mediterranean countries (SEMCs) studied in the MEDPRO project.<sup>1</sup> In addition to these data, for each of the SEMCs detailed data have been compiled on social accounting, bilateral trade, consumption and investment matrices. Table 1 summarises the economic and structural indicators along with the period for which the indicators have been compiled for the database. Table 2 summarises the matrices compiled for the MEDPRO project along with their sectoral disaggregation.

*Table 1. Economic and structural data for the MEDPRO project*

| Data group                    | Indicators  | Period    |
|-------------------------------|---|-----------|
| <b>People – Human capital</b> | Unemployment, total (% of total labour force)   | 1990–2008 |
|                               | Life expectancy at birth, total/female/male (years)   | 1990–2008 |
|                               | Fertility rate, total (births per woman)  | 1990–2008 |
|                               | School enrollment, primary, total/female/male (% of net)  | 1990–2008 |
|                               | School enrollment, secondary, total/female/male (% net)   | 1990–2008 |
|                               | Public spending on education, total (% of government expenditure)   | 1990–2008 |
| <b>States and markets</b>     | Time required to start a business (days)  | 2003–08   |
|                               | Market capitalisation of listed companies (% of GDP)  | 1990–2008 |
|                               | Military expenditure (% of GDP)   | 1990–2008 |
|                               | High-technology exports (% of manufactured exports)   | 1990–2008 |
|                               | Governance indicators (voice and accountability, political stability, government effectiveness, rule of law, control of corruption, regulatory quality) | 1996–2008 |
| <b>Global links</b>           | Total debt service (% of exports of goods, services and income)   | 1990–2008 |
|                               | Foreign direct investment, net inflows (% of GDP)   | 1990–2008 |
| <b>Energy</b>                 | Detailed energy balances (imports/exports/ production by product)   | 1990–2008 |
|                               | Oil/gas reserves  | 1990–2008 |

<sup>1</sup> The SEMCs are Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, the Palestinian Autonomy, Syria, Tunisia and Turkey.

*Table 1. Economic and structural data for the MEDPRO project (cont'd)*

| <b>Data group</b>                        | <b>Indicators</b>  | <b>Period</b>                |
|--|--|------------------------------|
| <b>Water &amp; sanitation facilities</b> | Proportion of population using improved sanitation facilities, total/urban/rural (in %)              | 1990, 1995, 2000, 2005, 2008 |
|  | Proportion of population using improved drinking-water sources, total/urban/rural (in %)             | 1990, 1995, 2000, 2005, 2008 |
| <b>Telecommunications</b>                | Telephone lines (per 100 people)   | 1990–2008                    |
|  | Mobile and fixed-line telephone subscribers (per 100 people)   | 1990–2008                    |
|  | Mobile cellular subscriptions (per 100 people)   | 1990–2008                    |
|  | Population covered by mobile cellular network (%)  | 1990–2008                    |
|  | Internet users (per 100 people)  | 1990–2008                    |
|  | Telecommunications investment (% of revenue)   | 1990–2008                    |
| <b>Rail, roads &amp; logistics</b>       | Roads, paved (% of total roads)  | 1990–2008                    |
|  | Railways, passengers carried (million passengers – km)   | 1990–2008                    |
| <b>Agriculture</b>                       | Logistics performance index: Competence and quality of logistics services (1=low to 5=high)          | 2006                         |
|  | Logistics performance index: Quality of trade and transport-related infrastructure (1=low to 5=high) | 2006                         |
|  | Cereal yield (kg per hectare)  | 1990–2008                    |
| <b>Environment</b>                       | Agricultural irrigated land (% of total agricultural land)   | 1990–2008                    |
|  | Agricultural land (% of land area)   | 1990–2008                    |
|  | Forest area (% of land area)   | 1990–2008                    |
|  | GHG emissions (total and at disaggregated levels)  | 1990, 1995, 2000, 2005       |

*Table 2. Sectors and matrices for the MEDPRO project*

|  |   |
|--|---|
| <b>SEMCs</b>   | Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, Palestine, Syria, Tunisia, Turkey  |
| <b>Matrices compiled for each of the SEMCs</b>                   | Social accounting matrix, trade matrix, consumption matrix, investment matrix   |
| <b>SAM sectoral classification</b>                               | Agriculture, animal products, coal, crude oil, oil refining, natural gas extraction, gas distribution, transmission and distribution of electricity, water, chemical products, other energy intensive, electric goods – other equipment goods, transport equipment, consumer goods industries – food, consumer goods industries – rest, textiles and clothing, construction, transport, communication, business – financial services, public services, recreational and other services, dwellings |
| <b>Consumption by purpose categories in consumption matrices</b> | Food, beverages and tobacco, clothing and footwear, housing and water charges, fuels and power, household equipment and operation excl. heating and cooking appliances, heating and cooking appliances, medical care and health, purchase of vehicles, operation of personal transport equipment, transport services, communication, recreational services, miscellaneous goods and services, education   |

The compilation of the database has combined several data sources, ranging from the scholarly literature to the international financial institutions (such as the International Monetary Fund (IMF) and World Bank) and the national statistical offices. The construction of the economic and structural



database faced significant limitations associated with data scarcity and the lack of detailed matrices available from official national or international sources for most of the SEMCs. In the presence of data scarcity, an extensive part of the research has concerned the employment of the available data in tandem with appropriate balancing methods, so as to derive the final dataset.

The data and the applied methodological approaches are discussed in the subsequent sections. The remainder of the report develops as follows: section 2 reviews the data collected for the SEMCs. Section 3 focuses on the methods and data used for the construction of the social accounting matrices (SAMs) for the SEMCs. Section 4 details the data and the methods used for the compilation of the trade, consumption and investment matrices for the SEMCs. The last section concludes.

## 2. Economic and structural data for the SEMCs

The starting point of the compilation of the economic and structural database has been the collection of data on a wide set of economic, governance, environmental and development indicators for the SEMCs. The outcome of this data collection has been the construction of a common format database for each of the SEMCs. For the compilation of the database, the following data sources were used: the World Bank, the IMF, the Arab Monetary Fund, the World Health Organisation (WHO), the United Nations, the US Energy Information Administration (EIA) and the International Energy Agency (IEA). Where possible, the consistency of the data with the national statistics has been controlled for.<sup>2</sup> The database is available in Excel format.<sup>3</sup> The data are presented in category groups by source, for each of the SEMCs.

The first group of data entails governance and institutional quality indicators. The respective data are extracted from the World Bank Worldwide Governance Indicators (WBI) database, first constructed by Kaufman et al. (1999) and further developed by Kaufman et al. (2008).<sup>4</sup> The indicators are composite indicators constructed from a wide group of existing perception indicators derived from different data sources and organisations. The indicators reflect perceptions of the quality of governance and institutions in the SEMCs for the period 1996–2007.<sup>5</sup> The aspects assessed are government effectiveness, rule of law, control of corruption, political stability, regulatory quality and voice and accountability. The indicators are standardised and range in value from -2.5 (reflecting relatively worse governance outcomes) to +2.5 (reflecting relatively better governance outcomes). The indicators are comparable across time and countries.

In addition to the governance indicators, the database includes figures on development indicators for the SEMCs. These pertain to people and human capital, state and market characteristics, infrastructure and global links. The primary sources of the latter data have been the WHO database<sup>6</sup> and the World Bank Development Indicators (WBI) database.<sup>7</sup> The data are sufficiently detailed and cover information on access to water and sanitation facilities and are disaggregated at the levels of rural and urban population. Additional development data have been collected on people and human capital. These include figures on unemployment rates, school enrolment (primary and secondary, total as well as male and female enrolment), public spending on education, life expectancy at birth (total, male, female) and fertility rates. Further data in the group of development indicators concern agricultural land and cereal yield, forest areas, foreign direct investment and infrastructure indicators. The latter include rail and road statistics as well as quality measures of logistical performance.

Lastly, the economic and structural database includes detailed figures on energy balances, oil and gas reserves and greenhouse gas emissions for each of the SEMCs. The data have been extracted from the

<sup>2</sup> The data comparison has not revealed any major discrepancies between the figures provided by national and international sources.

<sup>3</sup> MEDPRO economic and structural database.xlsx.

<sup>4</sup> See the World Bank (<http://info.worldbank.org/governance/wgi/index.asp>).

<sup>5</sup> The indicators are not available for 1997 or 1999.

<sup>6</sup> See the WHO (<http://www.who.int/research/en/>).

<sup>7</sup> See the World Bank (<http://data.worldbank.org/data-catalog/world-development-indicators>).



US EIA<sup>8</sup> and the IEA.<sup>9</sup> Energy balances provide detailed figures on production, imports and exports at disaggregated levels by product. Greenhouse gas emissions data are disaggregated by type of gas and source of emission.

Since the base year of GEM-E3 is 2007, the SAMs, the consumption matrices, and the trade and investment matrices were compiled for this specific year.<sup>10</sup> The constructed database includes time series of the aforementioned data for the period 1990–2008. The database provides good coverage of each of the SEMCs.<sup>11</sup> The completeness of the dataset varies among countries. The completeness of the database has depended to a large extent on the data availability as well as on the quality of the available data. The choice to include information over an extended period of time is made on several grounds. First, the observation of the data that cover an extended period of time, rather than just a specific year, can facilitate the qualitative analysis of the SEMCs. In addition, in several cases information for the year 2007 is missing.

Overall, the collection of the data summarised above aims at facilitating the assessment of the developments in the SEMCs. Furthermore, it aims at enabling the development of the quantitative models and alternative scenarios for the purposes of the MEDPRO project. Nevertheless, for the development of the GEM-E3 model, further data are necessary. These include i) balanced SAMs at the national level, ii) detailed consumption and investment matrices, and iii) data on trade flows and transport costs between regions.

For this purpose, an extensive amount of research has focused on the extraction of the relevant data and on the construction of the appropriate matrices. Several factors have shaped the latter efforts. These include i) the data availability, ii) the sectoral detail required for the development of the GEM-E3 model, and iii) the methodological alternatives employed so as to construct the appropriate matrices. The following sections detail the methods and the data used to construct the necessary matrices for the GEM-E3 model.

### 3. Constructing the social accounting matrices for the GEM-E3 model

A key requirement for the GEM-E3 model is the availability of a SAM for each country (and/or region) assessed. The SAM is a matrix that records the economy-wide data accounts for transactions in an integrated framework (Pyatt et al., 1977). A typical SAM includes accounts for sectors of production, factors of production (such as labour and capital) and various actors ('institutions', such as government and households) that receive income and demand goods. In this respect, the SAM rearranges the national accounts so as to indicate the receipts of factor incomes and their allocation among various spending institutions. Figure 1 provides a graphical representation of the typical SAM employed in the GEM-E3 model.

In a SAM, each account is represented by a row and a column. Each cell shows the payment from the account of its column to the account of its row. Hence, the incomes of an account appear along its row and its expenditures along its column. The underlying principle of double-entry accounting requires that, for each account in the SAM, total revenue (row total) equals total expenditure (column total). In other words, the total receipts and expenditure of each account must balance. The SAM for which every row equals the corresponding column sum is therefore balanced.

<sup>8</sup> See the US EIA (<http://www.eia.doe.gov/>).

<sup>9</sup> See the IEA (<http://www.iea.org/stats/index.asp>).

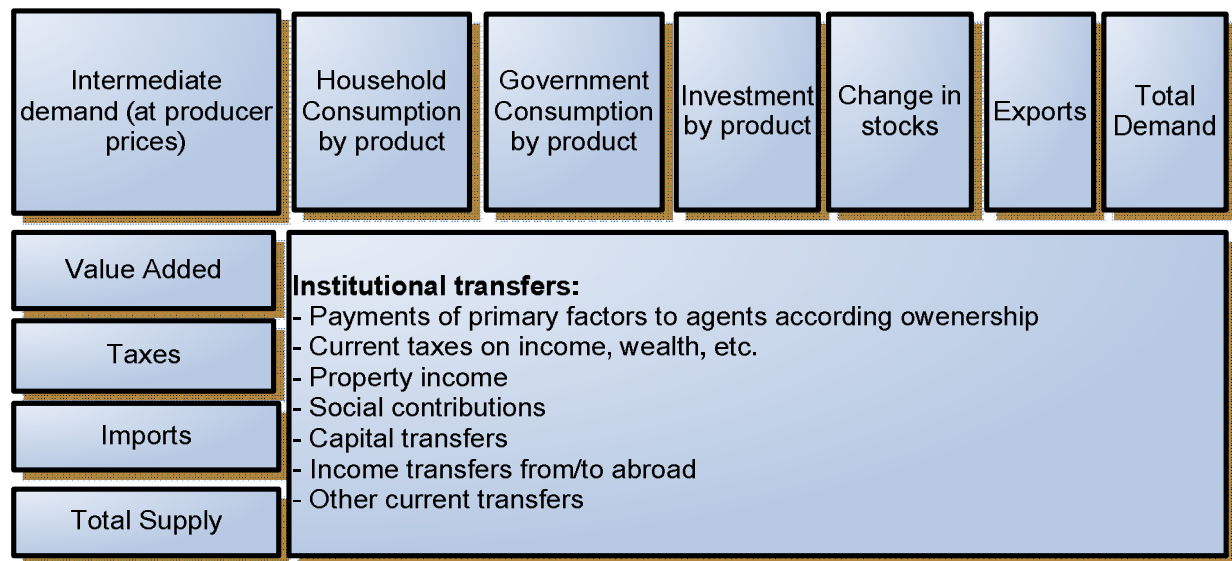
<sup>10</sup> The base year is the year upon which the calibration of the GEM-E3 model is made. The choice of the base year is made on the grounds of the most up-to-date available data. The year 2007 is the latest for which the Global Trade Analysis Projects (GTAP) database provides data.

<sup>11</sup> Nevertheless, this is not the case for the Palestinian Autonomy, for which data scarcity on international databases has been a significant limitation. The primary source of data for Palestine has been the Palestinian Central Bureau of Statistics (see <http://www.pcbs.gov.ps/>).





Figure 1. Typical SAM for the GEM-E3 model



Following the principles of double-entry accounting, if  $T$  is defined as the  $n \times n$  SAM matrix with  $t_{ij}$  being the payment from column-account  $j$  to row-account  $i$ , total row sums and total column sums must balance.

Within the framework of the MEDPRO project, the construction and the availability of the SAMs for each of the SEMCs remains an extremely useful input to the MEDPRO database given their importance for the development of the GEM-E3 model. The SAMs have a prominent relevance for the development of the GEM-E3 model for two reasons. First, they facilitate the systematisation of the national accounts by putting greater emphasis on essential concepts. Serving the modelling purposes, the economic theory that is implicit in the national accounts is translated into a set of concepts and definitions, which build into an overall SAM for each country assessed. Second, the SAMs provide a reliable approach to organising the dataset of the GEM-E3 model. This enables the direct calibration of the GEM-E3 model coefficients. The latter relies on the principle that every economic model has its corresponding accounting framework, and every such framework can be set out as a SAM.

Since the model is calibrated on a base year SAM, it is quite important to complete the SAMs that reflect the economic structures of the economies under study. Within the framework of the GEM-E3 modelling, the SAM remains a snapshot of the conditions prevailing in the socio-economic system under analysis. If these conditions are not accurately reflected, the outcome of the model simulations is bound to be misleading. Given the latter argument, a primary concern during the development of the economic and structural database for the MEDPRO project has been the construction of a valid SAM for each of the SEMCs. This has been motivated to a large degree by the lack of available SAMs from national (i.e. statistical offices) and/or international sources, such as the Global Trade Analysis Project (GTAP).<sup>12</sup> With the exception of Egypt, Morocco, Tunisia and Turkey (for which the necessary input-output tables to obtain a SAM were available in GTAP), for the remaining SEMCs the SAMs had to be constructed.

Constructing new SAMs for each of the SEMCs was beyond the aim of this project. A ‘top-down’ approach was employed as the option for completing the SAMs. This was based on the use of data provided in the national accounts aggregates of the respective countries. This alternative was

<sup>12</sup> The GTAP database is a consistent representation of the world economy in a specific base year. The information of the database includes national input-output tables, trade, macroeconomic and protection data from several sources. The underlying input-output tables are heterogeneous in sources, base years and sectoral detail. Nevertheless, to achieve consistency, substantial efforts have been made to make the disparate sources comparable. These efforts facilitate the operation of economic simulation models, ensuring GTAP users have a consistent set of economic facts. See GTAP (<https://www.gtap.agecon.purdue.edu/default.asp>).

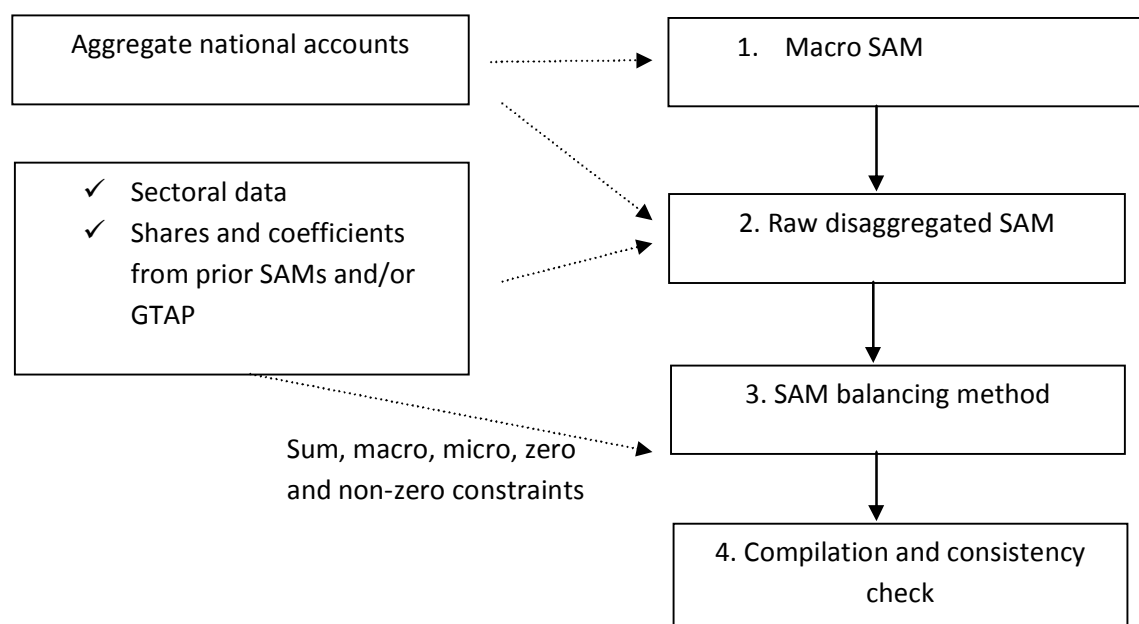
preferred as it could assure consistency and flexibility by sticking to the national accounts aggregates during all the stages of the estimation process.<sup>13</sup> The top-down methodology used to construct the SAMs was similar for each country. Nevertheless, country-specific data limitations shaped the final approach adopted in the construction of the SAM for each country. In this respect, it is useful prior to discussing the data particularities and obstacles encountered for each country to briefly review the overall top-down methodology for SAM construction.

### 3.1 Methods

The cornerstone of the top-down approach used to construct the SAMs for the SEMCs has been the information included in the national accounts of the respective countries. The top-down approach reflects the utilisation of macro-level data provided in the national accounts, and the disaggregation of the macro data at micro (sectoral) levels to obtain detailed SAMs. In line with this approach, the SAM entries to be estimated were initially adjusted in a summary set of national accounts.

The first stage of this approach included the construction of aggregated macroeconomic SAMs based on the data obtained from the national accounts of the respective countries (Figure 2). The construction of the macro SAMs used the information provided in the national accounts on final private and government consumption, etc. Given the key role played by the macro SAMs in the success of the estimation process, any discrepancies in the national accounts data were revealed and then corrected. In this process, the quality of the data was further checked by comparing the figures with those obtained from alternative national and international data sources as well as by controlling the validity of the macroeconomic figures.

Figure 2. Approach to SAM building



<sup>13</sup> Alternatively a ‘bottom-up’ approach could have been employed for the construction of the SAMs. According to this approach, the construction of the SAM initiates from disaggregated data and continues with the confrontation of the latter with previously computed aggregates, which are, in a sense, guesses. By using the top-down approach, the *a posteriori* accuracy and comprehensiveness of the bottom-up approach is given up in order to achieve *a priori* consistency. In the case of the SEMCs a bottom-up approach would be more difficult to apply given the data limitations.



In the second stage of the procedure, the SAMs were disaggregated so as to generate more detailed SAMs. This procedure involved the disaggregation of the available information obtained from the national accounts on value added, operating surplus, intermediate consumption and taxes to the GTAP sectors of production. This was done in order to put the available data into a format similar to the data on the rest of the countries examined for MEDPRO purposes, which were extracted from GTAP. After putting the data into the GTAP sectoral aggregation format, appropriate aggregation of the sectoral data was carried out in order to obtain a new SAM structure compatible with the GEM-E3 model requirements for MEDPRO purposes. The aggregation yielded a common format matrix for each of the SEMCs, including a total of 23 sectors of production.<sup>14</sup>

This stage was carried out by making the most of the data available in the national accounts and sectoral data from other national sources, such as the central banks and statistical offices of the respective countries. Nevertheless, this stage had to overcome the significant data constraints with regard to input–output tables, i.e. the flows between the sales and purchases (final and intermediate) of industry outputs and/or the sales and purchases (final and intermediate) of product outputs. With the exception of Lebanon, Libya, Israel and Palestine, for which an input–output table was available, for the remaining countries no such tables were available. To overcome these data limitations, the data provided from the GTAP database corresponding to the respective countries was employed. In the GTAP database, Jordan, Palestine, Syria and Lebanon are part of a larger single region, namely XWS, which represents a group of countries that includes Iraq and Yemen among the aforementioned countries. Similarly, Algeria, Libya and the rest of the Western Saharan countries constitute one ‘country’ in the GTAP database, namely XNF. In addition to the GTAP aggregate data, evidence from the scholarly literature was used to formulate the relative significance of the different sectors of production in each country.

In the scholarly literature to date, several attempts have been made to construct SAMs for the countries included in the SEMC group. Indicative is the work of Lucke (2001), which details the construction of the SAM for Jordan (13 sectors included) for 1998 and the SAM for Syria for 1999 (13 sectors included). Dessus and Ghaleb (2006) construct a SAM for Lebanon (1 sector included) for 1997. Lastly, Kerwat et al. (2009) construct a SAM for Libya for 2000 (13 sectors included). The information provided in the latter works has been applied for the purposes of robustness checks of the data and methods used as well as of the resulting SAM coefficients obtained for the MEDPRO project.

As an outcome of the second stage, the resulting SAMs were unbalanced, i.e. the sum of the rows did not equal that of the corresponding columns. This was due to data discrepancies in the matrices, resulting from either the use of different data sources or existing inconsistencies in the collected data, or both. Furthermore, in the presence of significant data limitations, the SAMs did not provide any information on specific flows at the sectoral level, such as household or government consumption, or investment. Hence in most of the cases, the disaggregated SAMs had several blank cells. Consequently, the next stage of the SAMs’ construction focused on the appropriate disaggregation of the data obtained from the national accounts, so as to derive more complete SAMs, and on the balancing of the constructed SAMs.<sup>15</sup> For this purpose, appropriate methods were implemented.

<sup>14</sup> The disaggregation is based on the sectors included in the GEM-E3 model developed for the MEDPRO project. These are agriculture, animal products, coal, crude oil, oil refining, natural gas extraction, gas distribution, transmission and distribution of electricity, water, chemical products, other energy-intensive, electrical goods – other equipment goods, transport equipment, consumer goods industries – food, consumer goods industries – rest, textiles and clothing, construction, transport, communication, business – financial services, public services, recreational and other services, and dwellings.

<sup>15</sup> The balancing of the SAMs is associated with the classic problem of ‘updating’ or ‘balancing’ the input–output matrix given the new information on the row and column as well as the lack of updated information on the input–output flows. The generalisation of this problem to a full  $n \times n$  SAM is to find  $n^2$  unknown non-negative parameters of a new coefficient matrix,  $A^*$ , using an existing coefficient matrix,  $A$ , provided there is knowledge of new row and column sums.

In an accounting matrix context, the balancing problem is associated with balancing (and updating) input–output tables to satisfy known row and column constraints, or with the situation in which, although account totals may themselves be unknown, there are accounting restrictions on the corresponding row and column totals. In all cases, the basic consideration is to choose a criterion to define a measure of ‘closeness’ and thereafter to carry out a constrained minimisation solution, where the constraint set may involve additional and more complex constraints to the basic restrictions associated with the balancing problems.

The literature to date proposes alternative approaches for constructing and balancing a SAM. These range from the traditional RAS techniques and restricted ordinary least squares (OLS) to the most recent, popular approaches of cross-entropy (CE). To construct the SAMs for the SEMCs, the restricted OLS approach has been employed. The choice has been based on the simple straightforward implementation of the method. Furthermore, this method is preferred as it allows for the assignment of weights to the additional information/constraints used to construct the SAM.

The method consists of minimising the differences between the new SAM and the initial SAM properties by making use of a set of constraints.<sup>16</sup> In the restricted OLS construction approach, the new balanced SAM derives from the utilisation of an initial estimate of the SAM along the set of desired linear constraints among the elements of the SAM. These may either be the standard accounting restrictions or linear restrictions on sums of subsets of elements (e.g. sums of sectoral value added to equal total GDP) or restrictions on ratios of elements.

The objective of the SAM compiling and balancing procedure has been the minimisation of the differences between the values of the cells of the newly constructed SAMs and the initial SAMs. For this purpose, a simple minimisation problem has been constructed using non-linear programming. In this process, the notations summarised in Table 3 and the variables summarised in Table 4 have been used.

*Table 3. SAM balancing notations*

| <b>Subscripts</b> | <b>Description</b>  |
|-------------------|---|
| $s=1,...,n=s^*$   | Sectors of production – each sector produces only one product                                     |
| $o=1,2$           | Products by origin, i.e. imported or domestic   |
| $h=1,2$           | Institutions, i.e. households and government  |
| $f=1,...,5$       | Factors of production, i.e. skilled labour, unskilled labour, capital, natural resources and land |
| $reg=1,...,r$     | Countries   |
| $ss=1,...,m=ss^*$ | Sectors of production in the initial SAM (based on national accounts)                             |
| $oo=1,...,l$      | Products by origin in the initial SAM (based on national accounts)                                |
| $ff=1,...,p$      | Factors of production in the initial SAM (based on national accounts)                             |
| $hh=1,...,q$      | Institutions in the initial SAM (based on national accounts)                                      |

*Table 4. SAM balancing variables*

| <b>Variable</b>  | <b>Description</b>  |
|------------------|---|
| $D_s$            | Demand for product produced by sector $s$ or demand that sector $s$ is faced with – each sector produces only one product |
| $S_s$            | Supply of sector $s$ or supply of product produced by sector $s$ – each sector produces only one product                  |
| $VDFM_{o,s,s^*}$ | Intermediate demand for $o$ imported or domestic inputs of sector $s$ from sector $s^*$                                   |

<sup>16</sup> The mathematical programming and optimisation have employed GAMS.

Table 4. SAM balancing variables (cont'd)

|                     |   |
|---------------------|---|
| $INV_{s,o}$         | Demand of sector $s$ for $o$ imported or domestically produced investment goods   |
| $VM_{h,o,s}$        | Demand of $h$ institution (government, household) for $o$ imported or domestically produced by sector $s$ goods   |
| $EXP_s$             | Exports of sector $s$   |
| $TFRV_s$            | Ordinary import duties in sector $s$  |
| $XTRV_s$            | Ordinary export subsidies in sector $s$   |
| $VST_s$             | Exports margins of sector $s$   |
| $VM_{s,f}$          | Added value of the $f$ factor of production employed by sector $s$  |
| $FBTS_{f,s}$        | $f$ factor-based tax/subsidy in sector $s$  |
| $VTWR_s$            | Import margins of sector $s$  |
| $IMP_s$             | Imports of sector $s$   |
| $ISEP_{o,s}$        | Taxes or subsidies associated with the $o$ domestically produced or imported intermediate inputs in sector $s$  |
| $INTSUB_{o,s,reg}$  | Ratio of intermediate input taxes/subsidies over intermediate demand of sector $s$ for products $o$ domestically produced or imported in country $reg$                              |
| $FT_{s,f,reg}$      | Ratio of factor-based taxes/subsidies over the value added of factor $f$ employed in sector $s$ in country $reg$  |
| $OSEP_s$            | Subsidies in output of sector $s$   |
| $ROSEP_{s,reg}$     | Ratio of output subsidies over output of sector $s$ in country $reg$  |
| $VFM_{ss,ff}^*$     | Added value of the $ff$ factor of production employed in sector $ss$ in the initial unbalanced SAM (based on national accounts)   |
| $VDFM_{oo,ss,ss}^*$ | Intermediate demand for product by origin ( $o$ , domestically produced or imported) by sector $ss$ from sector $ss^*$ , in the initial unbalanced SAM (based on national accounts) |
| $VM_{hh,oo,ss}^*$   | Demand of $hh$ institution for $oo$ imported product or domestically produced by sector $ss$ in the initial unbalanced SAM (based on national accounts)                             |

For each SAM constructed, the optimisation problem is summarised by the following objective equation:

$$\begin{aligned}
Diff = & w_1 * (\sum_{s=1}^n D_s - \sum_{s=1}^n S_s) + w_2 * fadiff + w_3 * iddiff + w_4 * indiff \\
& + w_5 * \sum_{ss=1}^m fadiff_{ss} + w_6 * \sum_{ss=1}^m iddiff_{ss} + w_7 * \sum_{ss=1}^m indiff_{ss} \\
& + w_8 * \sum_{s=1}^n \sum_{s^*=1}^n prodiff_{s,s^*} + w_9 * \sum_{f=1}^5 \sum_{s^*=1}^n vaddiff_{f,s^*}
\end{aligned} \tag{1}$$

The objective has been related to the minimisation of  $Diff$ , with  $Diff$  being the distance between the estimations associated with the new SAM and the information included in the initial SAM, which has been constructed with the use of information included in the national accounts and in the existing SAMs in the literature.  $fadiff$ ,  $iddiff$ ,  $indiff$ , and  $fadiff_s$ ,  $iddiff_s$ ,  $indiff_s$  are the distance between the level estimations and the distance between the estimations at the sectoral level associated with the added value, intermediate demand and institutional demand, respectively, between the new constructed SAM and the initial SAM.<sup>17</sup>  $prodiff_{s,s^*}$  and  $vaddiff_{f,s^*}$  are the distance between the sectoral production

<sup>17</sup> Each differential in the objective function has been activated depending on the primary data availability for each country under consideration.

and value added structure in the new constructed SAMs and those provided for the group of countries among which the countries under consideration belong to the GTAP database.

Each element of equation (1) has been associated with a weight term  $w_1, \dots, w_9$ . The weight terms have been applied so as to enable the procedure to distinguish the relevant significance of the information used and to enable the analysis to pay a closer attention to the relatively more reliable data. This has reflected the attempts to assign a relatively greater weight to the information included in the national accounts, particularly with regard to the employed factors of production and the value added. The objective equation has been followed by a set of constraints and equations. The set of the constraints applied reflects the different types of prior information associated with the national accounts, the prior SAMs found in the literature, moment constraints, economic aggregates and inequality constraints. Moment constraints have been associated with the most common type of information available for the construction of the SAMs, i.e. the sums for some or all the columns and rows. Along with column and row sums, additional aggregated data from national accounts, such as value added, consumption, investment, government receipts and expenditures, have been used in the SAM construction attempt in the form of further linear adding-up constraints on various elements of the SAM. Lastly, in the SAM construction procedure, given the information provided in the national accounts and the underlying macroeconomic relationships, where appropriate, bounds have been put upon the variables of the economic aggregates included in the constructed SAMs so as to obtain a reliable snapshot of the economies under consideration.

In the SAM and in the bilateral trade construction and balancing procedure, special attention has been given to the trade flows. Trade data, i.e. imports, exports and margins on international trade, have been fixed to ensure consistency between the constructed SAMs and the trade matrices for each country. The fixed values of the trade data have been used in the compilation of the SAMs in order to maintain consistency with the GTAP trade data.

The core constraint of the SAM balancing problem has been the equality of the column and row sums associated with the same account. In practical terms, this reflects the balancing problem connected with the equality of the demand and supply with which each sector of production and the respective product is associated.

The core underlying assumption of the GEM-E3 model is that each sector produces only one product. Hence the supply and demand of each product reflects the supply and demand that each sector of production faces. In this respect, the core constraint of the equality of demand and supply that each product/sector faces is given as follows:

$$D_s = S_s \quad (2)$$

For every sector  $s$ , demand is given by

$$D_s = \sum_{o=1}^2 \sum_{s^*=1}^n VDFM_{o,s,s^*} + \sum_{o=1}^2 INV_{s,o} + \sum_{h=1}^2 \sum_{o=1}^2 VM_{h,o,s} + VST_s + EXP_s \quad (3)$$

and supply is given by

$$S_s = \sum_{o=1}^2 \sum_{s^*=1}^n VDFM_{o,s,s^*} + \sum_{f=1}^5 VFM_{s,f} + \sum_{f=1}^5 FBTS_{f,s} - \sum_{o=1}^2 ISEP_{o,s} - OSEP_s + TFRV_s + XTRV_s + VTWR_s + IMP_s \quad (4)$$

$VDFM_{o,s,s^*}$  is the intermediate demand of sector  $s$  for  $o$  inputs imported or domestically produced by sector  $s^*$ .  $INV_{s,o}$  is the demand of sector  $s$  for investment, which may be produced domestically or imported.  $VM_{h,o,s}$  represents the institutional demand for products produced domestically or imported.  $VST_s$  and  $EXP_s$  are the margins on exports and the exports of sector  $s$  respectively.  $VFM_{s,f}$  and  $FBTS_{f,s}$  represent the added value and the taxes or subsidies (or both) associated with the  $f$  factors of production employed in sector  $s$ .  $ISEP_{o,s}$  and  $OSEP_s$  are the taxes/subsidies on the intermediate inputs



and output respectively.  $TFRV_s$ ,  $XTRV_s$  are import duties and export subsidies. Lastly,  $VTWR_s$  and  $IMP_s$  represent the margins on imports and the imports of sector  $s$  respectively.

Complementary constraints have reflected the additional information on taxes and subsidies, value added, institutional demand and intermediate demand provided in the national accounts, in the prior SAMs in the existing literature and in GTAP.

In the presence of limited information on taxes and subsidies regarding intermediate inputs, factors of production and output for the SEMCs, the information provided in GTAP for the countries of interest has been used. Under this approach, the tax and subsidy constraints have applied the rates of the respective taxes and subsidies associated with XNF and XWS in GTAP. With regard to the taxes and subsidies associated with the factors of production, the constraint is given by

$$FBTS_{f,s} = FT_{s,f,reg} * VFM_{s,f} \text{ for } reg = \{XWF\} \text{ or } reg = \{XNF\} \quad (5)$$

$FBTS_{f,s}$  is the tax or subsidy associated with the factor of production  $f$  employed in sector  $s$ .  $FT_{s,f,reg}$  is the ratio of factor-based taxes or subsidies over the added value for XNF or XWS respectively.<sup>18</sup> Depending on whether the SEMC country under consideration belongs to the XNF or the XWS group in GTAP, the respective ratio of factor-based taxes or subsidies is used in the constraint equation.

With regard to the taxes and subsidies on intermediate inputs, the constraint applied is given by

$$ISEP_{o,s} = INTSUB_{o,s,reg} * \sum_{s^*=1}^n VDFM_{o,s,s^*} \text{ for } reg = \{XWF\} \text{ or } reg = \{XNF\} \quad (6)$$

$ISEP_{o,s}$  represents the subsidies or taxes associated with the domestically produced or imported intermediate inputs of sector  $s$ .  $INTSUB_{o,s,reg}$  is the ratio of input subsidies over intermediate demand for XNF and XWS respectively.<sup>19</sup> Depending on whether the SEMC under consideration belongs to the XNF or the XWS group in GTAP, the respective ratio of input subsidies is employed in the constraint set in the optimisation problem.

The constraint associated with output subsidies is given by the following equation:

$$OSEP_s = ROSEP_{s,reg} * \left( \sum_{f=1}^5 VFM_{s,f} + \sum_{o=1}^2 \sum_{s^*=1}^n VDFM_{o,s,s^*} + \sum_{o=1}^2 ISEP_{o,s} + \sum_{f=1}^5 FTRV_{f,s} \right) \\ \text{for } reg = \{XWF\} \text{ or } reg = \{XNF\} \quad (7)$$

$OSEP_s$  represents the output subsidies associated with sector  $s$ .  $ROSEP_{s,reg}$  is the ratio of output subsidies over output for XNF and XWS respectively.<sup>20</sup> Depending on whether the SEMC under consideration belongs to the XNF or the XWS group in GTAP, the respective ratio of output subsidies is used in the constraint equation.

In the case of import duties and export subsidies, the following constraints have been employed:

$$TFRV_s = RTFRV_{s,reg} * IMP_s + VTWR_s \\ \text{for } reg = \{XWF\} \text{ or } reg = \{XNF\} \quad (8)$$

and

<sup>18</sup> In the SAM construction and balancing procedure, the ratio of factor-based taxes and subsidies has been set to range at a level of 20% with respect to the XNF and XWS ratios.

<sup>19</sup> This rate has been set to range at a level of 20% with respect to the XNF and XWS ratios.

<sup>20</sup> Similar to the aforementioned rates,  $ROSEP_{s,reg}$  has been set to range at a level of 20% with respect to the XNF and XWS ratios.

$$XTRV_s = RXTRV_{s,reg} * EXP_s$$

$$\text{for } reg = \{XWF\} \text{ or } reg = \{XNF\} \quad (9)$$

$TFRV_s$  are the import duties associated with sector  $s$ .  $RTRV_{s,reg}$  is the ratio of import duties over the sum of imports and margins on imports for XNF and XWS respectively, depending on whether the SEMC under consideration belongs to the XNF or the XWS group in GTAP. In the case of exports,  $XTRV_s$  represents the export subsidies in sector  $s$ . To maintain consistency with the GTAP trade data, similar to the import duties, the level of export subsidies is estimated by using the ratio of export subsidies over total exports, namely  $RXTRV_{s,reg}$  for XNF and XWS respectively.

In addition to the tax- and subsidy-related constraints, further equations have been employed as constraints associated with the properties of the objective equation (1). These are associated with the differentials between the new SAM and the initial SAM based on national accounts experience. To enable these differences to be derived, appropriate aggregation and mapping of the sectors of production of the MEDPRO GEM-E3 have been undertaken so as to match the latter with the respective sectors of production included in the initial SAMs, as derived from the information provided in the national accounts and the prior SAMs identified in the literature to date.

The additional constraints imposed are given by the following equations:

$$fadi\text{diff} = \left( \sum_{s=1}^n \sum_{f=1}^5 VFM_{s,f} - \sum_{ss=1}^m \sum_{ff=1}^p VFM_{ss,ff}^* \right)^2 \quad \text{for } s=ss \text{ and } f=ff \quad (10)$$

$$iddiff = \left( \sum_{o=1}^2 \sum_{s=1}^n \sum_{s^*=1}^n VDFM_{o,s,s^*} - \sum_{oo=1}^l \sum_{ss=1}^m \sum_{ss^*=1}^m VDFM_{oo,ss,ss^*}^* \right)^2 \quad \text{for } s=ss, s^*=ss^* \text{ and } o=oo \quad (11)$$

$$indiff = \left( \sum_{h=1}^2 \sum_{o=1}^2 \sum_{s=1}^n VM_{h,o,s} - \sum_{hh=1}^q \sum_{oo=1}^l \sum_{ss=1}^m VM_{hh,oo,ss}^* \right)^2 \quad \text{for } h=hh, o=oo \text{ and } s=ss \quad (12)$$

$fadi\text{diff}$ ,  $iddiff$  and  $indiff$  are the distance between the added value associated with the factors of production, the intermediate demand and the demand of institutions in the new SAM and the initial unbalanced SAM. Along with these constraints, which restrict the properties of the new SAM to being as close as possible to the initial SAM values, further constraints have been imposed regarding the added value associated with the alternative factors of production, the intermediate demand and the demand of institutions at the sectoral level. For this purpose the following constraints have been employed:

$$fadi\text{diff}_{ss} = \left( \sum_{f=1}^5 VFM_{s,f} - \sum_{ff=1}^p VFM_{ss,ff}^* \right)^2 \quad \text{for } s=ss \text{ and } f=ff \quad (13)$$

$$iddiff_{ss} = \left( \sum_{o=1}^2 \sum_{s^*=1}^n VDFM_{o,s,s^*} - \sum_{oo=1}^l \sum_{ss^*=1}^m VDFM_{oo,ss,ss^*}^* \right)^2 \quad \text{for } s=ss, s^*=ss^* \text{ and } o=oo \quad (14)$$

$$indiff_{ss} = \left( \sum_{h=1}^2 \sum_{o=1}^2 VM_{h,o,s} - \sum_{hh=1}^q \sum_{oo=1}^l VM_{hh,oo,ss}^* \right)^2 \quad \text{for } h=hh, o=oo \text{ and } s=ss \quad (15)$$

$fadi\text{diff}_{ss}$ ,  $iddiff_{ss}$  and  $indiff_{ss}$  are the distance between the added value associated with the different factors of production, the intermediate demand and the demand of institutions, respectively, at the sectoral level in the new balanced SAM and the initial unbalanced SAM.



In addition, the following constraints have been applied with regard to the production and the value added structure:

$$proddiff_{s,s*} = (prodshare_{s,s*} - prodfunct_{s,s*})^2 \quad (16)$$

$$vadiff_{f,s*} = (vashare_{f,s*} - vafunct_{f,s*})^2 \quad (17)$$

$proddiff_{s,s*}$  and  $vadiff_{f,s*}$  are the differences between the production and value added shares depicted in the constructed SAMs and the SAMs associated with the GTAP database.  $prodshare_{s,s*}$  is the ratio of intermediate demand over the sum of intermediate demand and value added as derived from the constructed SAMs while  $prodfunct_{s,s*}$  is the ratio of the intermediate demand over the sum of intermediate demand and value added associated with the data extracted from the GTAP database. Similarly,  $vashare_{f,s*}$  and  $vafunct_{f,s*}$  represent the ratio of value added over the sum of intermediate demand and value added in the constructed SAMs and the SAMs associated with the data extracted from the GTAP database with regard to the country group in which the countries under consideration fall.

Lastly, an additional constraint imposed on the SAM constructing and balancing method concerns imports. According to this constraint, imports are set to be greater than or equal to the sum of intermediated demand for imported goods and the institutional demand (household, government) for imported goods. This constraint is summarised in the following equation:

$$IMP_s \geq \sum_{s*=1}^n VDFM_{o,s,s*} + \sum_{h=1}^2 VM_{h,o,s} + INV_{s,o} \text{ for } o=imported \quad (18)$$

At this point it should be noted that, given the particularities of each country and the data limitations associated with the SEMCs, the imposed constraints have been given varying degrees of weights in the SAM construction procedure used for each country. Given the primary importance of national accounts, the information provided by the latter has been given greater weight for the SAM balancing procedure. Furthermore, given the availability and the robustness of the available information, in several cases the additional constraints have been subject to upper or lower bounds or to explicit limitations on the values allowed to be assigned.

For instance, the values of intermediate demand or added value have been constrained to being positive or zero variables. In the case of taxes and subsidies, given the evidence from the national accounts and GTAP, the values of the taxes and subsidies associated with specific sectors have been subject to upper or lower limits in the assigned values. The specific weights and bounds on the variables have been employed so as to facilitate the balancing procedure and to maintain the constructed SAM as close as possible to the initial unbalanced SAM and to the economic reality present in each of the SEMCs.

The balancing method yielded new, balanced disaggregated SAMs, the consistency of which has been checked by confirming that the lowest possible differentials between the new and the initial SAM have been obtained, by confirming that each new balanced SAM adds up to the macro SAM and by ensuring that the structure of each economy under consideration and the macroeconomic snapshot provided by the initial SAMs and the figures of the national accounts has been maintained. After this final stage, the new balanced SAMs have been obtained with all the required parameters for the purposes of CGE modelling.

### 3.2 Data

The methodology discussed in the previous section has been followed in order to construct the SAMs for each of the SEMCs for which such information has not been available from official national or international sources. At the same time, the availability and the level of detail of the retrieved data

have not been the same for each of the SEMCs. Thus, the data availability has shaped in each case the methodological details as well as the assumptions underlying the construction of the respective SAMs. The aim of this section is to provide an overview of the data sources used in the construction of the SAMs for each of the SEMCs, as well as to discuss how the data and the methodological challenges have been addressed.

The primary objective has been to extract the necessary data for 2007, which is the base year for the GEM-E3 model.<sup>21</sup> The GTAP database provides detailed input–output tables for several of the SEMCs. Hence for **Egypt, Morocco, Tunisia** and **Turkey**, the input–output tables available on the GTAP database have been the starting point of the construction of the respective SAMs. Yet, the sectoral disaggregation of GTAP exceeds the sectoral disaggregation employed in the GEM-E3 model framework for the MEDPRO project. Therefore, appropriate aggregation of the sectoral data provided by the GTAP database has been carried out in order to derive the SAMs for the purposes of the MEDPRO project.

For the remaining countries (for which GTAP provides information at a country group level), national accounts and data from national and international sources have been used to construct valid SAMs. In this process, the data provided by GTAP have been used after controlling for their validity and their application in each country case. This has been confirmed by comparing the figures in GTAP with the figures included in the SAMs that the existing works in the scholarly literature suggest.

In the case of Algeria, the bulk of the necessary data have been retrieved from the National Office of Statistics.<sup>22</sup> The available data include figures on gross production, intermediate consumption, value added, fixed capital consumption, taxes on production, remuneration of employees and operating surplus for 19 sectors for 2004.<sup>23</sup> The data are available at disaggregated levels by type of ownership of the sector, i.e. private or public. To construct the SAM for Algeria, the figures disaggregated by ownership have been added up so as to obtain total figures and the macro SAM for Algeria.

The derived macro SAM was not balanced. Furthermore, the obtained SAM was not at the level of sectoral detail required for the MEDPRO purposes. To obtain a balanced SAM with the appropriate level of sectoral disaggregation, the balancing method summarised in the previous section has been applied. For this purpose, the SAM figures from GTAP with regard to the country group to which Algeria belongs (XNF) have been used in order to obtain the balanced SAM at the required level of sectoral detail.

The efforts to construct a SAM for **Israel** have benefited from the available SAM in the OECD database.<sup>24</sup> The OECD database provides the SAM for Israel for 2000. The unbalanced SAM includes 37 sectors of production.<sup>25</sup> Given the sectoral discrepancies with regard to the required SAM for the

<sup>21</sup> The selection of the base year is made on the grounds of the most recent data available. In the GTAP this corresponds to 2007.

<sup>22</sup> See the National Office of Statistics (<http://www.ons.dz>).

<sup>23</sup> The sectors are agriculture, water and energy, hydrocarbons, national petroleum services, mining and quarrying, steel industry, machinery and electricity, construction materials, building, public works and hydraulics, chemical products, food industries, textile and clothing, leather, wood and paper, other industries, transport and telecommunications, commerce, hotels, cafes and restaurants, business services and services to households.

<sup>24</sup> See OECD (<http://stats.oecd.org/Index.aspx>).

<sup>25</sup> These are agriculture, hunting, forestry and fishing, mining and quarrying, food products, beverages and tobacco, textiles, textile products, leather and footwear, wood and products of wood and cork, pulp, paper, paper products, printing and publishing, coke, refined petroleum products and nuclear fuel, chemicals and chemical products, rubber and plastics products, other non-metallic mineral products, basic metals, fabricated metal products except machinery and equipment, machinery and equipment, office, accounting and computing machinery, electrical machinery and apparatus, radio, television and communication equipment, medical, precision and optical instruments, motor vehicles, trailers and semi-trailers, other transport equipment, manufacturing, recycling, electricity, gas and water supply, construction, wholesale and retail trade, repairs, hotels and restaurants, transport and storage, post and telecommunications, finance and insurance, real estate activities, renting of machinery and equipment, computer and related activities, research and development, other



GEM-E3 model, similar to the other countries, the restricted OLS balancing method has been applied so as to derive a new balanced SAM with the appropriate sectors of production.

To construct a SAM for **Jordan**, the Department of Statistics of Jordan has been the main source of information on national accounts and data at the sectoral level of production.<sup>26</sup> The available information includes figures for 2004 on gross output, compensation of employees, consumption of fixed capital, taxes on production and imports, operating surplus and gross fixed capital formation by kind of economic activity. The data are provided for 15 sectors of production.<sup>27</sup> The macro SAM constructed with the data obtained from the national accounts was unbalanced. In addition, the sectors included in the macro SAM were fewer than the sectors required for the GEM-E3 model. Lastly, no information has been available on institutional demand and intermediate demand at the sectoral level.

To disaggregate the information provided in the national accounts to the level required for the GEM-E3 model and to balance the disaggregated SAM, the figures provided by GTAP as well as the SAM for Jordan constructed by Lucke (2001) have been employed. Lucke (2001) constructs the SAM for Jordan for 1998, which includes 13 sectors of production. After carrying out the appropriate calculations on the latter SAM so as to represent 2004 values, the coefficients of the SAM along with the coefficients provided by GTAP have been employed to identify the relevant significance of the different sectors of production for the Jordanian economy. This information has been utilised in the subsequent balancing method, which has been used to derive the balanced SAM with a higher level of sectoral disaggregation, as appropriate for the GEM-E3 model.

In the case of **Lebanon**, the Economic Accounts Mission of the Presidency of the Council of Ministers has been the main source of information.<sup>28</sup> The data retrieved entail figures for 2004 on private and public consumption, gross fixed capital formation (private and public), exports and imports as well as value added, intermediate taxes by type, subsidies, social security contributions, intermediate uses and intermediate consumption for eight sectors of production.<sup>29</sup> The macro SAM based on the national accounts was unbalanced. In addition, the sectoral level of detail provided by the national accounts had to be disaggregated to a larger number of sectors so as to match the requirements of the GEM-E3 model. Again, the balancing method has been applied to achieve a balanced SAM at a higher level of sectoral detail. For this purpose, the SAM figures provided by GTAP have been used.<sup>30</sup>

For **Libya**, the main source of information has been the SAM Libya constructed by Kerwat et al. (2009). The authors construct a SAM for Libya for 2000.<sup>31</sup> The authors base their SAM construction procedure on a set of unpublished Libyan national accounts for the period 1986–2000. Given the data limitations on sectoral disaggregation of the national account figures, the authors proceed on the assumption that the division of the national account components would resemble those of another economy that can be claimed to be similar to Libya. For this purpose the authors approximate the

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business activities, public administration and defence, compulsory social security, education, health and social work, other community, social and personal services, private households with employed persons.

<sup>26</sup> See Department of Statistics of Jordan ([http://www.dos.gov.jo/home\\_e.htm](http://www.dos.gov.jo/home_e.htm)).

<sup>27</sup> These are agriculture, hunting and forestry, mining and quarrying, manufacturing, electricity and water supply, construction, wholesale and retail trade, repair of motor vehicles and personal goods, hotels and restaurants, transport, storage and communications, financial intermediation, real estate, renting and business activities, public administration, defence and social security, education, health and social work, other community, social and personal service activities and private households with employed persons.

<sup>28</sup> See the Economic Accounts Mission (<http://www.pcm.gov.lb>).

<sup>29</sup> These are agriculture and livestock, energy and water, manufacturing, construction, transport and communications, trade and administration and other services.

<sup>30</sup> Dessus and Ghaleb (2006) provide a SAM for Lebanon for 1997. Although their work has been consulted in the process of constructing a SAM for Lebanon, the inputs have been of limited validity, given the fact that their SAM is not disaggregated to sectors of productions, including only one sector of production.

<sup>31</sup> The SAM includes 13 sectors, namely, agriculture, fishing and forestry, oil and natural gas, mining, manufacturing, electricity, gas and water, construction, trade, restaurants and hotels, transportation and communication, finance, public services, education services, health services and other services.

SAM ratios using data from Saudi Arabia, an oil-dominated economy that appears to be similar to Libya.<sup>32</sup> To be valid for the GEM-E3 model, the SAM had to be disaggregated at a greater level of sectoral detail. For this purpose, the method discussed in the previous section has been applied in tandem with the aggregate sectoral data provided in the initial SAM constructed by Kerwat et al. (2009).

In the case of **Palestine**, the construction of the SAM for the MEDPRO project and the GEM-E3 model has been based on the SAM provided by the Palestine Economic Policy Research Institute (MAS).<sup>33</sup> MAS, in association with the Palestinian Central Bureau of Statistics and the Palestine Monetary Authority, has constructed a provisional SAM for Palestine for 2008. This includes four sectors of production: agriculture, manufacturing, market services and non-market services. To construct the SAM for 2004, the SAM provided by MAS has been improved with the use of information provided in the national accounts. The disaggregation of the SAM at a higher level of sectoral detail has been based on the figures regarding intermediate consumption, compensation of employees, final consumption, taxes on imports, custom duties, imports, savings and value added provided by the Palestinian Central Bureau of Statistics.<sup>34</sup> Similar to other countries, the balancing and the disaggregation of the SAM so as to include more sectors have been achieved with the applications of restricted OLS methods.

Lastly, the construction of the SAM for **Syria** has used the data included in the national accounts available at the Central Bureau of Statistics of Syria on gross output, intermediate consumption, consumption of fixed capital, GDP at factor cost as well as at market prices, net indirect taxes (taxes minus subsidies), consumption, investment and increase in stocks, compensation of employees and operating surplus for nine sectors of production.<sup>35</sup> Given the lack of information on institutional demand and on the compensation of the factors of production, complementary to the national accounts, the figures provided by GTAP have been used.

#### 4. Constructing trade, consumption and investment matrices for the GEM-E3 model

In addition to the SAMs, further trade, investment and consumption matrices are required for each of the countries studied with the GEM-E3 model developed for the MEDPRO project. The trade matrix is a snapshot of the flows of goods between two trading partners. In a matrix form, each element  $x_{ab}$  of an  $m \times m$  trade matrix  $M$  for  $m$  countries represents the flows of goods from country  $a$  to country  $b$ . If trade is depicted in terms of exports, each element  $x_{ab}$  of the trade matrix represents the exports of country  $a$  to country  $b$ , as reported by the exporter, for a fixed commodity  $k$  and time  $t$ . On the other hand, if trade is expressed in terms of imports, each element  $m_{ab}$  of the trade matrix will represent the imports of country  $a$  from country  $b$ , as observed on the import side. Theoretically speaking,  $x_{ab}$  and  $m_{ab}$  may represent the same flow of goods: the merchandise trade of commodity  $k$ , in time  $t$ , with provenance  $a$  and destination  $b$  (Parniczky, 1980). Nevertheless, in practice the values of imports and exports differ due to the CIF/FOB ratios.

In the investment matrix, each element  $i_{df}$  of an  $s \times s$  investment matrix  $I$  for  $s$  sectors represents the value of investment goods purchased by sector  $f$  from sector  $d$ . The sum of each column of the investment matrix equals the value of the investment undertaken by sector  $f$ . The row sums equal the revenues of sector  $d$  from inputs related to the investment of other sectors.

The consumption matrix is a snapshot of the composition of the consumption expenditure by purpose of the household disposable income. Each element  $c_{pq}$  of the  $s \times l$  consumption matrix  $C$  for  $s$  sectors of

<sup>32</sup> The authors employ data on Saudi Arabia as presented in the SAM for Saudi Arabia for 2000 in the work of Chemingui and Lofgren (2004).

<sup>33</sup> See MAS (<http://www.pal-econ.org/index.php>).

<sup>34</sup> See the Palestinian Central Bureau of Statistics (<http://www.pcbs.gov.ps>).

<sup>35</sup> These are agriculture, mining and manufacturing, building and construction, wholesale and retail trade, transport and communication, finance and insurance, social and personal services, government services and private non-profit services.



production and  $l$  categories of household consumption by purpose represents the value of the consumption by purpose  $q$  associated with the  $p$  sector. The sum of each column of the consumption matrix equals the household consumption by purpose. The sum of each row of the consumption matrix is equal to the respective cells in the SAM that represent the final demand of households for the respective sector of production.

Similar to the case of the SAMs, no trade, investment or consumption matrices have been available for any of the SEMCs from national or international sources or in the existing literature. As an exception and an initial pool of information to work with, GTAP offers a trade matrix for XNF and XWS. For this purpose, the compilation of the economic and structural database for the MEDPRO project has proceeded with the construction of the appropriate matrices for each of the SEMCs. To construct the trade, consumption and investment matrices for each of the SEMCs, appropriate methods have been applied in tandem with the data retrieved from the national accounts.

For the construction of the trade, investment and consumption matrices, RAS and CE methods have been used. RAS has been a traditional approach to matrix constructing and balancing. RAS starts with a consistent matrix for a particular prior period and ‘updates’ it for a later period, given new information on row and column totals, but no information on the flows within the matrix. Golan et al. (1994) suggest a variety of estimation techniques using “maximum entropy econometrics” in order to address such estimation problems. Robinson et al. (2001) extend these applications to cases where different kinds of prior information, other than knowledge of row and column sums, are available. The literature suggests additional methods for improvement along the lines of the RAS method or techniques that rely on constraints. The most recent and popular techniques, which rely on making the most of a constraint set fall into the category of CE methods.

Given the data availability, the advantages and the limitations associated with the alternative balancing approaches, RAS has been employed for the construction of the consumption matrix, where both row and column sums have been available, while CE has been used to construct the trade and investment matrices for each of the SEMCs. The RAS approach was preferred for the construction of the consumption matrices because the targets that needed to be met were associated with the totals of the rows and columns. This was a necessary requirement so as to be consistent with the consumption figures included in the SAM, given the fact that no information has been available on the consumption matrices for any of the 11 SEMCs.

In contrast, for the construction of the investment and trade matrices, CE methods have been preferred. This has been motivated by several reasons. First, CE is an efficient and cost-effective technique that allows for the ‘maximisation’ of the use of all the information available from a variety of sources. In addition, it allows for the inconsistencies resulting from incomplete knowledge on all the updated or on the newly incorporated flows and account sums, measurement errors and incompatible data sources to all be efficiently removed. Given the combination of different data sources for the construction of the trade and investment matrices, CE methods have further emerged as the best alternative option.

The following sections detail the methodological alternatives and the data used to construct the consumption, investment and trade matrices for each of the SEMCs.

#### 4.1 Trade matrices

For the construction of the trade matrices, two main sources of information have been used: i) the GTAP database and ii) the UN Comtrade database.<sup>36</sup> GTAP offers a starting point in the attempt to construct trade matrices for each of the SEMCs by providing a trade matrix for the group ‘countries’ XNF and XWS. As discussed above, XNF and XWS provide information on groups of countries, the members of which include each of the SEMCs of interest. To be consistent with the global trade volumes of GTAP, the aggregate trade information provided by GTAP had to be maintained. Yet, the group aggregates had to be disaggregated so as to derive valid trade matrices for each of the SEMCs of interest.

<sup>36</sup> See the UN Comtrade database (<http://comtrade.un.org>).



For this purpose further data extracted from the UN Comtrade database have been utilised. The UN Comtrade database provides data on import and export flows by commodity and partner country. The UN Comtrade data include import and export flows for each of the SEMCs. The data fall into the Harmonized Commodity Description and Coding System (HS) and are available at a 6-digit level of detail.<sup>37</sup> In order for these data to be compatible with the sectors of the GTAP database, the concordance proposed by Hucheson (2006) has been adopted.

To derive valid trade matrices for each of the SEMCs, CE methods have been employed. The notations and the variables used in the CE are summarised in Tables 5 and 6 respectively. To maintain the global trade volumes and the proportionality of trade in GTAP, the trade flow aggregates provided by GTAP have been combined with the bilateral trade flows extracted from the UN Comtrade database so as to obtain accurate trade matrices for the base year. The goal has been to construct new trade matrices that would maintain the regional trade flows provided by GTAP and would record a trade structure close to that proposed by the flows recorded in the UN Comtrade data.

*Table 5. Notations used in the construction of the trade matrices*

| Notation         | Description   |
|------------------|---|
| $s=1,...,n$      | Sectors of production   |
| $reg=1,...,r$    | Importer countries in the constructed trade matrix and in the UN Comtrade database                                  |
| $reg_1=1,...,r$  | Exporter countries in the constructed trade matrix and in the UN Comtrade database                                  |
| $reg_a=1,2$      | Subgroup of countries – XNF countries, i.e. Algeria and Libya   |
| $reg_b=1,...,13$ | Subgroup of countries – MEDPRO countries belonging to XWS countries, i.e. Israel, Jordan, Palestine, Syria, Lebanon |
| $a=1,...,k$      | Importer countries in GTAP  |
| $b=1,...,k$      | Exporter countries in GTAP  |

*Table 6. Variables used in the construction of the trade matrices*

| Variable             | Description  |
|----------------------|--|
| $BM_{s,reg,reg_1}$   | Imports of sector $s$ in country $reg$ from country $reg_1$ in the constructed trade matrix                        |
| $BM^*_{s,reg,reg_1}$ | Imports of sector $s$ in country $reg$ from country $reg_1$ according to the UN Comtrade data                      |
| $exh_s$              | Sum of shares for each of the SEMCs in total XWS exports of sector $s$   |
| $imp_s$              | Sum of shares for each of the SEMCs in total XWS imports of sector $s$   |
| $IM_{s,a,b}$         | Imports of sector $s$ in country $a$ from country $b$ according to the GTAP data                                   |
| $EM_{s,reg,reg_1}$   | Exports of sector $s$ from country $reg$ to country $reg_1$  |
| $CIF_{s,reg,reg_1}$  | Cost, insurance and freight (CIF) rate associated with imports of sector $s$ in country $reg$ from country $reg_1$ |
| $VTWR_{s,reg,reg_1}$ | Value of international transport sales in country $reg$ from country $reg_1$ associated with sector $s$            |
| $VXWR_{s,reg,reg_1}$ | Bilateral exports from country $reg$ to country $reg_1$ associated with sector $s$                                 |

For this purpose, the CE procedure employed consisted of the objective equation given by

$$Cebil = \sum_{s=1}^n \sum_{reg}^r \sum_{reg_1}^r [BM_{s,reg,reg_1} * (\log BM_{s,reg,reg_1} - \log BM^*_{s,reg,reg_1})] \quad (19)$$

<sup>37</sup> For the countries not available in HS coding, the data are offered in the SITC coding system.





The objective has concerned the minimisation of *Cebil*, with *Cebil* being the distance between the properties of the new trade matrix  $BM_{s,reg,reg_1}$  and the import data included in the initial trade matrix

$BM_{s,reg,reg_1}^*$  constructed with the information extracted from the UN Comtrade database, after the appropriate aggregation of the data so as to match the GTAP sectoral format.

To ensure consistency with the GTAP trade volumes, further constraints have complemented the CE method. Given the fact that the import and export data provided by GTAP are at the group level for XNF and XWS, additional constraints have been imposed so as to associate the aggregate information of GTAP with the disaggregated information provided in the UN Comtrade database for each of the SEMCs included in XNF and XWS. For this purpose, the constraints summarised in equations (20) to (29) have been applied.

Each of these constraints has been applied to derive a regional disaggregation of the trade flows compatible with the trade aggregates provided by GTAP for XNF and XWS and used for the construction and the balancing of the SAMs.

With regard to the trade flows associated with XWS, the main challenge has been connected with the disaggregation of the countries included in the XWS group to those belonging to the SEMCs of interest and to the rest of the countries that are not studied in the MEDPRO project. For this purpose, a calculation has been made of the sum of the share of imports ( $imh_s$ ) and the sum of the shares of exports ( $exh_s$ ) of Israel, Jordan, Palestine, Syria and Lebanon in relation to the total exports of the countries belonging to XWS for each sector of production  $s$ .

$$IM_{s,a,b} = \sum_{reg=1}^r BM_{s,reg,reg_1} \quad \text{for } reg_1 \neq reg_a, reg_b \text{ and } reg = reg_a \quad (20)$$

$$IM_{s,a,b} = \sum_{reg=1}^r \sum_{reg_1=1}^r BM_{s,reg,reg_1} \quad \text{for } reg = reg_a \text{ and } reg_1 = reg_a \quad (21)$$

$$IM_{s,a,b} * exh_s = \sum_{reg=1}^r \sum_{reg_1=1}^r BM_{s,reg,reg_1} \quad \text{for } reg = reg_a \text{ and } reg_1 = reg_b \quad (22)$$

$$IM_{s,a,b} = \sum_{reg_1=1}^r BM_{s,reg,reg_1} \quad \text{for any } reg \neq reg_a, reg_b \quad (23)$$

$$IM_{s,a,b} * imh_s = \sum_{reg=1}^r BM_{s,reg,reg_1} \quad \text{for } reg_1 \neq reg_a, reg_b \text{ and } reg = reg_b \quad (24)$$

$$IM_{s,a,b} * exh_s = \sum_{reg_1=1}^r BM_{s,reg,reg_1} \quad \text{for } reg \neq reg_a, reg_b \quad (25)$$

$$IM_{s,a,b} * imh_s = \sum_{reg=1}^r \sum_{reg_1=1}^r BM_{s,reg,reg_1} \quad \text{for } reg = reg_b \text{ and } reg_1 = reg_a \quad (26)$$

$$IM_{s,a,b} * imh_s * exh_s = \sum_{reg=1}^r \sum_{reg_1=1}^r BM_{s,reg,reg_1} \quad \text{for } reg = reg_1 = reg_b \quad (27)$$

The bilateral imports of each MEDPRO country from the rest of the world have been calculated by subtracting the sum of imports from *reg* countries from the total imports in GTAP. In a similar way, the bilateral trade flows of the rest of the XWS region have been calculated in a proper manner so as to be in line with the GTAP trade volumes.

After obtaining the import trade matrices for each of the SEMCs, the appropriate transformation has been implemented to obtain the trade matrices expressed in export flows. For this purpose, the bilateral ratio of CIF as derived from the GTAP parameters has been used. In this way, the derivation of the export trade matrices has been based on the division of the elements of the import trade matrix constructed for each of the SEMCs with the CIF rates as summarised by the following equations:

$$EM_{s,reg,reg_1} = BM_{s,reg,reg_1} / (1 + CIF_{s,a,b}) \quad \text{for } a=reg \text{ and } b=reg_1 \quad (28)$$

where

$$CIF_{s,a,b} = VTWR_{s,a,b} / VXWD_{s,a,b} \quad (29)$$

$EM_{s,reg,reg_1}$  represents the exports of sector *s* from country *reg* to country *reg<sub>1</sub>*. The CIF ratio ( $CIF_{s,a,b}$ ) is estimated with the use of the GTAP parameters associated with the value of international transport sales ( $VTWR_{s,a,b}$ ) and bilateral exports ( $VXWR_{s,a,b}$ ).

In the final stage of the construction and the balancing process, the derived matrices for each of the SEMCs have been controlled for their consistency with the trade patterns that characterise each country of interest as well as with the trade figures in the respective SAMs.

## 4.2 Consumption matrices

The attempt to construct the consumption matrices for the SEMCs had to overcome significant data limitations. In most of the cases, little information has been available on the composition of the consumption expenditures of households. For the bulk of the SEMCs, the data provided in the national accounts regarded household expenditures associated with specific sectors of production. In the presence of significant data limitations, the construction of the consumption matrices had to develop on simplifying assumptions. Thus, the construction of the consumption matrices has been based on the aggregate figures regarding household consumption provided by the national accounts and on the structure of the consumption matrix available for the UK for 2000.<sup>38</sup> Given the lack of prior consumption matrices for the SEMCs and of detailed information on the composition of household consumption by purpose, the matrix available for the UK has been used as a basic platform for the construction of the consumption matrices. The latter matrix has been employed in tandem with the aggregate figures on household consumption provided in the national accounts for each of the SEMCs so as to construct the individual matrices.<sup>39</sup>

The combination of the coefficients of the consumption matrix for the UK and the aggregate figures provided in the national accounts have been used in tandem with RAS techniques, so as to construct the consumption matrices for each of the SEMCs. In a RAS framework, the problem of constructing the consumption matrices has been associated with finding a new consumption matrix that would be close to the existing consumption matrix *A* and would conform to the new row and column sums.

<sup>38</sup> The matrix has been provided by the UK Statistical Office.

<sup>39</sup> For the GEM-E3 model, the household consumption sectors include 14 sectors, namely, food, beverages and tobacco, clothing and footwear, housing and water charges, fuels and power, household equipment and operation (excluding heating and cooking appliances), heating and cooking appliances, medical care and health, purchase of vehicles, operation of personal transport equipment, transport services, communication, recreational services, miscellaneous goods and services and education. Given the restricted number of sectors considered for the household consumption expenditures, appropriate aggregation of the consumption sectors in the UK consumption matrix has been made so as to derive the desired level of sectoral aggregation.



A classic approach to this problem is the generation of a new matrix  $A^*$  from the old matrix  $A$  by means of ‘biproportional’ row and column operations. That is,

$$a_{i,j}^* = R_i a_{i,j} S_j \quad (30)$$

The value of every new entry  $a_{i,j}^*$  is found by multiplying the initial entry  $a_{ij}$  with a row multiplicand  $R_i$  and a column multiplicand  $S_j$ . The two multiplier effects are assumed to operate uniformly as there exists only one row and column multiplicand for every row and column of the  $A$  matrix.

In matrix terms, that is

$$A^* = \hat{R} A \hat{S} \quad (31)$$

where the hat indicates a diagonal matrix of elements  $R$  and  $S$ . Bacharach (1970) indicated that this method works in the sense that a unique set of positive multipliers (normalised) exists that satisfies the biproportionality condition and that the elements  $R$  and  $S$  can be found by a simple iterative procedure.

The use of RAS so as to construct the consumption matrices for each of the SEMCs has been developed by paying attention to several considerations. The first regarded the columns’ totals of the consumption matrix. When divided by total household consumption, each column total in the consumption matrix provides information on the share of total household consumption being directed at the specific purpose. In this respect, the values of the columns’ totals of the consumption matrix have to be consistent with the SAM values associated with household consumption.<sup>40</sup>

For Israel, Palestine, Libya, Syria and Jordan, this information has been retrieved from the national accounts. For the remaining SEMCs, for which such information has been missing, the construction of the matrices has proceeded on the assumption that the respective shares would be close to the shares recorded for the aforementioned SEMCs.

Moreover, the implementation of RAS has been associated with the rows’ totals of the consumption matrix. Each row total of the consumption matrix equals the household expenditures associated with the respective sector of production. Hence in the RAS procedure, the rows’ totals had to be maintained in line with the figures provided in the national accounts.

Lastly, a further consideration regarded the coefficients of the consumption matrix as derived from the respective matrix for the UK. In the absence of available data for the SEMCs, the consumption matrix for the UK has been assumed to be representative of the household consumption composition recorded in the SEMCs. This might be a strong assumption; nevertheless, in the absence of further data it has emerged as a valid starting point in the construction procedure. This has facilitated the matrix constructing procedure, while the additional requirements of the construction method associated with the rows’ and columns’ totals have ensured consistency with the figures provided in the national accounts and the household consumption figures included in the constructed SAMs.

The implementation of RAS in order to obtain the consumption matrices for each of the SEMCs in tandem with the figures on household consumption provided in the national accounts and the consumption matrix structure, as obtained from the consumption matrix for the UK, have yielded appropriate matrices for the MEDPRO GEM-E3 model. The derived matrices have been controlled for their consistency and their harmonisation with the constructed SAMs.

### 4.3 Investment matrices

As discussed in the introductory part of this section, the investment matrix is a snapshot of the investment undertaken by each sector of production. Each cell of the investment matrix represents the

<sup>40</sup> For the calculation of the columns’ totals, data from the national accounts of the respective countries have been used regarding the percentage share of household expenditure on each aspect of consumption by purpose category.

value of investment goods purchased by the column's sector from the row's sector. Hence the columns' totals equal the value of the investment undertaken by the respective columns' sectors, while the rows' totals equal the revenues of the rows' sectors from inputs related to the investment of the columns' sectors.

Similar to the construction of the trade and consumption matrices, the construction of the investment matrices had to overcome significant data limitations. With regard to the data employed for the construction of the investment matrices, the available information included aggregate figures on gross fixed capital formation at the sectoral levels, provided in the national accounts of the respective countries. This information has provided the values in the columns' totals of the investment matrices.

Nevertheless, the construction of the investment matrices has been subject to data limitations on the rows' totals, i.e. on the revenues of the sectors of production from inputs related to the investment of the column sectors of production. Further data limitations have been associated with the composition of the investment undertaken by the sectors of production. For this purpose, the construction attempt has developed on simplifying assumptions with regard to the shares of each sectors' inputs in the investment of the other sectors and on the composition of the investment undertaken by each sector.

Given the information on the columns' totals and the assumptions on the composition of the investment undertaken by the different sectors of production, for the construction of the investment matrices CE methods have been applied.

The CE procedure applied consisted of the objective equation given by

$$Ceim = \sum_{s=1}^n \sum_{s_1=1}^n \left[ SHIM_{s,s_1} * (\log SHIM_{s,s_1} - \log SHIM_{s,s_1}^*) \right] \quad (32)$$

where  $Ceim$  is the distance between the shares of each sector in the investment undertaken by the columns' sectors of production in the new investment matrix  $SHIM_{s,s_1}$  and of the initial investment

matrix  $SHIM_{s,s_1}^*$ , which has been constructed according to the simplifying assumptions on the composition of the investment undertaken by each sector.

To be consistent with the assumptions on the investment composition as well as with the information included in the SAMs constructed with regard to the investment figures, the additional constraints summarised in equations (33) to (35) regarding the columns' and rows' totals as well as the shares of each sector of production in the investment undertaken by the other sectors of production, have complemented the CE methods. The additional constraints are given by

$$SHIM_{s,s_1} = \frac{IM_{s,s_1}}{\sum_{s_1=1}^n IM_{s,s_1}} \quad (33)$$

$$\sum_{s=1}^n SHIM_{s,s_1} = 1 \quad (34)$$

$$\sum_{s_1=1}^n IM_{s,s_1} = \sum_{o=1}^2 INV_{s,o} \quad (35)$$

According to equation (33), the shares of the sector's  $s$  inputs related to the investment expenditures of the sector  $s_1$  ( $SHIM_{s,s_1}$ ) are constrained to being equal to the rate of investment inputs from sector  $s$  to sector  $s_1$  ( $IM_{s,s_1}$ ) over the column's sum, which equals the investment undertaken by sector  $s$ . Equation (34) constrains the sum of the shares of the inputs from the  $s$  sectors to the investment undertaken by sector  $s_1$  to equal 1. Lastly, equation (35) constrains the columns' totals of the

investment matrix to equal the investment expenditures recorded in the respective SAMs associated with the respective sectors  $s$  of production.

The implementation of CE in order to obtain the investment matrices for each of the SEMCs in tandem with the figures on investment provided in the national accounts have led to the construction of the appropriate investment matrices for the MEDPRO GEM-E3 model. The derived matrices have been controlled for their consistency with the constructed SAMs.

## 5. Conclusion

The present report has summarised the data and methods employed for the development of the economic and structural database for the MEDPRO project. The database provides a collection of economic, governance, environmental and development indicators for the SEMCs. The database aims at complementing the qualitative analysis of the SEMCs as well as the quantitative assessment and the scenario development with the GEM-E3 model. In addition to the secondary data, the database has been complemented by the construction of social accounting, trade, investment and consumption matrices for each of the SEMCs. This remains a significant input to the MEDPRO project, given the primacy of the latter as essential requirements for the GEM-E3 model developed for the MEDPRO project.

This task has been confronted by several data and methodological challenges. The latter have been addressed through the employment of simplifying assumptions based on a thorough investigation of the economies under consideration and on the development of the appropriate numerical exercises. The outcome of these efforts has been the derivation of appropriate matrices to be utilised for the purposes of the MEDPRO project. This is a first step towards obtaining valid and appropriate datasets to work with.

## References

- Bacharach, M. (1970), *Biproportional Matrices and Input-Output Change*, Cambridge, MA: Cambridge University Press.
- Dessus, S. and J. Ghaleb (2006), *Lebanon – Trade and Competition Policies for Growth: A General Equilibrium Analysis*, Middle East and North Africa Working Paper No. 46, World Bank, Washington, D.C.
- Hutcheson, T. (2006), “S2002-CPC 1.1-ISIC, Rev3-GTAP Concordance” ([www.gtap.agecon.purdue.edu/resources/res\\_display.asp?RecordID=1916](http://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=1916)).
- Golan, A., J. Judge and S. Robinson (1994), “Recovering information from incomplete or partial multisectoral economic data”, *Review of Economics and Statistics*, Vol. 76, No. 3, pp. 541-549.
- Kaufmann, D., A. Kraay and P. Zoido-Lobaton (1999), *Aggregating governance indicators*, Policy Research Working Paper No. 2195, World Bank, Washington, D.C.
- Kaufmann, D., D. Kraay and H. Mastruzzi (2008), *Governance matters III: Governance indicators for 1996–2007*, World Bank, Washington, D.C.
- Kerwat, J., J. Dewhurst and H. Molana (2009), *Constructing a Social Accounting Matrix for Libya*, Discussion Papers in Economics, Working Paper No. 223, University of Dundee.
- Lucke, B. (2001), *Fiscal Impact of Trade Liberalization: The Case of Jordan and Syria*, FEMISE Research Programme.
- Parniczky, G., (1980), “On the inconsistency of the world trade statistics”, *International Statistical Review*, Vol. 48, No. 1, pp. 43-48.
- Pyatt, G. and A.R. Roe (eds) (1977), *Social Accounting for Development Planning with Special Reference to Sri Lanka*, Cambridge, MA: Cambridge University Press.
- Robinson, S., A. Cattaneo and M. El-Said (2001), “Updating and estimating a social accounting matrix using cross entropy methods”, *Economic Systems Research*, Vol. 13, No. 1, pp. 47–64.
- Schneider, M.H. and S.A. Zenios (1990), “A Comparative Study of Algorithms for Matrix Balancing”, *Operational research*, Vol. 38, No. 3, pp. 439-455.
- Stone, R. (1977), “Foreword”, in G. Pyatt and A.R. Roe (eds), *Social Accounting for Development Planning with Special Reference to Sri Lanka*, Cambridge, MA: Cambridge University Press.

## Databases and websites

- Arab Monetary Fund ([www.amf.org.ae](http://www.amf.org.ae))
- Economic Accounts Mission, Lebanon (<http://www.pcm.gov.lb>)
- Global Trade Analysis Project ([www.gtap.agecon.purdue.edu/default.asp](http://www.gtap.agecon.purdue.edu/default.asp))
- Hashemite Kingdom of Jordan Department of Statistics ([www.dos.gov.jo/home\\_e.htm](http://www.dos.gov.jo/home_e.htm))
- International Energy Agency (IEA) ([www.iea.org/stats/index.asp](http://www.iea.org/stats/index.asp))
- International Monetary Fund ([www.imf.org](http://www.imf.org))
- National Office of Statistics, Algeria (<http://www.ons.dz>).
- OECD (<http://stats.oecd.org/Index.aspx>)
- Palestine Economic Policy Research Institute (MAS) ([www.pal-econ.org/index.php](http://www.pal-econ.org/index.php))
- Palestinian Central Bureau of Statistics ([www.pcbs.gov.ps](http://www.pcbs.gov.ps))
- UN Comtrade (<http://comtrade.un.org/>)
- US Energy Information Administration ([www.eia.doe.gov/](http://www.eia.doe.gov/))
- World Bank ([www.worldbank.org](http://www.worldbank.org))
- World Bank Development Indicators (<http://data.worldbank.org/data-catalog/world-development-indicators>)
- World Bank Worldwide Governance Indicators (<http://info.worldbank.org/governance/wgi/index.asp>)
- World Health Organisation ([www.who.int/research/en/](http://www.who.int/research/en/))







## About MEDPRO

MEDPRO – Mediterranean Prospects – is a consortium of 17 highly reputed institutions from throughout the Mediterranean funded under the EU's 7<sup>th</sup> Framework Programme and coordinated by the Centre for European Policy Studies based in Brussels. At its core, MEDPRO explores the key challenges facing the countries in the Southern Mediterranean region in the coming decades. Towards this end, MEDPRO will undertake a prospective analysis, building on scenarios for regional integration and cooperation with the EU up to 2030 and on various impact assessments. A multi-disciplinary approach is taken to the research, which is organised into seven fields of study: geopolitics and governance; demography, health and ageing; management of environment and natural resources; energy and climate change mitigation; economic integration, trade, investment and sectoral analyses; financial services and capital markets; human capital, social protection, inequality and migration. By carrying out this work, MEDPRO aims to deliver a sound scientific underpinning for future policy decisions at both domestic and EU levels.

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| <b>Title</b>                           | MEDPRO – Prospective Analysis for the Mediterranean Region   |
| <b>Description</b>                     | MEDPRO explores the challenges facing the countries in the South Mediterranean region in the coming decades. The project will undertake a comprehensive foresight analysis to provide a sound scientific underpinning for future policy decisions at both domestic and EU levels.  |
| <b>Mediterranean countries covered</b> | Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, Palestine, Syria, Tunisia and Turkey  |
| <b>Coordinator</b>                     | Dr. Rym Ayadi, Centre for European Policy Studies (CEPS), <a href="mailto:rym.ayadi@ceps.eu">rym.ayadi@ceps.eu</a>   |
| <b>Consortium</b>                      | Centre for European Policy Studies, <b>CEPS</b> , Belgium; Center for Social and Economic Research, <b>CASE</b> , Poland; Cyprus Center for European and International Affairs, <b>CCEIA</b> , Cyprus; Fondazione Eni Enrico Mattei, <b>FEEM</b> , Italy; Forum Euro-Méditerranéen des Instituts de Sciences Economiques, <b>FEMISE</b> , France; Faculty of Economics and Political Sciences, <b>FEPS</b> , Egypt; Istituto Affari Internazionali, <b>IAI</b> , Italy; Institute of Communication and Computer Systems, <b>ICCS/NTUA</b> , Greece; Institut Européen de la Méditerranée, <b>IEMed</b> , Spain; Institut Marocain des Relations Internationales, <b>IMRI</b> , Morocco; Istituto di Studi per l'Integrazione dei Sistemi, <b>ISIS</b> , Italy; Institut Tunisien de la Compétitivité et des Etudes Quantitatives, <b>ITCEQ</b> , Tunisia; Mediterranean Agronomic Institute of Bari, <b>MAIB</b> , Italy; Palestine Economic Policy Research Institute, <b>MAS</b> , Palestine; Netherlands Interdisciplinary Demographic Institute, <b>NIDI</b> , Netherlands; Universidad Politécnica de Madrid, <b>UPM</b> , Spain; Centre for European Economic Research, <b>ZEW</b> , Germany |
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| <b>Duration</b>                        | 1 April 2010 – 31 March 2013 (36 months)   |
| <b>EC Scientific Officer</b>           | Dr. Domenico Rossetti Di Valdalbero, DG RESEARCH   |
| <b>Website</b>                         | <a href="http://www.medpro-foresight.eu">www.medpro-foresight.eu</a>   |
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