
MASSACHUSETTS
INSTITUTE OF TECHNOLOGY

working paper
department
of economics

# EFFECTS OF CONSTRUCTION LABOR MIGRATION ON THE EGYPTIAN ECONOMY

NO. 243

massachusetts
institute of
technology

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Revised July 10, 1979

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This monograph is the result of research undertaken as part of the Cairo University/Massachusetts Institute of Technology Technological Planning Program and represents the collaboration of two projects in that program: the Project on Egyptian Labor Migration and the Project on Improved Methods of Macroeconomic and Sectoral Planning. Since this study is based on the analytic methods and data developed in those projects, it is heavily indebted to their contributions. Neither the Cairo University/MIT Technological Planning Program nor the United States Agency for International Development which finances it bears any responsibility for the contents of this paper.

* The author gratefully acknowledges the valuable contributions of Youssef Boutros-Ghali and Balbir Singh-Sihag in computational assistance and analysis.

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## I. Summary and Conclusions

The critical effects on Egypt of the large scale emigration of its construction workers are confirmed by the analysis using the general equilibrium model GEM-3, developed to simulate the Egyptian economy. The solutions to that model make it clear that the emigration has been a major source of output and factor price changes as well as changes in the levels and distribution of income. The calculations also suggest that the emigration has had a strong negative impact on the investment plans and, therefore, on the achievement of the growth targets of the Egyptian economy. These negative effects have been somewhat offset by the remittances generated by the workers abroad. While such remittances may have been less critical when other large sources of foreign exchange were available on relatively easy terms, in the present circumstances their existence is especially fortuitous.

The economy wide effects of the emigration of Egyptian construction labor can be analyzed only with a general equilibrium economic model such as GEM-3 which encompasses the entire economy. The results of the application of the model to this subject extend and enrich partial equilibrium analyses and provide quantitative insights not otherwise available. It cannot be claimed that the solutions provide "proofs" of the effects of the emigration of construction workers. Yet, they generate plausible explanations of observed economic phenomena. In this way they also support the empirical studies which have estimated the scale of the migration at the relatively high levels which were investigated in the model solutions.

The tests using the GEM-3 model are, in many ways, counter-factual analyses: what would have happended in 1976 if portions of the construction labor force were withdrawn under various assumed conditions. The conditions

include the maintenance of investment, export and government expenditure levels, the receipt of remittances at estimated "actual" levels, and a number of specific and often somewhat restrictive assumptions about the characteristics of production, factor supply conditions and so on. Thus, the results must be interpreted carefully, not as predictions of the effects of emigration, with all the actual induced effects present, but as predictions under conditions which do not wholly conform to reality. But that is the nature of all such analyses in social science and, used with care, the GEM-3 results can provide useful insights.

1. Wage increases

The most direct effects of the emigration of construction labor are the increases in the wages of labor in that sector. These spill over into wage increases in any other sector from which labor can move into construction. In the model solutions--and in reality--when labor flows from agriculture to construction, the shortage of construction labor then affects labor supply conditions and wages in agriculture. In addition, increases in factor incomes raise consumer demands whose satisfaction requires more inputs and puts greater pressure on fixed inputs, which contributes to cost increases. Since output prices are determined by costs in the model--and to a considerable extent in reality--output prices also rise.

The differences in construction wages which are generated by the model solutions under the alternative assumptions of no labor mobility and full labor mobility between the construction and agricultural sectors indicate the importance of using judgement in interpreting the results. In the solutions in which 50 percent of the construction labor force is withdrawn and there is no labor mobility, labor wages rise by 326 percent in the construction

sector. If there were full labor mobility from agriculture to construction sector, the increase is only 20 percent. Estimates of the actual increases in construction wages after 1973 range up to and even beyond the larger increase. Labor has actually moved into construction from agriculture and from some other sectors as well, but not easily from any sector. In addition, because the model embodies the unrealistic assumption that the labor which does move into construction is of the same quality as the labor which leaves, that tends to further dampen the wage changes it generates as compared to what actually happens.

2. Changes in capital requirements

If the emigration of construction labor were to have been fully offset, increases in the use of capital both in construction and in agriculture would have been necessary. If there were no labor mobility between construction and agriculture, the capital used in the construction sector in order to make up for the emigration of 50 percent of the construction labor force would have to more than double. If there were perfect mobility, the required increase in the construction capital stock would be only 10 percent and the agricultural capital stock would rise by 8.6 percent. At the same level of construction labor emigration, if there were mobility between construction and agriculture, the labor force in construction would not fall by 50 percent but by only 8.2 percent, while the agricultural labor force would fall by 7.7 percent.

The important implications to be drawn from these results are not that they predict the precise effects of the emigration of construction labor. Rather the results indicate the magnitude of the adjustments made necessary by the emigration, if the exogenous and endogenous expenditure and output

levels of the year were to be maintained. Since those adjustments are manifestly beyond what could be reasonably expected under the best of circumstances, the conclusion to be drawn from the model solutions is that the investment and other expenditure targets could not be achieved. Thus, the model solutions suggest that the emigration of construction labor has been a major bottleneck in the achievement of the economic goals of the Egyptian economy.

3. Income effects

The simulation of the emigration of construction labor without replacement from the agricultural sector demonstrates that incomes would nonetheless rise in both construction and agriculture. If there were labor mobility which replaced emigrating construction labor, income levels would change only slightly in construction, but still rise substantially in agriculture. In both cases, the relative changes in income are roughly the same in all income classes in agriculture. However, in urban areas the highest income classes would benefit most.

4. Consumption effects

The changes in real consumption indicated by the model solutions are less than the changes in nominal income and less in urban than in rural areas in all the experiments. In fact, total real consumption in urban areas actually falls as a result of construction labor migration when it is somewhat offset by mobility of labor from agriculture. Though real consumption per construction worker would rise, it would fall in other sectors. The increases in incomes in this case are actually less than the increases in prices, tending to identify and confirm one of the common complaints of recent years.

## 5. The longer term implications of construction labor emigration

The emigration of a large part of the Egyptian construction labor force is a "once-and-for-all-change." The price and wage increases resulting from the emigration, take time to work their way through the economy to their full impact. Yet they do not keep recurring anew each year in their full strength. The tests made are tests of the implications of a single change in the availability of labor in construction. When that change has been accomplished, the system settles down to a new equilibrium unless it is perturbed again by further changes.

The model solutions indicate the effects of the large increases in the emigration of construction labor. The solutions do not predict that all those effects will continue to be felt at the same levels year after year unless the emigration continues to grow year after year. Since continued growth of construction labor emigration at the same rate is unlikely, the negative effects of that emigration will presumably diminish over time as various adjustments are made. In actuality, it seems plausible that the negative effects of the emigration of construction labor have, by 1978 and 1979, been mostly absorbed by the Egyptian economy. Wages, prices, incomes and other variables have all changed in response to the emigration. Bottlenecks to investment have been created. But the growth of the domestic labor force in construction indicates that the Egyptian economy has, by 1978 and 1979, been reasonably effective in overcoming the bottlenecks through the transfer of labor. That labor, in turn, has benefitted from training on the job.

This reasoning does not mean that there are no more development problems to be overcome. The emigration of critical workers has been one such difficulty; it may become so again if emigration of construction workers

further increases or emigration of other critical types of labor grows. But the problems associated with the first wave of construction labor emigration, which this analysis indicates to have been quite substantial, should, by now, be largely behind the Egyptian economy.

## 6. The use of the GEM-3 model

The GEM-3 model which is used to test the consequences of the emigration of construction labor is a constrained multisector equilibrium system. It is linear in all of its relations except the production of value added. All the components of final demand are specified exogenously except consumption which is determined endogenously by a linear consumption expenditure system for each of six classes of income recipients. Overall equilibrium is achieved by adjusting incomes and savings to equal investment. Output prices are determined by costs rather than by supply and demand interactions.

A model of this type is useful for quantitative analyses of the effects of changes in certain types of policy instruments or other exogenously imposed influences. Tax and subsidy policies are examples. With respect to other types of influences, the GEM-3 model serves primarily as a tool of qualitative analysis taking the place of theories which have too few sectors to be enlightening or which omit features such as income distribution which may be essential to the outcomes. In these latter uses, although the solutions of the model emerge in a quantitative form, it is really their qualitative implications which are revealing. This is the type of problem for which GEM-3 is used in this investigation, and the precise quantitative results are not intended to be taken at face value.

The differences in what can be expected in the different types of application arise because certain restrictive assumptions which are built

into the model have more or less significance under alternative conditions. For example, in studying the results of tax or subsidy policies, in which demand rather than supply responses are critical for the outcomes, the GEM-3 models can be used to provide useful quantitative estimates. On the other hand, when supply responses are critical, such as in the present use of the model to examine the effects of the emigration of a large proportion of the construction labor force, the quantitative results are often dominated by the special assumptions about the nature of production relations and the conditions of factor supply and the adjustment processes. Thus, in this application the model should be appreciated as serving the same functions as a theoretical model: the particular quantitative results provide qualitative indications of the implications of a set of interrelationships which are too detailed to be treated by conventional theoretical models.

To some degree also, the qualitative nature of the GEM-3 solutions which demonstrate the effects of the emigration of construction labor only confirm in more detail a partial equilibrium analysis. However, there are aspects of the results which could only have been obtained by using a general equilibrium model which can take into account the important interdependent relationships in the economy.

## II. Introduction

The large scale migration of Egyptian construction workers to the Arab oil exporting countries has been induced by the acceleration of investment in those countries after the oil price increases of 1973-74. In order to carry out such investment forty to sixty percent of the total capital required for each project must usually finance construction activities and the proportion will be even higher for certain kinds of basic infrastructures. Thus the rapid expansion of the output of the construction sectors of the oil exporting countries has been a necessary concomitant of their growth. The same facts and logic indicate that construction must also expand rapidly in the Egyptian economy in order to accelerate investment and growth there. Moreover, it has been argued that years of neglect of the existing capital stock has created a backlog of maintenance requirements in Egypt which impose additional demand on the construction sector.

Construction activities require many inputs: raw materials, some capital and relatively skilled labor. All but the latter can be purchased easily in international markets. The international market for skilled labor is less extensive. In these conditions the supply of Egyptian construction labor to the Arab oil exporting nations has been a major facilitator of their growth. The obverse of that proposition is that the immediate impact of this emigration has been to hinder the expansion of Egyptian investment.[1] There is an indirect effect of the increased supply of foreign exchange from emigrant remittances which somewhat offsets this. In the recent circumstances in Egypt, in which investment is not constrained primarily by a lack of foreign exchange to buy equipment, the indirect effect cannot be completely offsetting, however. Construction output must be "locally" produced and additional foreign exchange resources cannot supply a "nontraded" good. Only if domestic investment and construction were at relatively low

levels and emigration drained off unemployed labor would that emigration not constrain domestic construction and, therefore, investment in Egypt. It appears that the rate of construction labor emigration has been so high relative to domestic demand that it has further constricted the construction bottleneck to investment and growth.

There are several reasons why it is difficult to elicit the consequences of construction labor emigration in a precise and quantitative manner from the existing data. First of all, the data itself has a number of inadequacies in coverage, detail, timeliness, and, perhaps, in accuracy. Secondly, many adjustments to the emigration take place which hide its consequences. And, finally, there are many other influences working their way through the system at the same time which make it difficult to identify the particular effects of migration. Thus, it is necessary to have some type of analytical tool in order to isolate just those effects of construction labor migration. In fact, more than one tool is necessary as the effects are pervasive and of such different types that it is unlikely that a single technique will serve the purpose.

It is clear that the analytical approach should take into account the indirect as well as the direct effects of the emigration. Any cost increases in the construction sector will be passed on to other sectors. The constraints on construction output will limit investment and have effects on overall growth. The increases in wages which are induced will affect income and consumption patterns, and so on. It is, therefore, necessary to use a general equilibrium model, i.e., one which reflects the general interdependence in the system, in order to include all the relevant effects.

This paper reports on the use of such a model, the GEM-3 (General Equilibrium Model) model, which has been developed to analyze economic policy in the Egyptian economy, for the investigation of some of the consequences of the migration of Egyptian construction labor.

The next section discusses in general terms the direct economic consequences of the emigration of construction labor. The GEM-3 model used for detailed analysis of the consequences is described briefly in Section IV with emphasis being placed on the weaknesses as well as strengths of the model for the purposes for which it will be used. Section V will describe the consequences of the emigration of construction labor as elicited from the results obtained in applying the GEM-3 model to analyze the issues.

## III. A General View of the Economic Effects of the Emigration of Egyptian Construction Labor

A preceding paper has already discussed the general effects of the migration of Egyptian construction workers in some detail. So this section will only take up those features which are critical for the modeling of the phenomenon.[2] As noted previously, the magnitude of the migration of the construction labor force is, itself, not known with precision. Alternative estimates which have been prepared put the numbers between 293,000 and 434,000 with the latter figure appearing to be closer to reality. Since the total number of construction workers is itself a figure about which there is some question, it is even more difficult to determine the emigration as a proportion of the labor force. However, using the data which is available, these proportions seem to be from 31 to 154 percent of the construction labor force in 1976. Using what appears to be the most likely estimate of construction labor emigration, it seems that 46 to 53 percent of the total construction labor force has emigrated.[3]

Although the numbers involved are large as a proportion of the total construction labor force, they nonetheless probably underestimate the consequences of the emigration of the effective labor supply to the sector. That is because the emigration undoubtedly contains a disproportionate number of relatively highly skilled workers. There are important components of the total construction labor force such as carpenters, electricians, plumbers and other craftsmen whose training times are long by comparison with most other types of labor. Since these relatively skilled workers are especially scarce in the Arab oil-exporting countries they are a particularly significant proportion of emigrating construction workers. Thus, the emigration, rather than taking a cross-section of the construction labor force and leaving average productivity unchanged on this account,

must have tended to reduce the productivity of the construction labor force

It would be difficult, however, to measure the productivity effects of the emigration because of other factors which have also been operating to reduce labor productivity, including materials shortages. These have been sporadic but widespread and have caused continuing delays in construction, leaving workers idle for some portion of their time on the job. In addition, the emigration of skilled design and equipment engineers, who may or may not be counted as part of the construction labor force but nonetheless provide important inputs, may create another constraint.

There has been a substantial increase in wages of construction workers, as noted elsewhere.[4] This, as well as the decrease in productivity, has undoubtedly contributed to the recognized increase in labor costs. The resulting increase in the cost of construction and, thus, of investment must have tended to reduce quantities demanded relative to what the levels would otherwise have been, except in those sectors in which demand is completely inelastic. The latter may be represented by some government projects, especially military or national demonstration projects such as reconstruction along the Suez Canal. But the increased costs of construction mean that both government and private budgets will cover less. This is just another way of recognizing that the emigration of construction workers has drained away real productive resources which, in the mid-1970's, have been a constraint on Egyptian investment and growth.

While it is not likely that the constraining effects of construction labor emigration have been uniform among sectors or between the public and private sector, the data are not enlightening on the differential effects and *a priori* reasoning is not conclusive. Presumably, private sector wages are more flexible than government wages. They can adjust upwards

more readily both to induce construction workers to remain in the country and to attract new entrants to this labor force. Private sector output prices can also adjust to make this possible. For these reasons, the construction output for the private sector may have suffered less from emigration than public sector construction. On the other hand, much of government construction is done by private contractors. In addition, the government exercises wide-ranging controls over the distribution of construction materials which, while not at all perfect, do have a considerable degree of effectiveness. It is possible that this latter type of regulation is more constraining than the differences in degree of price and wage flexibility in the public and private sectors in determining the composition of output.

Similarly, while the shortages of workers, especially in critical skills, may contribute to unusual delays in completion of construction projects, the shortages of materials may be more important in this respect also. Again, the available data do not permit a more precise assessment of the issues.

Turning from the sectoral to the economy-wide effects of the migration of construction workers, it has been argued elsewhere that the emigration of Egyptian labor in general and of construction workers in particular may be one of the most important channels of adjustment of prices and wages in the Egyptian economy both to international influences and to changes in the level and composition of demand within the economy.[5] That is because of the extensive system of regulation and control which prevents or delays most other potential domestic adjustments. There are price controls or subsidies on many producer and consumer goods, as well as direct allocation mechanisms. In addition, many sectors of the economy are dominated by public firms whose price and wage structures are "administerd" rather than

being determined primarily by market influences. The administration of wages of workers in public firms and the government bureaucracy also limits the scope of income changes in reaction to changes in demand and supply patterns and prices. All of these controls, administered prices and subsidies as well as a fixed exchange rate, have tended to insulate the domestic economy from international price changes and also to prevent price changes within particular sectors from being reflected widely through the system.

The areas of the Egyptian economy in which prices and incomes are relatively free to adjust to real changes in demand and supply conditions are mainly in the privately organized parts of the economy, which include most of agriculture, construction, some of industry, and the service sectors. Thus, the most direct effects of the migration of Egyptian labor on the distribution of income will not be transmitted through changes in the wages of civil servants or public sector employees but through the impact of changes in just those sectors in which incomes are determined flexibly by market forces. By comparison, a substantial part of total Egyptian emigration is composed of teachers and other professionals "seconded" from the Egyptian civil service. Since their wages are not determined in markets, their departure does not readily affect the incomes of those public employees who remain. The distributional effects of the flow of remittances of the higher earnings abroad of all types of emigrants will be spread more widely across sectors, however.

The increases in domestic wages, which are caused by the emigration of construction and similar labor, will have further effects as those incomes are spent, reflecting the particular patterns of demand of the income classes among which this labor is divided. In turn, these consumption

demands will generate additional output. These indirect effects may be quite substantial, depending on the demand elasticities, on the one hand, and supply conditions, on the other. There will be corresponding changes in imports and in taxes and subsidies which are related to income.

It might be argued that the emigration of construction labor only removes labor easily replaceable from a substantial pool of unemployed workers. However, the unemployed urban workers typically do not have the skills, and, unfortunately, often not the physical stamina to do construction work. There is some controversy as to the extent of unemployment in Egyptian agriculture and, therefore, the effects of withdrawing labor from that sector. However, it does not appear to be the case that the unemployed include a large proportion of the adult males in agriculture who would be the replacements for emigration labor.[6]

As noted, the changes due to the emigration of construction workers have all occurred as other major influences have impinged on the Egyptian economy in 1974: large scale emigration of workers of other types, changes in the level and composition of investment and of imports and exports which have been generated independently of the migration, changes in tax and subsidy rates and so on. All of these have also worked their way through the system, having a succession of repercussive effects. The use of the GEM-3 model to analyze the implications of the migration of construction workers is a means of identifying these indirect as well as the more direct effects of the migration alone.

## IV. The Adaptation of the Structure of the GEM-3 Model to the Analysis of Construction Labor Emigration

The GEM-3 model has both strengths and weaknesses as an analytical tool for the analysis of the effects of migration.[7] Its strengths are related to its character as a general equilibrium model with the simultaneous determination of both prices and outputs in a number of sectors of the economy. In addition to calculating the intermediate inputs used in each sector, the model will determine, subject to the constraints which are imposed with respect to availability, the use of primary inputs of labor, land, capital and their incomes. While intermediate inputs are determined by a fixed coefficients input-output table, value added is generated by a variable coefficients production function. This permits substitution among primary factors as their relative availabilities change. In turn, there will be changes in factor returns which are determined within the model. Factor incomes are allocated among rural and urban recipients and distributed among the size classes of income recipients in each sector.

The real values of investment, government expenditure and export components of final demand are determined exogenously. But consumption is determined endogenously for each class of income recipient. Imports are also determined endogenously with components related to total output, investment and the income of each class of recipient. Taxes and subsidies are also determined endogenously and those taxes and subsidies which are paid by or to income recipients are calculated for each income class. All of this is done while maintaining overall and sectoral consistency.

The weaknesses of the GEM-3 model are of a number of types, but only those most critical for the analysis of the effects of construction labor migration will be mentioned. The exogenous determination of the investment,

export and government expenditure components of final demand means that there is no endogenous modification of the levels and composition of investment in reaction to changes in costs such as those which occur as the result of construction labor migration. This means that the adjustments of investment and output which in actuality occur in response to changes in labor availabilities and costs are not analyzed within the model.

This is not unusual in models of this type, particularly with respect to government investment since that is, to a considerable extent, determined by non-economic factors in any case. Of course, the dominance of the public sector in Egyptian investment strengthens the argument for exogenous specification of all investment.

The technology for the use of intermediate inputs is embodied in an input-output, fixed coefficients matrix, so there is no possibility for substitution among these inputs or for labor or other primary inputs as relative costs change. The production function for value added, while allowing for substitution, is a Cobb-Douglas function with an elasticity of substitution of unity in all sectors which implies constancy of the income shares paid to productive factors whatever the relative amounts of the factors used in production.

The linearity, with fixed coefficients, in the intermediate input technology is matched by analogous relationships in other parts of the model. Government taxes and subsidies are determined in this manner, as are imports. The shares of each income group in the income earned by each type of factor in each sector are also determined by linear relations with fixed coefficients. The consumption demand relations are also linear, but in these linear relations relative prices have an effect on the consumption of the output of each sector.

The usual justification for linearity other than that of analytical and computational convenience, or even necessity, is that for relatively

small changes it is likely to be a satisfactory approximation. Yet in the application for which the model will be used, relatively large changes are imposed on the construction labor force. One might, therefore, fear that the solutions may move outside the range in which the linearity assumptions are appropriate for the variables most closely connected to the direct impact of the emigration. There is no way that adjustments can be made for this, except in the use of primary inputs, where the production technology is non-linear, though of a special type. Thus, in examining the results of the model solutions, post hoc, it will be necessary to take these limitations into account.

Although prices are determined within the model, the price determination process is of a "mark-up" type, rather than being determined by supply and demand forces. That is, prices are set equal to costs of intermediate and primary inputs. It is only in the determination of the costs of value added by the primary factors that market forces play a role as relative factor inputs adjust to relative scarcities. This structure might be acceptable as a first approximation inasmuch as relative scarcities are determined by the demand for the outputs which the inputs will produce. However, in actuality the availabilities of many inputs are fixed rather than themselves being responsive to prices. If all primary input availabilities were fixed, there would be little scope for adjustment within the model to increases in final demands. It is only by specifying that the supplies of some inputs are not constrained that the model is allowed some freedom to find solutions.

The computational problems of finding a solution to a fully constrained model are formidable. The algorithm used to solve the mathematical problem posed by the model is reasonably effective with only a small number of constraints, say eight to ten, but has not been able to handle more than sixteen. In addition, it is not empirically warranted to apply the primary

factor constraints uniformly. There is excess capacity in the capital stock in some sectors and underemployed labor as well. This point will be expanded and demonstrated explicitly in the application of the models to test the significance of the emigration of construction workers.

It should also be noted that there is no freedom within the model as it stands to fix the prices of any inputs, even when in reality they are constrained, except by assuming that the supply is elastic at a specified price. However, at least within a short period in Egypt, wages in public sector firms and government activities are not really determined by relative factor scarcities which in turn depend on relative product demands as well as factor supplies. In the model this is treated by specifying a perfectly elastic supply of capital and labor in government enterprises, which reflects a widely held view as to the realities in these sectors. In some other sectors as well, one or more factors are assumed to be available in elastic supply at a fixed price. Otherwise, it is assumed in the model that wages as well as other primary factor prices are flexible. This may not be unrealistic as a "long run" assumption even though not applicable within short periods. However, most of the other relationships in the model are justified as short run approximations. The constraints are imposed only as absolute limits to each type of resource which is available to each sector or group of sectors, rather than in terms of an increasing supply price for increasing amounts of resources used.

The total land available to agriculture is constrained but it is assumed that the land can be shifted among the four agricultural sectors: staple food, non-staple food, cotton and other agriculture. The total amount of agricultural labor is also constrained but allowed to shift among the four sectors. In one set of solutions labor is allowed to shift from the

agricultural sectors to construction as well. The supply of agricultural capital is assumed to be elastic at a fixed price. The same capital supply conditions are assumed for both the construction and service sectors, given the relatively small capital requirements in these activities. With less justification, perhaps, a similar assumption is adopted for the petroleum sector. In the private sector of urban industry, labor and capital are both constrained.

The constraint pattern on primary factors implies that additional capital is necessary in the agricultural sectors to permit increases in output there. Conceivably, additional land can also be created by reclamation. But no provision is made within the model for the latter possibility. The assumption that availability of intermediate inputs is the only active constraint on output in industrial enterprise in the public sectors has also been the position of some of the various national and international assistance programs. These have concentrated on balance of payments relief in large part to provide intermediate inputs to sustain current production. On the other hand, the starvation of the private sector for capital is well recognized.

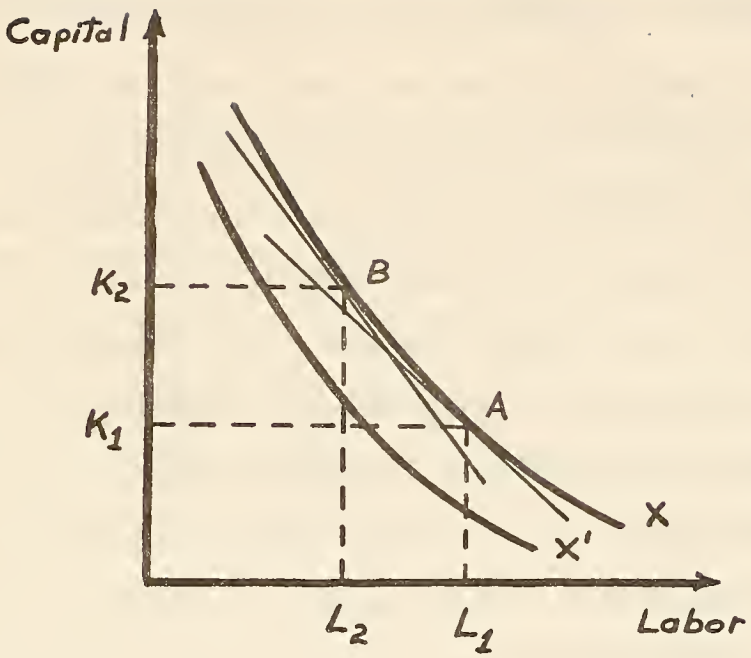
The weaknesses and limitations of the GEM-3 model mean that it will not be possible to accept its solutions as indicative of the precise quantitative effects when it is applied to analyze the emigration of construction workers. However, if the quantitative results are interpreted as suggesting qualitative effects, they should be enlightening. In particular, quantitative results which indicate these indirect effects of emigration which could only be discovered in the context of a model of general interdependence will provide interesting qualitative insights.

The direct effects of the emigration of construction labor and the indirect effects transmitted to other sectors are determined simultaneously in a manner which does not correspond completely to the usual assumptions about market interactions. It is tempting to explain all the price changes in terms of endogenous shifts in supply and demand. But output prices are cost determined. Relative factor prices are determined by exogenously specified factor supply conditions and endogenously determined factor demands while the levels of both factor and product prices are also set so as to satisfy the requirement that savings must equal investment.

All the constraints of the model contribute to and interact in the results obtained in any solution. However, it is useful to think of the results as emerging from a two stage process as follows. Factor prices are initially normalized at unity with the necessary implications for the choice of units of measurement. Given the production functions for the generation of value added, these factor prices immediately determine the land, labor, and capital input proportions used in each sector. Sectoral prices, incomes, private consumption and the other endogenous variables of the model are simultaneously determined at levels consistent with the exogenous specifications through successive interactions. The first step is actually rather an easy matter of matrix inversion and multiplication and a number of other simple algebraic calculations.

There is, however, no guarantee that the results of this first set of interactions are consistent with the factor availabilities. The factor availability constraints and factor prices must be made consistent and yet meet the final demand constraints and the endogenously determined elements of a solution. To achieve this, a more complex algorithm must be used for the solution of the non-linear relations created by the Cobb-Douglas production

Figure 1



functions which are implicit in the equations for the cost of value added in each sector. It is in this stage of the solution process that relative factor prices and, consequently, product prices are adjusted up or down to satisfy all the constraints including the one that incomes must be at levels which will generate the savings which, in turn, must be equal to investment.

Figure 1 may help in understanding the solution process at work. The lines X and X' in the Figure represent production isoquants for the generation of value added in the construction sector. Suppose that X represents the desired output level, which is completely specified exogenously by investment requirements. That output level is produced with the labor and capital inputs $L_1$ and $K_1$.

The withdrawal of labor from the construction sector is indicated by the shift from $L_1$ to $L_2$. If only the original amount of capital were available to be used, construction output would have to fall to X'. However, since the availability of capital in this sector is not constrained, the output will be maintained by the addition of capital to the level $K_2$.

At the original capital/labor ratio and production point A, the ratio of the marginal productivities of the factors and, therefore, their relative returns is indicated by the slope of the tangent line. The higher slope of the tangent line at the new production point B indicates the relatively higher wage rate for labor and lower capital rental.

In the experiment which allows labor mobility between the construction and the agriculture sectors, similar changes also occur in the latter sectors. Some agricultural labor will move into the construction sector to replace the emigrating labor. The loss of labor in agriculture will be offset by decreases in final demands on that sector and by increased use of capital in order to meet the demands on that sector given the fixed amount of land.

## V. The Application of GEM-3 to Analyze the Effects of Construction Labor Emigration

The emigration of construction labor from Egypt has been due to forces exogenous to that economy: an increase in investment programs, construction labor requirements and, therefore, wages in the Arab oil-exporting countries. In the same way, therefore, the emigration is imposed exogenously on the model by the withdrawal of labor from the construction sector. The other conditions assumed for the Egyptian economy are respresented in the Social Accounting Matrix estimated for 1976.[8] This includes the substantial remittances which were repatriated by emigrant workers in 1976. Thus, the tests which are made are as if experiments: what have been the consequences of the emigration of construction labor when, otherwise, conditions were as if they had prevailed in 1976?

The amount of labor withdrawn is determined as a fraction of the labor force which was originally calculated to be necessary to produce the output of the construction sector in 1976. Thus, this is not a test of the effects of the emigration from 1973 to 1976, except insofar that emigration in those years might have reduced the availability of construction labor in 1976. However, as noted in another study, the number of construction workers has grown so substantially that the emigrants have been replaced, at least in terms of the numbers of workers if not in terms of their skills.[9] The solution provides insight as to what would have happened if the construction labor force in 1976 were suddenly reduced by emigration, as if the other conditions of final demand and resource supplies prevailed in 1976.

The tests were run in several variants. First, alternative percentages of the construction labor force were withdrawn without replacement from any other sector. The percentages were 20 percent, 40 percent and 50 percent.

The latter ranges might seem somwhat high, yet they are well within the range of the estimates of the actual share of the construction labor force which emigrated in the years after 1974. Moreover, as pointed out above, the loss in productivity of the remaining labor force was certainly relatively larger than the numbers leaving as there is a high proportion of especially skilled workers among the emigrants. In this variant of the test, the only means by which the construction sector can meet the exogenously imposed demands for its output, which are only for investment purposes, is by more intensive use of capital in place of the departed labor. Since the availability of capital is not constrained in this sector, that substitution takes place automatically in the model solutions. This is, of course, not completely realistic. Yet the amounts of capital involved are relatively small and the type of capital is usually unsophisticated and often readily constructed or borrowed from other sectors and the changes in technique necessary are modest. So it is plausible to assume that substitution of capital for labor can to a considerable extent take place readily. However, there is little doubt that the automaticity and ease of the process is overstated in the model and its solutions.

In the second major variant of the experiment, labor in the agricultural sector was allowed to replace labor drawn from the construction sector as endogenously determined within the model to be necessary. The extent of the transfer of the labor from agriculture to construction depends on the relative demands for output in the two sectors and the constraints of land in agriculture. It should be noted that the assumption of a Cobb-Douglas production function implies an elasticity of substitution of unity in both agriculture and construction. In this second variant also 20, 40 and 50 percent of the construction labor force were withdrawn in successive trials.

It is still true that capital use in the construction sector is unconstrained and that is also the case in agriculture, although in the latter sector, land is a constraining factor.

The effects of the withdrawal of construction labor run all through the system and manifest themselves in the levels of output achieved, the output and factor prices, government revenues and expenditures, private incomes and expenditures, imports and the trade balance and so on. However, since much of the expenditure in the system is exogenously determined and productive factors are typically constrained to be used in particular sectors, most of the effects are confined to particular sectors and variables. Thus, the results have some special features which are not immediately intuitive unless the special structure of the model is kept in mind.

1. Factor and output price effects

Table 1 indicates what is, perhaps, the most direct effect of the withdrawal of construction labor: the induced changes in factor prices in each of the sectors. These are listed for each of the percentage amounts of construction labor withdrawal which were tested. In this case the replacement from agriculture of the labor withdrawn from construction is not permitted. It should be noted that, prior to the withdrawal of labor in any of the experiments, the model is calibrated so that the initial factor prices in each sector are set at one. This implies, of course, that the quantities of factors used in each sector must be measured in appropriate units. It should also be recalled that in this version capital availabilities are not constrained in the agricultural and construction sectors.

The largest factor price effect of the withdrawal of construction

## Table 1

Factor Prices After Construction Labor Emigration Classified by Percentage Construction Labor Force Reduction with Original Prices Set at Unity

Without Labor Mobility

| Sector | 20% | | | 40% | | | 50% | | |
|---|---|---|---|---|---|---|---|---|---|
| | Land | Capital | Labor | Land | Capital | Labor | Land | Capital | Labor |
| 1. Staple Food | 1.023 | 1 | 1.0226 | 1.064 | 1 | 1.0628 | 1.098 | 1 | 1.096 |
| 2. Non-Staple Food | 1.023 | 1 | 1.0226 | 1.064 | 1 | 1.0628 | 1.098 | 1 | 1.096 |
| 3. Cotton | 1.023 | 1 | 1.0226 | 1.064 | 1 | 1.0628 | 1.098 | 1 | 1.096 |
| 4. Other Agriculture | 1.023 | 1 | 1.0226 | 1.064 | 1 | 1.0628 | 1.098 | 1 | 1.096 |
| 5. Food Processing | | 1.0284 | 1 | | 1.0784 | 1 | | 1.120 | 1 |
| 6. Textiles | | 1.0334 | 1 | | 1.0902 | 1 | | 1.137 | 1 |
| 7. Other Industries | | 1.0147 | 1 | | 1.040 | 1 | | 1.061 | 1 |
| 8. Construction | | 1 | 1.593 | | 1 | 2.907 | | 1.0 | 4.258 |
| 9. Oil and Products | | 1.0676 | 1 | | 1.214 | 1 | | 1.337 | 1 |
| 10. Transportation, Communications | | 1.0547 | 1 | | 1.150 | 1 | | 1.232 | 1 |
| 11. Housing | | 1.0334 | 1 | | 1.090 | 1 | | 1.137 | 1 |
| 12. Other Services | | 1 | 1 | | 1 | 1 | | 1 | 1 |

labor is, as expected, on the price of labor in construction itself. The effect of the withdrawal of only 20% of the labor construction force is to increase labor wages by 59 percent. If 40 percent of the labor force were withdrawn, wages would almost triple in comparison to the situation without emigration. And if 50 percent of the labor force emigrated, wages would rise by 325.8 percent. This is striking confirmation of the qualitative analysis of the emigration phenomenon. As noted previously, the withdrawal of 50 percent of construction labor is within the range of estimates of actual events and may even underestimate the impact on effective labor supply in construction.

Table 2 reports the calculated factor price changes in the various sectors due to the withdrawal of construction labor under the assumption that labor is allowed to move freely between that sector and the agricultural sectors. There is an implicit assumption as well that all of the labor in both sectors is of the same quality and has the same productivity. In this case the calculated induced increases in wages are dampened considerably as compared to the calculated wages when labor is assumed to be immobile. Wages in construction rise by 7 percent, 15 percent and 20 percent for percentage withdrawals of 20, 40 and 50 percent of the labor force. Since, under the assumptions made in these tests, the labor force in the agricultural and construction sectors is now merged, the same percentage wage increases occur in the agricultural sectors. Accompanying the wage increases in agriculture are corresponding 3.7, 7.9 and 10.2 percent increases in land rentals. Since capital is not constrained in the agricultural sector in this version of the model, its price does not change.

Associated with the factor price increases are increases in output prices, since in this model prices are determined only by costs. The price

Table 2

Factor Prices After Construction Labor Emigration Classified by Percentage Construction Labor Force Reduction with Original Prices Set at Unity

With Labor Mobility

| Sector | 20% | | | 40% | | | 50% | | |
|---|---|---|---|---|---|---|---|---|---|
| | Land | Capital | Labor | Land | Capital | Labor | Land | Capital | Labor |
| 1. Staple Food | 1.037 | 1 | 1.076 | 1.079 | 1 | 1.152 | 1.102 | 1 | 1.196 |
| 2. Non-Staple Food | 1.037 | 1 | 1.076 | 1.079 | 1 | 1.152 | 1.102 | 1 | 1.196 |
| 3. Cotton | 1.037 | 1 | 1.076 | 1.079 | 1 | 1.152 | 1.102 | 1 | 1.196 |
| 4. Other Agriculture | 1.037 | 1 | 1.076 | 1.079 | 1 | 1.152 | 1.102 | 1 | 1.196 |
| 5. Food Processing | | 1.004 | 1 | | 1.009 | 1 | | 1.012 | 1 |
| 6. Textiles | | 1.009 | 1 | | 1.019 | 1 | | 1.024 | 1 |
| 7. Other Industries | | 1.005 | 1 | | 1.010 | 1 | | 1.013 | 1 |
| 8. Construction | | 1 | 1.071 | | 1 | 1.152 | | 1.0 | 1.196 |
| 9. Oil and Products | | 1.010 | 1 | | 1.019 | 1 | | 1.025 | 1 |
| 10. Transportation, Communications | | .998 | 1 | | .996 | 1 | | 1.0 | 1 |
| 11. Housing | | 1.003 | 1 | | 1.007 | 1 | | 1.007 | 1 |
| 12. Other Services | | 1 | 1 | | 1 | 1 | | 1.0 | 1 |

changes which occur as a result of the various amounts of construction labor emigration are shown in Tables 3 and 4 for the various sectors, as determined in the model solutions computed for the various percentage reductions in the labor force in the construction sector without and with mobility of labor from the agricultural sectors. As would be expected, the largest price increase is in the construction sector itself when there is no mobility of labor into that sector. Moreover, the price of the output of the construction sector rises more rapidly than the labor force reductions after the first withdrawal of 20 percent of the labor force. That induces a 10 percent increase in construction output prices when there is no mobility of labor and only a 1.5 percent increase when labor is mobile between the construction and the agricultural sectors. When the amount of labor emigrating rises to 40 percent of the construction labor force, the construction output price rises by 30 percent without labor mobility and by 3.2 percent with labor mobility from agriculture. When the labor withdrawal reaches 50 percent of the construction labor force, the price increase in construction is 45.4 percent without labor mobility from agriculture and 4 percent with such labor mobility.

It is difficult to judge whether these are under-estimates or over-estimates of the actual effects of labor withdrawal. On the one hand, more flexibility is built into the model, for example in the factor supply conditions than actually exists. This flexibility is represented by the assumptions for a number of sectors that enough complementary factors, especially capital, are always available at perfectly elastic supply to meet exogenous and endogenous demand. In addition labor in construction and agriculture is assumed to be homogeneous in quality. On the other hand, there is no adjustment of final or intermediate demands to prices except

Table 3

Output Prices After Construction Labor Emigration Without Labor Mobility
(Initial Prices at Unity)

| Sector | | Construction Labor Force Reduction | | | |
|---|---|---|---|---|---|
| | | 50% Reduction | 40% Reduction | 20% Reduction | No Reduction |
| Staple Food | 1 | 1.056 | 1.037 | 1.013 | 1.0 |
| Non-Staple Food | 2 | 1.052 | 1.034 | 1.012 | 1.0 |
| Cotton | 3 | 1.058 | 1.038 | 1.014 | 1.0 |
| Other Agriculture | 4 | 1.074 | 1.048 | 1.017 | 1.0 |
| Food Processing Industries | 5 | 1.031 | 1.020 | 1.007 | 1.0 |
| Textile Industry | 6 | 1.041 | 1.027 | 1.010 | 1.0 |
| Other Industries | 7 | 1.004 | 1.003 | 1.001 | 1.0 |
| Construction | 8 | 1.454 | 1.300 | 1.100 | 1.0 |
| Crude Oil & Products | 9 | 1.042 | 1.027 | 1.009 | 1.0 |
| Transportation, Communications | 10 | 1.017 | 1.011 | 1.004 | 1.0 |
| Housing | 11 | 1.088 | 1.058 | 1.021 | 1.0 |
| Other Services | 12 | 1.007 | 1.004 | 1.001 | 1.0 |

for small effects on consumption. On balance, it seems reasonable to believe that the model probably underestimates the immediate impact effects. In any case, the model results should primarily be interpreted as a qualitative confirmation through an explicit general equilibirum model of simpler partial equilibrium analyses.

The model results include the price effects of migration which occur in other sectors than construction. Even when labor mobility from agriculture to construction is not allowed, prices in the agricultural sector rise by 5.2 to 7.4 percent and housing prices by almost 9 percent when 50 percent of the labor from agriculture to construction is allowed, that moderates the increases in prices in construction and in all other sectors but agriculture. In the agricultural sectors, however, the price increases are larger than the previous case and range from 8.2 to 11.6 percent. It is important in appreciating the factor and output price results which are obtained to understand just how they are generated in the solution of the GEM-3 model. To pose the issues it may help to recall that the estimates of the construction labor force range from 2.8 to 4.5 percent of the total Egyptian labor force while the labor force in agriculture constitutes 45 to 50 percent of the total. The question then arises as to why, when there is labor mobility between construction and agriculture, the withdrawal of 50 percent of the construction labor force, for example, which may be no more than, say, 2.5 percent of the labor force of the combined agricultural and construction sectors, leads to a labor wage increase in those sectors of almost 20 percent? And why do agricultural prices in this case of assumed intersectoral labor mobility increase so much more than when there is no labor mobility among the two sectors?

Table 4

Output Prices After Construction Labor Emigration With Mobility of Labor Between Construction and Agriculture

(Initial Prices at Unity)

| Sector | | Construction Labor Force Reduction | | | |
|---|---|---|---|---|---|
| | | 50% Reduction | 40% Reduction | 20% Reduction | No Reduction |
| Staple Food | 1 | 1.090 | 1.071 | 1.033 | 1.0 |
| Non-Staple Food | 2 | 1.082 | 1.064 | 1.030 | 1.0 |
| Cotton | 3 | 1.096 | 1.075 | 1.035 | 1.0 |
| Other Agriculture | 4 | 1.116 | 1.090 | 1.043 | 1.0 |
| Food Processing Industries | 5 | 1.036 | 1.028 | 1.013 | 1.0 |
| Textile Industry | 6 | 1.025 | 1.019 | 1.009 | 1.0 |
| Other Industries | 7 | 1.001 | 1.011 | 1.000 | 1.0 |
| Construction | 8 | 1.040 | 1.032 | 1.015 | 1.0 |
| Crude Oil & Products | 9 | 1.003 | 1.002 | 1.001 | 1.0 |
| Transportation, Communications | 10 | 1.001 | 1.001 | 1.000 | 1.0 |
| Housing | 11 | 1.006 | 1.005 | 1.002 | 1.0 |
| Other Services | 12 | 1.003 | 1.002 | 1.001 | 1.0 |

The answer consists of several parts because all aspects of the model interact in generating each feature of a solution.

The particular results depend on the parameters of the production functions in both sectors, of course. But the production function is a simple one which reproduces the gross patterns of the sectors and should be an acceptable approximation for small changes. It is possible, of course, that a 2.5 percent change in total labor availability in both the construction and agricultural sectors is not a "small change". That is, the test may take the solutions outside the range of acceptable approximations. Unfortunately, this cannot be tested without an alternative specification which on a priori grounds would be a better approximation.

The results also depend on the demands for the output of the sectors. The demand for construction is for investment purposes and is specified exogenously. Only a small part of the demand for the output of the agricultural sectors is exogenously determined, the rest being directly or indirectly related to the larger, endogenously determined consumption demand. Thus, increases in income which stimulate consumption have a substantial effect on the demands for agricultural goods. The stimulus to consumption, in turn, is largely the result of the redistribution of income which takes place when a particular type of labor is withdrawn from the economy. The changes in output of the various sectors which are associated in the solutions for a 50 percent withdrawal of labor from the construction sector, with and without the assumptions of labor mobility among the sectors, are listed in Table 5.

However, it should be emphasized again that the levels of output and factor prices are not determined solely by conventional supply-demand

adjustments in the GEM-3 models. In these models the levels of prices and incomes must also adjust in order to generate enough saving to meet the exogenously determined investment, taking into account the endogenously determined consumption.

Relative wages in construction must rise because there is less labor to combine with the increased amounts of capital. When the labor scarcity is spread into the agricultural sector, the effect is qualitatively the same but moderated. Output prices are determined by the costs of intermediates and primary inputs and these cost levels, in turn, reflecting output prices, must be set by the constraints on the model to generate sufficient incomes to produce the necessary saving. Since the savings rates in the agricultural sectors are relatively high, this is also a reason why the model solution process tends to concentrate the increases in prices and income in these sectors.

The lesson to be drawn from these results for prices is not only that there would be changes in the levels of construction prices which are associated with the emigration of labor. As noted, a partial equilibrium analysis would reveal that. The important result obtained uniquely from the model is the spread of the price increases to other sectors, but not all other sectors to the same extent.

The price increases which have actually occurred in the construction sector in recent years appear to be much larger than indicated by the model solutions. Yet it is not easy to attribute the portion of the actual price increases due to labor migration, to inflation in the costs other inputs and to the general increases in demand for the output of the construction sector. So the model results cannot be compared directly with the changes which have

Table 5

Changes in Sectoral Output Associated With Emigration of Fifty Per Cent of the Construction Labor Force

(per cent)

| Sector | With No Labor Mobility | With Mobility of Labor Between Agriculture and Construction |
|---|---|---|
| Staple Food | 1.8 | 0.1 |
| Non-Staple Food | 3.5 | -0.8 |
| Cotton | 1.3 | 0.3 |
| Other Agriculture | 3.3 | -0.9 |
| Food Processing Industries | 3.5 | 0.4 |
| Textile Industry | 4.1 | 0.8 |
| Other Industries | 2.3 | 0.5 |
| Construction | 0.3 | 0.0 |
| Crude Oil & Products | 2.1 | 0.2 |
| Transportation, Communications | 8.4 | -0.2 |
| Housing | 5.3 | 0.4 |
| Other Services | 2.6 | 0.4 |
| Total | 3.0 | 0.2 |

occurred as a check on their plausibility. Yet the model solutions, properly interpreted, point to construction labor emigration as a major source of general inflation in the Egyptian economy.

2. Factor demand effects

Table 6 lists the factor demands associated with the various model solutions. It should again be recalled in interpreting this table that in the construction sector only the amount of labor is constrained and capital inputs are assumed to adjust as they must to produce the output demanded from the sector with the labor available. In the agricultural sectors, both labor and land are constraints and, again, capital is assumed to adjust as necessary to generate the sectoral outputs. In the remaining sectors it is only in private enterprise that capital and labor are constrained and in the public enterprises, there is assumed to be an elastic supply of labor and capital.

Rows 2.1 through 2.12 of columns (1), (2) and (3) in Table 6 indicate the originally assumed endowments of primary factors in the various sectors. As indicated, land is used only in the agricultural sectors. Row 1 of columns (1) through (12) shows the factors demands in the construction sector corresponding to withdrawals of labor in the proportions indicated, under the assumption that there is no mobility of labor between the construction and the agricultural sectors. In this latter case, there is no direct effect on factor demands in other sectors but only an indirect effect as a result of a change in the patterns of consumer demand resulting from the relative changes in incomes of different income groups. These latter changes are small so the complete detail of factor demands in all sectors is not presented. Rows 2.1 through 2.12 of columns (4) through (12) of

TABLE 6

Factor Demands After Construction Labor Emigration
Classified by Percentage Construction Labor Force Reduction

Without Labor Mobility

| Sector | (1) No Reduction | | | (4) 20% | | | (7) 40% | | | (10) 50% | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Land | Capital | Labor | Land | Capital | Labor | Land | Capital | Labor | Land | Capital | Labor |
| 1. Construction | 0 | 122.09 | 131.42 | 0 | 155.68 | 105.50 | 0 | 212.82 | 79.12 | 0 | 259.67 | 65.92 |

With Labor Mobility

| | No Reduction | | | 20% | | | 40% | | | 50% | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Land | Capital | Labor | Land | Capital | Labor | Land | Capital | Labor | Land | Capital | Labor |
| 2.1 Staple Food | 72.53 | 103.33 | 140.98 | 72.77 | 105.03 | 137.33 | 73.0 | 111.08 | 133.68 | 73.13 | 113.22 | 131.85 |
| 2.2 Non-Staple Food | 165.42 | 344.95 | 295.38 | 164.35 | 354.17 | 284.99 | 163.2 | 364.09 | 274.65 | 162.68 | 369.55 | 269.50 |
| 2.3 Cotton | 46.89 | 63.00 | 92.15 | 47.06 | 65.67 | 89.56 | 47.2 | 68.57 | 86.97 | 47.33 | 70.12 | 85.66 |
| 2.4 Other Agriculture | 160.71 | 79.62 | 197.46 | 161.36 | 83.03 | 192.00 | 162.05 | 86.74 | 186.52 | 162.41 | 88.72 | 183.77 |
| 2.5 Food Processing | 0 | 107.67 | 56.30 | 0 | 107.7 | 56.52 | 0 | 107.72 | 56.75 | 0 | 107.73 | 56.88 |
| 2.6 Textiles | 0 | 163.22 | 166.81 | 0 | 163.38 | 167.60 | 0 | 163.54 | 168.47 | 0 | 163.62 | 168.89 |
| 2.7 Other Industries | 0 | 362.56 | 206.44 | 0 | 363.13 | 206.97 | 0 | 363.74 | 207.54 | 0 | 364.06 | 207.84 |
| 2.8 Construction | 0 | 122.09 | 131.92 | 0 | 126.59 | 127.56 | 0 | 131.46 | 123.18 | 0 | 134.05 | 120.99 |
| 2.9 Oil and Products | 0 | 302.95 | 21.09 | 0 | 303.10 | 21.14 | 0 | 303.26 | 21.18 | 0 | 303.35 | 21.21 |

| Sector | | No Reduction | | | 20% | | | 40% | | | 50% | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Land | Capital | Labor | Land | Capital | Labor | Land | Capital | Labor | Land | Capital | Labor |
| 2.10 | Transportation, Communications | 0 | 278.34 | 175.78 | 0 | 278.15 | 175.63 | 0 | 277.93 | 175.48 | 0 | 27.82 | 175.39 |
| 2.11 | Housing | 0 | 83.33 | 50.66 | 0 | 83.34 | 50.84 | 0 | 83.36 | 51.03 | 0 | 83.37 | 51.14 |
| 2.12 | Other Services | 0 | 742.82 | 1306.30 | 0 | 743.97 | 1308.34 | 0 | 745.23 | 1310.59 | 0 | 745.90 | 1311.69 |

Table 6 list the factor demands generated as a result of the withdrawal of construction labor in the percentages indicated, under the assumption that there is mobility of labor between the construction and agricultural sectors.

Focusing first of all on the case of no labor mobility between the construction and agricultural sectors, the effects on capital demands can be seen by comparing row 1 column (2) of that row with the entries in columns (5), (8) and (11). The increases in capital in the sector are explained as in Figure 1: they must be sufficient to maintain the output levels. In these experiments, if only 20 percent of the construction labor force were withdrawn, the amount of capital used in the construction sector would have to increase by 27 percent; if 40 percent of the labor force were withdrawn, the amount of capital used would have to increase by 74 percent; and if 50 percent of the labor force left construction, then the amount of capital needed to make up for their loss and maintain output would have to be 113 percent larger than otherwise.

These percentage changes in capital requirements are substantial and may indicate the degree of unreality embodied in the assumption that the changes are automatic. Before making this judgement, however, it should be recalled that the absolute magnitudes of capital involved are not large in comparison to capital used in other sectors and that the capital is, on the whole, not highly specialized and some responsiveness of supply to price increases would undoubtedly occur. In spite of these rationalizations, it is nonetheless true that, in the construction sector itself, the adjustments are so large as to cast doubt on whether it is reasonable to assume that they could be achieved. If the adjustments in capital inputs cannot be made, then the specified output levels in turn could not be reached.

Before making even a tentative judgement on this matter it is worth examining the results obtained under the assumption that labor is mobile between the agricultural and construction sectors. This involves comparisons among the columns (1) through (12) both along the agricultural sector rows and the construction row. The actual decline in labor used in construction, if 20 percent, 40 percent and 50 percent of its labor force were to be withdrawn, according to this model would be only 3.3, 6.6, and 8.3 percent, respectively, with the differences being made up by transfers of labor from the agricultural sector. There is some shifting of the agricultural labor force among the four agricultural sectors in response to changes in demand patterns resulting from shifts in income among the various producing and consuming groups. The total reductions in the agricultural labor force corresponding to the 20 percent, 40 percent and 50 percent withdrawals of construction labor are 3.1 percent, 6.1 percent and 7.7 percent respectively.

In order to meet the exogenously specified and endogenously induced demand for agricultural outputs with a smaller labor force, additional capital is required since the amount of land available is fixed in the model. The additional amounts of agricultural capital necessary in the cases of 20 percent, 40 percent and 50 percent withdrawals of construction labor are, respectively, 2.8 percent, 6.7 percent and 8.5 percent larger than the initial endowments. Since the amount of capital used in the agricultural sector is relatively large, in part simply because of the large size of the sector, these percentage increases represent quite substantial increments.

The additional capital used in the construction and agricultural sectors to compensate for the emigration of construction labor is provided automatically in the model solutions. Once these requirements are revealed, the results

suggest strongly that, in actuality, the adjustments could not be made. The real outcome of the construction labor emigration would, therefore, have to be a reduction in actual construction and an increase in prices above that calculated in the model. Thus, even when the solution of the model is "unrealistic", on careful examination it will indicate the real nature of the conditions which might be expected.

It might be noted in passing that the capital and labor adjustments in the other sectors are relatively modest and reflect either small errors or small adjustments to small changes in the patterns of induced consumption demands.

3. Consumption and income distribution effects

The emigration of construction labor has direct consequences for the levels and distribution of income in the urban areas in which the sector is located as the incomes of the factors employed in that sector adjust to the changes. The replacement of the construction worker emigrants by labor from agriculture sets off similar effects in agriculture. There are many indirect consequences as well, both in urban and rural areas, largely due to the effect of induced changes in consumption expenditures in the sectors supplying consumer goods. Changes of this type are impossible to analyze even in a qualitative manner with a partial equilibrium approach as they make themselves felt as a result of the general interdependence in the economy. Thus a general equilibrium analysis such as is contained in GEM-3 is essential in order to gain insights into the issues.

In the particular set of cases under examination the interdependent effects are relatively easy to follow. There are no feedbacks from consumption demand on the output of the construction sector due to increased

incomes in other sectors, as nearly all of the output of the construction sector is directed to investment and is exogenously specified. In addition there is no mobility of resources, other than labor, between the agriculture and construction sectors. There are, however, indirect effects on other sectors through consumption demand changes induced by shifts in the level and distribution of income.

The effects on incomes and consumption of the withdrawal of fifty percent of the construction labor force in the urban and rural sectors as a whole, and on the separate classes of income recipients in each sector are shown in Table 7.

The interpretation of the results with respect to the levels and distribution of incomes must be particularly careful, taking into account the "counterfactual" nature of the experiments. The levels of investment, exports and government expenditures are all assumed to remain unchanged in the face of substantial emigration and only the consumption component of aggregate demand and imports show the effects of income changes. This implies, in particular, that construction output is virtually maintained since nearly all of construction services are for investment and only a modest amount are intermediate inputs. The assumed elastic supply of capital makes all this possible. With construction output almost assured to be constant, the income generated in that sector is similarly almost unchanged in the face of labor emigration. The share of the different factors in that income is likewise constant, due to the use of Cobb-Douglas production functions for the generation of value added. But the rate of return to the different factors and the distribution of income will change due to the differential participation of the various income groups in the returns to labor and capital. The movement of agricultural labor into construction

## Table 7

Changes in Disposable Income and Consumption
Associated with Emigration of Fifty Percent of Construction Labor Force (Percent)

| | Urban Sectors | | | | Rural Sectors | | | | Urban & Rural |
|---|---|---|---|---|---|---|---|---|---|
| | Total | Lowest 60% of Recipients | Next 30% of Recipients | Highest 10% of Recipients | Total | Lowest 60% of Recipients | Next 30% of Recipients | Highest 10% of Recipients | Total |
| **Changes in Nominal Disposable Income** | | | | | | | | | |
| With no labor mobility | 9.9 | 7.8 | 7.9 | 13.6 | 9.1 | 9.1 | 9.1 | 9.3 | 9.7 |
| With full labor mobility between agriculture and construction | 1.0 | .8 | .8 | 1.3 | 9.4 | 9.4 | 9.3 | 9.5 | 4.0 |
| **Changes in Nominal Expenditure** | | | | | | | | | |
| With no mobility | +9.6 | +7.8 | +7.9 | 13.7 | +9.2 | +9.1 | +9.1 | +9.3 | +9.5 |
| With full mobility | +0.1 | +0.1 | +0.1 | +1.3 | +9.5 | +9.5 | +9.3 | +9.5 | +3.4 |
| **Changes in Real Consumption** | | | | | | | | | |
| With no mobility | +6.0 | +4.7 | +4.8 | +10.8 | +6.7 | +7.4 | +5.9 | +6.3 | +6.6 |
| With full mobility | -1.8 | -2.3 | -2.2 | -0.2 | +6.6 | +6.9 | +5.8 | +6.5 | 0.6 |

would tend to dampen the effects on urban incomes of the emigration of construction workers, but will spread effects such as those described above into the agricultural sectors. The changes in income will set off differential induced responses by consumption expenditures by sector due to the differences in the consumption income and price elasticities of the various income classes.

When there is no labor mobility between the construction and the agricultural sectors, the changes in nominal urban incomes are larger than when there is labor mobility. The induced effects on agricultural incomes are larger as well. It is striking to note that when there is no labor mobility, incomes nonetheless rise in the agricultural sector by almost as much as in the urban sector. This is partly a manifestation of the induced changes in demand and factor prices which have been noted above. The agricultural sector is one of the few large sectors in which availability of important productive factors are constrained yet its output must respond to large induced changes in consumption demand. So agricultural incomes must rise when construction labor migrates, even when there is no labor mobility. The increases in agricultural incomesare much greater than the increases in construction sector incomes when thereis labor mobility because of the changes in income which induce changes in consumption demand.

The uniformity of the relative income changes in the various classes of income recipients in agriculture is a special result of the assumption of Cobb-Douglas production functions with their implied constancy of factor shares and fixed participation by the various income groups in the functional incomes. Thus, although there is not complete uniformity among the income classes in their relative ownership of capital and land, as well as provision of labor, the differences are not so large that they lead to substantial changes in the distribution of income within agriculture.

The changes in income distribution patterns within the economic sectors of urban areas as a result of the emigration of construction labor are more substantial due to the larger differences in the participation of the various income classes in the functional returns.

The changes in the distribution of real consumption follow roughly the distribution of changes in income. When there is no labor mobility between the construction and agricultural sectors, real consumption increases in both rural and urban areas, with the former increasing more in accordance with the larger increase in income in rural areas. When there is mobility between the construction and agricultural sectors, total real consumption actually declines in the urban sectors while rising in rural areas. This effect arises because the increases in income in urban areas in this case are not enough to offset the increases in prices of consumer goods which were set off by the emigration of labor and, of course, there are fewer workers. The emigration of construction workers increases the real value of per capita consumption of those who remain, whether or not there is labor mobility. The small reductions in total real consumption in the case of labor mobility is more than offset by the 8.2 percent decline in the number of workers. But in urban sectors in which the labor force has not declined, real per capita consumption would fall.

The results of the model, therefore, tend to verify a complaint which has been common in Egypt: That, while incomes have increased, the prices of consumer goods have increased more, resulting in a decline in real consumption. The model, of course, associates the changes with replacement of the emigrating labor from the agricultural sector alone.

In reality, there have been replacements of emigrating labor from other sectors as well as from agriculture, and many other factors impinging

on the economy. The suppliers of capital in construction and agriculture have not been perfectly elastic so outputs have not been maintained to the degree presumed in the model. Thus, the induced effects of the emigration have been both more widespread and more profound than indicated by the solutions.

## Footnotes

1. For a more extended argument see N. Choucri et al. (1978), p. 127-129.
2. ibid., pp. 97-127.
3. ibid., pp. 71-87.
4. ibid., pp. 47-55.
5. ibid., pp. 119-129.
6. See Amr Mohie-Eldin (1977).
7. For a fuller description see R. S. Eckaus et al. (1978).
8. ibid., pp. 28-38.
9. See N. Choucri et al. (1978), pp. 28-38.

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