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The Role of Emigration and Migration in Swedish Industrialization - Some Preliminary Results using a Computable General Equilibrium Model

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THE ROLE OF EMIGRATION AND MIGRATION IN SWEDISH INDUSTRIALIZATION—SOME PRELIMINARY RESULTS USING A COMPUTABLE GENERAL EQUILIBRIUM MODEL

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FOREWORD

Roughly 1.8 billion people, 42 percent of the world's population, live in urban areas today. At the beginning of the last century, the urban population of the world totaled only 25 million. According to recent United Nations estimates, about 3.1 billion people, twice today's urban population, will be living in urban areas by the year 2000.

Scholars and policy makers often disagree when it comes to evaluating the desirability of current rapid rates of urban growth and urbanization in many parts of the globe. Some see this trend as fostering national processes of socioeconomic development, particuarly in the poorer and rapidly urbanizing countries of the Third World; whereas others believe the consequences to be largely undesirable and argue that such urban growth should be slowed down.

This paper presents counterfactural simulation results generated by a general equilibrium model that describes the urbanization and development experience of Sweden during the years 1870-1914. The simulations stress the effects of migration on the industrialization of Sweden. Urban Karlström's historical analysis of Sweden's development joins a collection of national case studies that are being concluded as part of the HSS Area's Population, Resources, and Growth Task.

A list of the papers in the Population, Resources, and Growth Series appears at the end of this paper.

Andrei Rogers
Chairman
Human Settlements
and Services Area

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ABSTRACT

This paper discusses some preliminary results of the Swedish case study of the Population, Resources, and Growth Task. The study highlights the Swedish demoeconomic development during its first phase of industrialization, the pre-World War I period, with specific emphasis on an analysis of the economic consequences of rural-to-urban migration and emigration. The paper starts with a short review of the model that has been developed—a so-called numerical general equilibrium model, especially designed to capture Swedish development. Results of simulations over a 20 year period are given. After discussing the capability of the model to capture the Swedish development, some policy analyses are carried out through counterfactual simulations, both in a static and a dynamic setting. Three dynamic simulations are undertaken to analyze the role of rural-to-urban migration and emigration in Swedish industrialization, and some preliminary results are presented concerning their importance for the development of the Swedish economy.

CONTENTS

THE ROLE OF EMIGRATION AND MIGRATION IN SWEDISH INDUSTRIALIZATION--SOME PRELIMINARY RESULTS USING A COMPUTABLE GENERAL EQUILIBRIUM MODEL

1. INTRODUCTION

Some of the most challenging problems of today are connected with urbanization and development. In order to understand the interaction between economic growth and urbanization in the Third World, there has been increasing interest in the analysis of the historical experiences of developed countries. This is the purpose of the Swedish case study, discussed in this paper. Through an analysis of the crucial factors in Swedish demoeconomic development, it is hoped that further insights into the interactions of economic and demographic variables can be gained.

When focusing on Swedish development, one will study a very small and a very open economy. Sweden in the 19th century was not a country in isolation but closely linked to and dependent on the rest of the world. Foreign demand and export was one of the growth-creating factors contributing to a per capita growth of Sweden, which was among the highest of that time. The annual growth in per capita income was 2 percent between 1870 and 1914. The openness of the economy played a crucial role not only in the economic development, but also in the demographic development. The industrial breakthrough coincided with the period of mass emigration to North America, an emigration that was of such a magnitude as to effect the growth pattern of the population.

Between 1870 and 1914 the Swedish population increased from 4.2 to 5.6 million people but during the same period emigration drained the population of roughly 1.1 million. There was not only considerable movement out of the country but also a substantial amount of rural-to-urban migration. The proportion of the population living in towns and cities increased from 13 to 31 percent during the prewar period.

Needless to say this extensive redistribution of the population had a large impact on the performance of economic growth. But the linkage between demographic and economic factors cannot be captured in a simple one-way direction. Especially when migration plays a role, the existence of causality in both directions between demographic and economic variables have to be taken into account. This interplay is crucial when highlighting urbanization and development, and affects the choice of methodology for this study.

Within a general equilibrium framework it is possible to reach beyond a partial analysis and reveal some of the important mechanisms in the rather complicated interplay between various variables causing the demoeconomic development of a country. Thus the model for this study has been developed within this approach. It is a so-called computable general equilibrium model within the tradition of multisectoral growth models. But our model has been designed to fit the Swedish prewar development for the purpose of undertaking counterfactual analysis.

For this paper preliminary results will be discussed. But before going into a discussion of the results, a brief review of the model will be given in section 2. In the third section some comments will be given about the data base, estimation procedure, and validation, and in section 4 some comparative static experiments will be displayed. In section 5 the capability of the model to replicate Swedish demoeconomic development between 1871 and 1880 will be discussed before going into counterfactual simulations. These counterfactual simulations will address the question of the role of migration, external as well as internal, in Swedish industrialization. Finally in the last section, some concluding remarks will be given.

2. THE MODEL

The model that has been used for the analysis has been presented in detail elsewhere (Karlström 1980), so in this section a brief overview will be given.*

Sector Division

The structure of the model is very much based on the duality between a traditional agricultural sector, and a more modern industrial sector. But to capture some of the mechanism that has driven the Swedish economic growth the model has to be extended beyond the two-sector analysis (see Table 1). Therefore the modern sector is divided into four sectors; an export-oriented industry sector, a homemarket-oriented industry sector, a service sector, and a building and construction sector.

The export-oriented sector consists of the branches of the industry that mainly meet demand from abroad, such as the wood industry, mining and metal, and the paper and pulp industry. The homemarket-oriented sector covers the rest of the manufacturing industry, mainly consumer goods of different types. The service sector is an aggregate of very different kinds of services, commerce, public administration, domestic service and services of dwellings. The building and construction sector produces a large share of the investment. These four non-agricultural sectors are treated as the urban sector opposed to the rural sector which is just the agricultural sector.

However, at this point it is necessary to notice one specific feature of Swedish industrialization; namely, that the industries to a great extent, were located in rural areas and not in towns and cities. In particular, the industries that initiated the new epoch, the wood, mining and metal industries, can be characterized as rural-based. In 1896, for example, 99.9 percent of workers in mining and basic metal industry and 42.5 percent of workers in metal manufacturing were occupied in rural areas. A typical feature of the Swedish urbanization process was the

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*The complete mathematical statement of the model is given in Appendix I.

Table 1 The production sectors in the model and their empirical counterparts.

Subscripts	Sector[a]
1	Agriculture, forestry, and fishing
2	Export-oriented industry (mining and metal, wood products, pulp, paper and printing, food products)
3	Homemarket-oriented industry (textile and clothing, leather, hair and rubber, chemical industries, power station, water and gas works, stone, clay, and glass)
4	Service (commerce and other services, public administration, transport and communication, services of dwellings)
5	Building and construction

[a] Sectors 2-5 are sometimes treated as one group, the urban sector (U), in contrast with the agriculture sector (A).

creation of new and larger towns. This phenomenon occurred through the growth of population agglomerations around rural industries. Thus, urbanization in Sweden did not continuously reflect the total movement of population. This point is important when interpreting the model. In the model all nonagricultural activities are characterized as urban. Thus migration and urbanization in the model reflects the total reallocation of population caused by industrialization, but the model results cannot be given a spatial/geographical interpretation.

Production Functions

Output is assumed to be a function of two sorts of inputs: resources and intermediate goods. In the four urban sectors, capital and labor are the two resources used. They are assumed to be substitutable factors and combined in a conventional neoclassical production function. To reflect the stylized fact that labor's share of value-added changed during the period of study, CES functions have been chosen for each of the urban sectors. In agriculture, land is treated as a factor of production in addition to capital and labor. Capital and labor are combined in a CES function which is nested into a Cobb-Douglas function. The requirement for intermediate resources is given by fixed input-output coefficients.

There is historical evidence that technological progress had an extensive growth-creating effect on the economy of Sweden. It has also been shown that the growth in technology was not neutral but was labor-saving (Jungenfelt 1966; Åberg 1969). Moreover, the labor-saving bias was a characteristic not only of the industrial sectors but also of the agricultural sector. The model formulation captures these characteristics. The technological factors are sector- and factor-specific and grow at different rates over time.

Factor Markets

In connection with the underlying theory it is assumed in the model that firms maximize profits and that there is perfect competition in all product and factor markets. Therefore, the factors of production are paid in correspondence with the value of its marginal product. It is also assumed that all resources are fully employed, and thus, no underemployment or unemployment occurs in the model. Instead unemployment during certain periods of time might be reflected in a downward adjustment of the wages.

When describing the factor markets, the distinction between rural and urban areas is important. In a pure general equilibrium model the labor force is allocated in each period of time in such a way as to equalize wages. In our model, which has to reflect the Swedish stylized facts, it is necessary to elaborate on this point. This is done in the following two ways.

Firstly, there are two labor markets in the model, one rural and one urban. These are tied together through migration of population from rural to urban areas. Thus, there are also two supply functions of labor. The supply is simply a certain share of the population in the two areas. But this share (total aggregate labor participation rate) is decomposed to capture different age and sex structures as well as different sex-specific labor participation rates between rural and urban areas. With two labor markets, two wages will be determined so that supply and demand are matched on both markets.

But, the assumption of one urban wage does not correspond with the large differences which have been observed among wages in the sectors constituting the urban sector (see Figure 1 in Karlström 1980:10). Therefore, secondly, the labor force is always allocated on the urban factor market so that a certain exogenously determined structure of the wages of the urban sectors remains stable over time. The difference in urban sectorial wages may reflect, for example, different shares of skilled labor.

These two constraints on the wage equalization mechanism put into a general equilibrium framework give more *realism* to our model but do not really move it away from the neoclassical theory. Even though the labor force is not perfectly mobile, through migration it will be reallocated from a low wage sector to an urban labor market with higher wages (migration is a function of relative wage differences). And by specifying an urban wage structure which is stable over time the relative increase in wages between two years is equalized among the urban sectors instead of assuming equalization of wages in each period of time.

Total savings (endogenously determined in the model) make up the total gross investments. Investments are divided between rural and urban areas. Difficulties in modeling the imperfect capital market which prevailed in Sweden during the prewar period, as well as problems in formulating an empirically reasonable function of the investors behavior, have made it necessary at this stage to determine the share of total investment allocated to the rural area exogenously. Within the urban sector the entire "urban" capital stock, not just new investments, is assumed to be completely mobile. Between the four urban sectors the capital is allocated so that an exogenously given structure of the sectorial rate of returns will be fulfilled in each period of time. There are many reasons to expect sectorial differences in the rate of return on capital, i.e., different risks connected with investments, different degrees of monopolization, different average size of firms, etc.

Household Demand and Income

Consumption demand and its pattern have long been suppressed in the explanation of the long-run growth process. In some empirical studies, however, the importance of final demand and its structure has been stressed. When income grows the budget share of different commodities changes. These changes are due to both price and income effects. Changes in relative prices affect the allocation of expenditure. When the per capita income grows, the marginal increase in demand for luxuries is larger than that for necessities. This so-called Engel effect has been a typical feature of the growth process in various types of countries on different development levels, and Sweden is no exception (Parks 1969:648).

Our formulation of the model determines commodity prices and the demand of the different commodities endogenously, as well as capturing the Engel effect. Thus, prices are allowed to influence demand, and demand influence prices. The selected form of the demand functions is the Linear Expenditure System. One demand system is specified for the urban area, and one for the rural. This allows us to investigate how important taste differences between rural and urban areas are. This is sometimes stressed in the development literature (Kelley et al. 1974:76).

The expenditure on consumption is what remains of income after deduction for taxes and savings. Already in the 1870's a large range of different taxes and duties existed in Sweden; different property taxes, a proportional income tax, a personal tax for adults independent of income, and so on. In the model, the 19th century taxation system is roughly described by a proportional tax on capital and wage. In addition to other incomes, the rural household also receives remittances from previous emigrants. These remittances have often been neglected in studies of this period, but they are of substantial magnitude. For the Swedish case the amount fluctuates around an average of 0.5 to 1 percent of the Swedish national product.

Savings and Investment

Savings originate from two different sources: private savings and government savings. Private savings are derived from labor and capital incomes in both agricultural and urban sectors. The parts of the income which is devoted to cover basic needs of population is subtracted from the base of savings. The saving shares are determined outside the model, and it is assumed that the savings ratio from capital income is higher than from labor income. Furthermore, savings are also undertaken by the government and its savings is what remains after governmental expenditures (exogenously determined) are deducted from governmental income. This income originates from three sources; taxes, custom duties, and foreign borrowing (exogenously determined). Thus the total savings is determined endogenously in the model, and determines investment in each period of time. Gross investment is added to the capital stock after deduction for depreciation, as previously described.

Export and Import

As has already been pointed out in the sectorial division of the model, exports have played a crucial role in Swedish economic development. One of the most characteristic features of the structural change of the export is the transition from exporting mainly raw materials and less refined commodities to more manufactured products. This is true both for agriculture and industry. Initially, imports concentrated on only a few products, as did exports, but as the economy grew imports became more and more diversified.

In order to allow for both exports and imports in the sectors, one has to assume a finite elasticity of substitution between domestically produced commodities and those supplied by foreign producers. Relying on this assumption separate export and import functions are formulated for each of the trade participating sectors.

Exports from the agricultural and the homemarket-oriented sectors are determined by the ratio between domestic production costs and world market prices and the increase of world markets. Sweden is assumed to be a small country on the world market, i.e., it cannot influence world market prices and they are therefore exogenous in the model. Domestic production costs are endogenously determined. For the export-oriented sector, it is assumed that the export-limiting factor is the growth of the capacity of the industry (i.e., increases of productivity and formation of new capital) and that its products are sold at world market prices on the home markets. Technically the export of this sector is determined as a residual in the balance of payments. This means, for instance, that the growth of the capacity of the export industry will implicitly be the limiting factor on exports through the development of other variables in the model.

The imported share of the domestic supply on the home markets are determined by the relationship between domestic production costs and world market prices.

Migration and Population Growth

As has already been pointed out, the differences in economic forces between the agricultural sector and the more modern industrial sectors caused a reallocation of the most mobile production factor—the labor force. Migration was stimulated by industrialization, and a strong relationship can be seen between the increase in migration and the industrial breakthrough. But population movements were not only directed to Swedish growth centers but also to North America. Emigration occurred in three big waves (see Figure 1) and has been explained by differences in economic performance between the United States and Sweden (see Hamberg 1976).

In the model migration is a function of the relative wage between rural and urban regions. The formulation lies within the Harris-Todaro approach even though the model assumes full employment. On the other hand, wages in the model are fully mobile, adjust to differences in supply and demand, and therefore reflect implicitly, by downward adjustment, excess supply or unemployment. In the version of the model that has been used for the results presented in this paper, emigration is exogenously determined.

The natural increase of population is determined outside the model. But by making the natural increase sector-specific in the model, it captures the big differences in the demographic variables between rural and urban regions. The urban areas showed higher crude birth and death rates during the initial years of

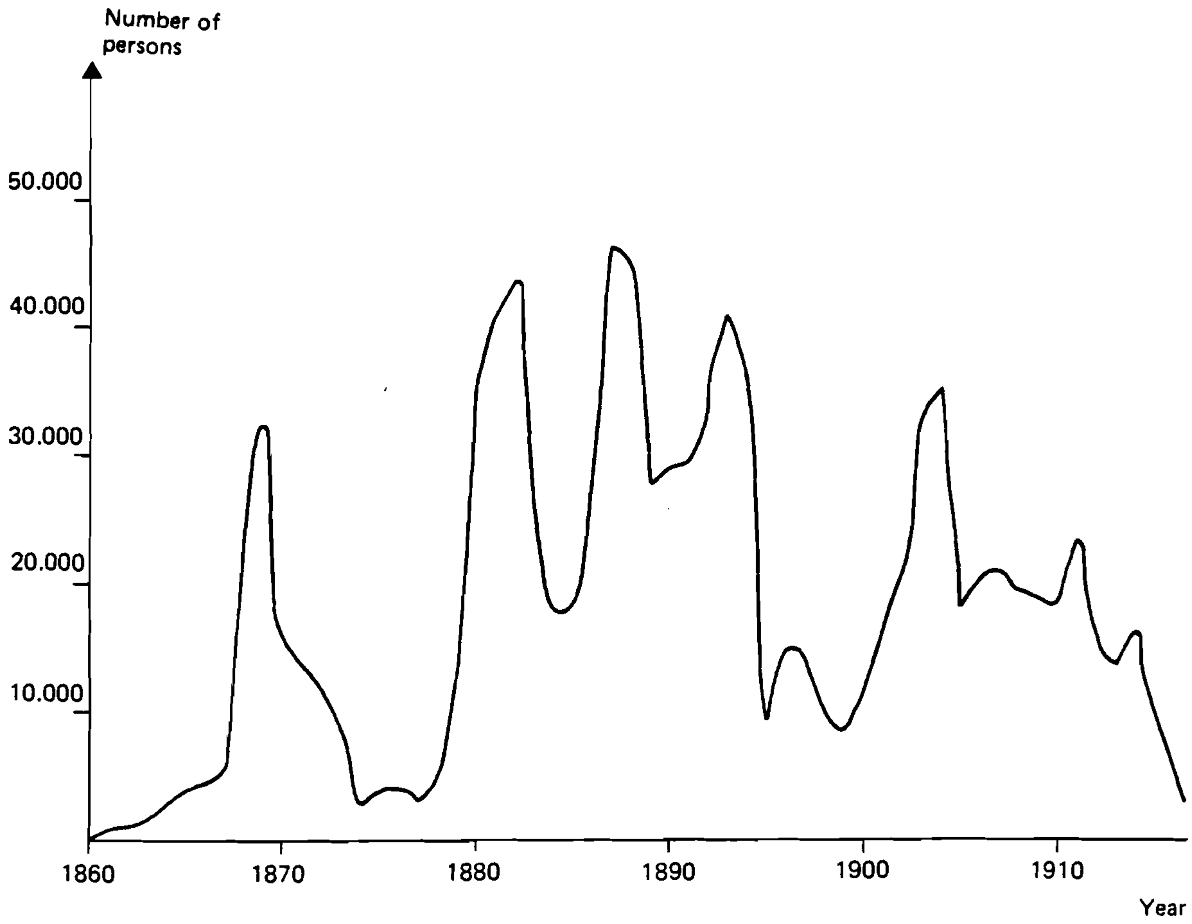

Figure 1 Registered emigration from Sweden to non-European countries, 1860-1915. (SOURCE: Runblom and Norman 1976, Table 5.1:117).

industrialization. The decline was, on the other hand, faster in urban areas. The patterns of change were similar even though the magnitude differed. The demographic dualism between rural and urban areas was thus reflected in the initial differences in the demographic variables rather than in the pattern of change.

Dynamics

For each period of time the model is solved so that a static equilibrium is reached. The growth process is thus a sequence of static equilibria, and it is generated mainly by the following variables:

1. Capital growth. The growth of capital is determined by the endogenously generated savings.

2. Productivity growth. The growth of productivity is sector and factor specific and is growing at rates determined outside the model.

3. Population growth. Fertility, mortality, and emigration determines the growth of total population. The regional population growth is endogenously determined because rural-to-urban migration is generated by the model.

3. DATA BASE AND VALIDATION

An extensive data base has been put together for the implementation of the model. In this section a brief overview of the principles of the data base, model estimation, and validation will be given.*

The first decision required for the numerical implementation is the choice of base point of time. The 1870s are looked upon as the beginning of Swedish industrialization. Therefore, we chose to start as early as possible in that decade. The year 1871 is picked because before that year some crucial data series do not exist, 1871 is also a reasonable year from the economic point of view. It is in the part of the upswing of the business

*For a detailed discussion see forthcoming working paper (Karlström 1982).

cycle, but has not reached the peak of the general business activity (see Jörberg 1961), and it is in the downswing of the first emigration cycle.

For a system as large as our model it is an overwhelming and even impossible task to estimate all the coefficients. For many of them no time series exist. Instead we are forced to rely on rougher methods. This is not only due to the distant period of time which is the focus of this study, but also is the common way when implementing a computable general equilibrium model.

It is of crucial importance that the data base which is used is consistent. Therefore, we have chosen to organize and put together available data in the form of input-output tables. Input-output tables are made for six years—1871, 1880, 1890, 1900, 1910, and 1913. The main source has been Johansson (1967) and Krantz and Nilsson (1975).

The input-output table is thus our main source for base year estimates of the coefficients. Together with time-series estimates of some coefficients sometimes picked from different studies and guesses based on qualitative information, all the coefficients have been estimated. The solution algorithms that have been used are developed by Andras Pór and a description can be found in Bergman and Pór (1982).

The base solution in 1871 is the first step in validating the model. Because the parameters are estimated so that the data base should be reproduced in the base year solution, it is nothing more than a technical validation of the model. The total validation includes two more steps. In the second step the sensitivity of the model to changes of parameters and exogenous variables will be analyzed and in the third step of validation the capability of the model to reproduce the growth of the Swedish economy will be evaluated.

The model displays a rather complicated nonlinear relationship between various variables capturing different possibilities of behavioral choice. Therefore, for example, sectorial production, distribution of factors of production, consumption patterns and so on could easily differ from actual base year data. The capability of reproducing the basic data set is thus a first test of the model. Does it pass the test? Indeed it does. In the base year all commodity prices are assumed to be one. None of the prices differ more than one percent from one. Even the rest of the endogenous variables are close to actual base-year data. Only one differs slightly more than one percent. Thus the model fulfills our criteria of technical validity. The next two steps, sensitivity analysis and dynamic base-run solution will be discussed in the next sections of the paper.

4. COMPARATIVE STATIC EXPERIMENTS

There are at least two purposes for doing some comparative static experiments. Firstly, by undertaking parameter changes and exploring the equilibrium effect on the model, further insights will be gained about the behavior of the model. Thus a further step in the attempt to validate the model is taken. Secondly, some of the comparative static experiments are interesting from the point of view of policy analysis. These experiments will reveal the static, but total (direct as well as indirect) effect, on the economy of some of the policy variables that the 19th century Swedish politicians discussed. These experiments will show how important it is to analyze economic policy within a general framework rather than a partial one.

The experiments that will be presented in this paper have been organized into two groups; rural experiments and population experiments.

Rural Experiments

Rural-to-urban migration is caused by the interplay between agricultural and industrial development. In this process it is not obvious which effect different rural development policies have. There is no automatic link between an increased productivity and an increased rural wage or income. Even though the marginal productivity of labor increases of a certain policy change, the effect on agricultural wage can very well be reversed because of a new lower equilibrium price on agricultural goods. It is thus not only the partial effect within the agricultural sector which is of interest when evaluating different agricultural policies but also the indirect effect via the linkages between the rural part and the rest of the economy.

In the Swedish case agricultural output per worker grew at an annual rate of 1.19 percent during the pre-world war period. This growth was due to not only an increased output per area of land (through a more capital intensive production) but also a growth in the land area per worker. The cultivation of new land played a certain role. Against this background we have carried out four rural experiments—an extension of cultivated land, an increase in agricultural capital stock, an increase in the efficiency of labor and a change in world market prices. Some of the results of the rural experiments are summarized in Table 2.*

Rural Experiment I: Increased Land

The exogenous acreage of land has been enlarged by 10 percent. It results in a 1.9 percent higher output of agricultural goods. In a specific period of time the capital stock and labor force is fixed in the rural area (migration occurs between two static solutions). Thus the marginal productivity of labor, as well as of capital, will increase. The higher supply on the agricultural market presses the price. The new equilibrium price is 2.5 percent lower, and outweighs the increase in marginal productivity causing a wage decrease of 2 percent. Even the rate of return on capital and the land rent decreases. Therefore the net income of rural households goes down, but not enough to balance the positive effect on demand of agricultural goods by the lower price. Rural demand increases by 0.3 percent.

The beneficiaries of the enlarged area of cultivated land are not the rural population but the urban. Their disposal income increases by 1.8 percent. This is a result of both an increase in the demand for intermediate goods from agriculture and an increase in the purchasing power of the urban region caused by the lowered price on agricultural goods. The urban households spend a larger share of their increased income on urban goods than on agricultural goods thus strengthening the tendency

*Further results are displayed in Appendix II.

Table 2. Comparative Static I: rural experiments (percentage difference compared with base run)

Variables	Base run	Experiments I	II	III	IV
Output agriculture	601.00	+1.9	+0.9	+ 6.9	+6.9
Wage in agriculture	0.26	-2.0	-0.2	- 7.4	-0.1
Domestic price of agricultural goods	1.00	-2.5	-1.2	- 8.5	-3.0
Gross investment	72.20	-0.9	-0.6	- 2.9	+2.0
Gross domestic product	966.7	+0.5	+0.2	+ 1.5	+2.7
GDP per capita	0.230	+0.4	+0.4	+ 1.3	+2.7
Migration pressure[a]	1.00	+6.1	+2.0	+14.8	+2.0

[a]Migration pressure is simply an index of the relationship between wages in rural and urban areas, set to 1 in the base run.

of income differences. This whole process results in a widening of the relative wages between rural and urban areas (the urban wages increase by 1.4 percent) and thus a higher pressure on rural to urban migration is the consequence of this experiment.

Rural Experiment II: Increase in Capital Stock

A 10 percent increase in the capital stock of agriculture results in a 0.9 percent higher output. The increased productivity of labor is counterbalanced by a price reduction on the agricultural commodity market. Agricultural price decreases by 1.2 percent and wage in agriculture by 0.2 percent. The effect in the urban sectors is similar to the consequences of an increase in land, but not so pronounced. The urban households face a wage increase of 0.7 percent, thus causing a somewhat higher rural-to-urban migration.

Rural Experiment III: Increase in Labor Productivity

In this experiment the efficiency of labor has been increased by 10 percent. (This has been done by increasing the efficiency parameter lh1 in the production function.) This increase results in a 6.7 percent higher output, agricultural production has been increased from 601 million Swedish Kronor (SKr) to 642.3 million. Such a large increase in supply causes dramatic changes on the commodity market. Parts of the increased supply are exported. When the domestic price level decreases, Sweden's relative prices are improved and export increases. At the same time, agricultural imports go down because of, in relative terms, the more expensive imported goods. The increased export and decreased import counteracts the domestic agricultural commodity market, but a new equilibrium price is established, 8.5 percent below the "base run" price. The price effect is large enough to counterbalance the increased productivity of labor. Wage decreases by roughly 7 percent.

The effects in the urban sector are very much the same as before; the lowered agricultural price augments the relative purchasing power. The increased agricultural demand for intermediary goods and the larger urban demand pushes the income of urban households up. Wages and rate of return on capital goes up by a little more than 4 percent. Thus the motives to migrate increase and a more rapid reallocation of population can be expected when labor productivity in agriculture expands.

This experiment displays more or less, the same picture as the previous two. Improvement in agriculture either by more acreage, capital stock, or labor productivity makes the situation worse for the rural population because the increased supply faces a relatively inelastic demand, and the price will fall. Thus an agricultural development policy should be combined with a demand increasing policy. An example is given in the next experiment.

Rural Experiment IV: Increase in Labor Productivity and World Market Price

This experiment was undertaken to simulate a scenario with a higher demand on agricultural goods through an increase in the foreign demand. It was done by increasing the world market price by 10 percent (PW1). At the same time we have kept the higher labor productivity discussed in the previous experiment.

A higher world market price has initially two effects on the economy; (1) export increases because Swedish goods are becoming relatively cheaper on the world market, and (2) a tendency towards higher prices on the domestic market of agricultural goods, because the imported supply in this market is becoming more expensive. The model simulation confirms these effects. Export of agriculture increases by 40 percent. This is caused not only by the higher world market price but also by increased labor productivity which decreases costs of production. The effect on export of only increased productivity is around 25 percent. The new equilibrium price is just 3 percent lower compared with the base solution. Remember that the price decrease, when only a productivity increase of labor was undertaken, was 8 percent.

The effect of an increased export is almost enough to outweigh the lowering effect on rural wage caused by increased labor productivity. Rural wage decreases by 0.1 percent. The aggregated effect on the economy is significant. Gross domestic product increases by 2.7 percent.

Population Experiments

The role of population increase in the development and urbanization process is very complicated. An increased population adds to the labor force and thus affects the supply side of the economy. It also affects demand of commodities and factors of production by enlarging the domestic market. The net effect on regional incomes, migration, and development of these interacting forces is not immediately obvious, and they have to be analyzed in a general equilibrium framework.

In the Swedish case emigration had a large impact on the development of population. Emigration started in the 1850s and before industrialization took off in the 1870s, the first big wave of emigration was terminated. It was a combined force of restrained religious freedom and bad harvests in the 1860s that caused this first wave. For a discussion of the Swedish emigration see Runblom and Norman (1976). In 1871 (which is the starting point for our study) the population would have been 5 percent higher if no emigration had occurred. This increase includes not only those who emigrated but also takes into account the expected population growth among the emigrants (Hofsten and Lundström 1976).

The comparative static experiments presented in this section examine the effect of 5 percent more people in the 1870 economy of Sweden. By choosing this amount of population increase we will also be able to indicate some of the consequences of emigration. In the first experiment the total increase of population is added to the rural population, in the second experiment the population is unchanged from the base run, but the labor participation rate is increased so that the agricultural labor force is the same in the two experiments. In the third experiment the 5 percent increase in population is equally distributed between rural and urban areas. Table 3 and Appendix II summarize the results of the three population experiments.

Population Experiment I: Increase in Rural Population

This experiment is undertaken by adding a 5 percent increase in total population to the rural population. The rural population thus increases by 6.9 percent. We have kept the rest of the parameters and the exogenous variables the same as in the base run. The increased population will thus give the same increase in labor force. (The total labor force participation rate, i.e., labor force out of total population, is 35 percent in agriculture.) This large change in population has an extensive effect on the agricultural wage. By increasing the labor force, and keeping land and capital stock fixed, the marginal productivity of labor diminishes. This downward pressure on wages is stengthened by a price decrease in the commodity market. Agricultural output increases by 4.8 percent. But this increase is not in its total added to the previous supply on the domestic market. Export increases (11.5 percent) and import decreases (2.2 percent). But even by foreign trade adjustments the domestic price has to be lowered by 3.8 percent to equilibrate the market. Increase in demand by rural (5.8 percent) and urban (3.9 percent) households, and for intermediary

Table 3. Comparative Static II: population experiments (percentage difference compared with base run)

Variables	Base run	Experiment I	II	III
Total population	4204.20	+ 5.0	0.0	+5.0
Rural population	3043.8	+ 6.9	0.0	+3.3
Urban population	1160.4	0.0	0.0	+9.1
Migration pressure	1.0	+10.5	+17.6	-6.0
Output agriculture	601.0	+ 4.8	+ 4.8	+2.4
Gross investment	72.0	+ 0.3	- 0.1	+5.4
Gross domestic product	966.7	+ 1.4	+ 1.1	+5.5
GDP per capita	0.230	- 3.4	+ 1.1	+0.4

deliveries, is not enough to match the increased supply. The lower productivity of labor and the lower price on agricultural output results in a new equilibrium wage 8.1 percent below the wage in the base solution.

However, the increased rural population has a reverse effect on urban wages. They increase by 2.1 percent. This is the result of a reallocation of labor among the urban sectors, which is caused by price and income changes. Thus the development in the rural as well as the urban regions has the same effect on rural-to-urban migration; it is strengthened. The relative wage differentials are increased by 10 percent.

When summing up the effects, gross domestic product increases by 1.4 percent to 980.2 million SKr. But this increase is not enough to balance the increased population. The per capita income decreases by 3.4 percent.

Population Experiment II: Increased Labor Participation Rate in Agriculture

The effect on the economy in the previous experiment can be divided into two parts; the effect via higher employment, and the direct effect on demand because of a higher population (subsistence consumption is defined per capita). This second experiment has been undertaken to see how important these two effects are. In this run we have kept the base run population unchanged but increased the labor participation rate by 6.9 percent. Thus we will have the same effect on agricultural output, it increases by 4.8 percent but not the direct demand effect of a higher population. The direct effect on demand caused by a higher population comes about because in the demand function a subsistence consumption of agricultural goods is first met before the demand on the rest of the goods is determined. A higher population increases demand on agricultural goods, *ceteris paribus*.

The big difference between these two runs can be expected in the commodity market of agricultural goods, which is what happens. The price falls by 6.1 percent instead of 3.8 percent even though there is a rise in exports by 18.6 percent instead of 11.1 percent and imports diminish by 6.6 percent compared with 2.2 percent in the previous run. The effect on agricultural wages is a disaster. It is 11.4 percent lower than in the base run. Even the return on capital and land goes down in rural areas (-3.5 percent).

In the urban region the effect is the same as in the previous experiment, but strengthened because of the increase in real purchasing power. Return on capital and wage increases by roughly 3 percent causing an increase in high income elasticity goods. The consumer goods sector increases by 2.6 percent and the service sector by 0.5 percent. This change in the demand pattern results in a reallocation of factors of production from the export-oriented sector (sector 2) to the sectors directed to final demand. Given that the resources of labor and capital in the urban region are fixed, output of sector 2 has to diminish as well as its export. Domestic demand pulls factors of production away from the base industries.

The total effect on the economy is slightly lower than in the previous run. GDP increases by 1.1 percent instead, compared with 1.4 percent. But per capita growth, of course positive in this case, is increased by 1.1 percent. Thus the direct effect via demand of a higher population is positive but not as important as the "employment increase" effect. Roughly 20 percent of the total effect on GDP can be connected with the direct demand-creating effect of a higher population.

Population Experiment III: Increase in Both Rural and Urban Population

In this experiment the 5 percent increase in total population has been equally allocated between rural and urban areas. It results in a 3.4 percent increase in rural population and a 9.0 percent growth of the urban population. The output-creating effect in agriculture is half of the effect in the previous two experiments. The enlarged demand for agricultural commodities due to mainly increased subsistence consumption outweighs the supply effect resulting in a higher equilibrium price. It contributes to a positive effect on the income of rural households. Both capitalist and laborer incomes increase with a larger change for the capitalists.

In the urban sector the higher supply of labor has a dramatic effect on factor return. The relative cost of labor is lowered and firms in the different urban sectors substitute labor for capital. At the same time a higher aggregated income of urban households increases demand. Both aggregate income of capital and labor increases. (The percentage change of the urban labor force is larger than the effect on urban wages.) The demand effect is stronger than the supply effect on the main urban commodity markets and domestic prices increase. Notable is the effect on the export-oriented sector. The higher supply of labor and the substitution of labor for capital release resources for production of sector 2, increasing its output by 9 percent, the main share being exported. Export of sector 2 increases by 11 percent.

The positive effects on total income and the relatively larger increase in capitalist income enlarge the savings. It increases by 9 percent compared with a more or less unaffected amount of savings when the population increase was concentrated in the rural sector (experiment I). (The savings rate is higher for capitalists' income compared with income of labor, but there is no difference between rural and urban households.) Thus an increase in population which is biased towards urban sectors will have a significant growth-creating effect. But this effect will not occur in a dynamic framework if the population increase in urban sectors has to be created by mainly rural-to-urban migration. A comparison between the first and third experiments indicates that as the process of urbanization continues, the pressure to migrate is slowed down by an increase in rural wage and a decrease in urban wage. The migration pressure increased by 10 percent in the first population experiment, and in the third run it was 6 percent lower compared with the base run. The growth-increasing effect will, therefore, never be so pronounced. But this tentative conclusion should be examined by dynamic simulation experiments.

5. DYNAMIC EXPERIMENTS

To be able to undertake counterfactual simulations of the Swedish demoeconomic development a reference path has first to be simulated. It is the base run, and should replicate as close as possible the historical trends of some of the crucial variables. The base run is carried out for the period 1871-1890. Being able to replicate history is also the last step in validating the model. In the next section the base simulation is evaluated followed by a discussion of three different counterfactual simulations. The first of these is a simulation with no possibility of emigration after the year 1871. The second tries to analyze the role of rural-to-urban migration by closing all migration possibilities. The last counterfactual simulation addresses the same question but analyses it by increasing migration response.

Base Run Simulation 1871-1890

During the period 1871 to 1890 Sweden underwent the first phase of industrialization. The first decade, the 1870s, was a period of rapid growth especially for the export-oriented industries, the sawmills, and the steelworks. The second part of the period, the 1880s, was slightly more dampened because of an international recession. This is reflected in the overall growth of GDP for the first and second half of this period. Gross domestic product grew at an annual rate of 2.3 percent for the entire period, but with a higher rate of 2.6 percent during the first decade (see Table 4).

These historical records are reflected in the performance of the model. The same tendency occurs. For the entire period 1871-1890, the model generates a growth of 2.9 percent but with a higher rate of 3.1 for the first part. The sectorial growth rates are also close to the historical trends.

During the 1870s agricultural output grew at a rate of 2.1 percent in the historical data and with 2.0 percent in the model. During the second part of the period the growth rate slowed down considerably. The model captures the tendency but not the magnitude of this change. Increasing competition on the world market is part of the reason for this development. World market prices for grain fell, and export diminished during the 1880s. Compared with 1871 agricultural export displayed a negative growth of 2.8 percent in the historical data and 2.4 percent in the model.

One of the crucial variables for the growth of the economy is capital formation. The formulation of capital growth is within the neoclassical theory of growth; savings determines investment. In the model savings are endogenously determined and generated by three different sources: rural households, urban households, and government (foreign savings is a part of governmental savings). The growth of total capital stock was 2.0 percent in the historical records for the 1871-1880 period, and 1.7 percent for the entire period. The model generates a

Table 4. Average annual growth rates (in percent) 1871-1890.

Variables[a]	1871-1880 Historical	1871-1880 Model	1871-1890 Historical	1871-1890 Model
X1	2.1	2.0	1.0	1.8
X2	4.1	5.2	5.1	3.7
X3	2.5	2.4	3.6	3.9
X4	3.1	3.1	2.5	3.2
X5	5.7	7.2	2.9	4.7
EX1	0.5	1.0	-2.8	-2.4
EX2	3.8	6.0	3.8	2.3
EX3	9.6	2.5	9.0	5.5
EX4	4.1	4.3	2.5	1.6
IM1	2.5	2.4	3.9	3.4
IM2	4.9	5.9	7.2	7.0
IM3	5.7	7.2	4.3	1.7
GDP	2.6	3.1	2.3	2.9

[a]See Appendix I for an explanation of the variables.

growth of capital stock of 1.9 percent during the first decade and 2.4 percent during the entire period. As can be seen in Table 5, capital stocks of urban and rural sectors generated by the model are close to the historical figures.

The other important factor of growth is population. In the dynamic simulations, population of rural and urban areas are endogenous. Population growth is determined by the net natural increase (which is different for the two regions), migration between the two regions, and emigration. No migration statistics are available on a yearly basis between the years of population censuses 1870, 1880, and 1890. The existing employment figures for agriculture are interpolations between these benchmark years so it is difficult to evaluate the migration pattern produced by the model. However, the resulting distribution of population in 1880 and 1890 can be compared with historical data. The figures are displayed in Figure 6.

Table 5. Average annual growth rates (in percent) 1871-1890.

Variables	1871-1880 Historical	1871-1880 Model	1871-1890 Historical	1871-1890 Model
Total population	0.9	1.0	0.7	0.7
Urban population	2.6	2.9	2.4	2.7
Rural population	0.2	0.2	-0.1	-0.2
Total labor force	1.1	1.2	0.6	0.7
Urban labor force	2.5	2.8	1.3	1.9
Rural labor force	0.4	0.3	0.1	-0.1
Total capital stock	2.0	1.9	1.7	2.4
Urban capital stock	3.1	2.9	2.5	3.3
Rural capital stock	0.6	0.6	0.5	1.1
GDP	2.6	3.1	2.3	2.9
GDP per capita	1.7	2.2	1.6	2.2

Table 6. Counterfactual Simulation I: no emigration (average annual growth rates in percent).

Variables	1880 Base run	1880 No emigration	1890 Base run	1890 No emigration
Total population	1.0	1.1	0.7	1.2
Urban population	2.9	3.0	2.7	2.9
Rural population	0.2	0.4	-0.2	0.3
Total capital stock	1.9	1.9	1.5	2.8
Urban capital stock	2.9	2.9	3.3	3.4
Rural capital stock	0.6	0.6	1.1	1.1
Degree of urbanization[a]	0.327	0.325	0.397	0.384
Degree of industrialization[b]	0.636	0.634	0.672	0.662
GDP	3.1	3.3	2.9	3.2
GDP per capita	2.2	2.1	2.2	2.0

[a] Share of urban population out of total population.
[b] Share of value-added of urban sectors (in fixed prices) out of GDP (in fixed prices).

In both 1880 and 1890 the distribution is very close between the historical records and the model simulations. Between 1871 and 1890 urban population grew at an annual average of 2.4 percent according to the statistics compared with 2.7 percent in the model, and this growth rate was rather stable over the whole period. The rural population was growing by 0.2 percent during the first part of the period. (The model figure is exactly the same as the historical rate.) During the 1880s outmigration overtook the net increase of population in rural areas and it started to decline. For the entire period, the percent of actual decline of the rural population was 0.1 percent compared with 0.2 percent in the model. This also explains the opposite sign of labor force change in the rural area between actual and model figures. In the model, the turning point of the rural population occurred somewhat earlier than it did historically, and the higher decline in the model outweighed the increase in labor supply caused by the increase labor participation rates for women that took place during the same period.

The base run simulation from 1871 to 1890 indicates that the model captures some of the essential factors of the demo-economic development of Sweden. The ability of the model to replicate the historical trends in some of the crucial variables allows us to use this base simulation as a reference path when undertaking counterfactual simulations. Through these simulations the importance of emigration and migration in the case of Sweden will be discussed.

Three dynamic experiments have been undertaken. The first evaluates the affects of emigration on the Swedish economy, and the other two the importance of rural-to-urban migration.

Counterfactual Simulation I: No Emigration

What role did emigration play in Sweden's development? Its consequences have been discussed since Wicksell pointed out in the 1880s that emigration solved the proletarization problem in Swedish agriculture (Wicksell 1882). But what were the long-term consequences of emigration? Would a larger population have increased the economic growth because of its enlargement of the home market? Was emigration a substitute for internal migration? These are some of the questions that have been addressed when discussing the consequences of emigration. By using our computable general equilibrium model we can contribute to the answering of some of these questions. Even though it might be impossible to estimate the total consequences on the Swedish economy of emigration, some indications of its effect can be given. Because emigration took place over such a long period of time, and changes in population (as we have seen in the static experiments) caused strong interacting forces in the economic system, an analysis should be carried out within a dynamic framework of a general equilibrium model.

By not allowing any emigration to take place and by keeping everything else equal, a hypothetical development path of the Swedish economy has been simulated over the period 1871 to 1890. This counterfactual simulation is then compared with our base run, and the differences indicate the consequences of emigration.

The period 1871 to 1890 covers both a time of very low emigration, the 1870s, and a time of high emigration, the 1880s. The pattern of emigration is displayed in Figure 1. In 1880 total Swedish population would have been 1.5 percent higher, and in 1890, 8.9 percent higher without emigration. This increase is not only due to the amount of emigrants but also to the natural increase they contributed to. Some of the results are displayed in Table 6.

The immediate effect, when closing the emigration possibility, is an increase in rural population because emigrants originated in rural rather than urban areas. The higher rural population has both a supply and demand effect on the commodity market. A higher supply of labor increases agricultural output and more population increases its demand (subsistence consumption is defined per capita). A larger labor force, *ceteris paribus*, decreases the marginal productivity of labor and this downward pressure on rural wage is strengthened by a price fall on agricultural goods. Without emigration agricultural wages start to fall. The immediate changes are the same as in the static population experiment I. But carrying out the experiment over time, the effects are moderated by migration. The enlarged wage gap between rural and urban areas increases rural-to-urban migration. In 1880 the urban population is 0.8 percent larger than in the base run, and in 1890, 5.2 percent. But the increased internal migration does not, during the period of study, outweigh migration.

Rural population is still larger in 1890 than in the base run (11.3 percent higher). It has increased by 0.3 percent compared with a decrease of 0.2 percent. As can be seen in Table 6 the degree of urbanization is lower in 1890. Thus, even though the internal rural-to-urban migration increased, urbanization decreased.

The larger urban population, in absolute terms, increases labor supply and thus the capacity of urban industries. Output of urban sectors starts to grow somewhat faster than in the base run. The larger agricultural production causes a direct increase in demand for intermediary goods. In 1880 there is no significant difference, but in 1890 the annual growth rate of the export-oriented industry changes the most, from 3.7 percent to 4.0 percent.

The changes in the urban sectors *increase* urban income and savings. Even governmental income increases because of higher tax revenues and adds to total savings. The decreased rural saving does not reverse the effect on total savings but increases it. This results in a faster growth of capital, which contributes to the overall increase in output both in rural and urban areas.

When summing up the effects on GDP, the growth is faster. It increases from 2.9 percent to 3.2 percent. But this faster growth is not enough to counterbalance the increase in total population, and thus GDP per capita falls from 2.2 percent to 2.0 percent.

Was the population better off with emigration or not? One way to analyze this is to compare rural and urban wages in this counterfactual simulation with the wages of the base run. Table 7 summarizes the results. The percentages given in Table 7 are based on real wages, i.e., the wages are deflated with a cost-of-living index generated by the model.

Table 7. Real wages in urban and rural areas, 1880 and 1890 (percentage difference compared with the base run).

Wages	1880	1890
Wage in agriculture	-1.8	-10.0
Wage in urban sector (average)	-0.1	+ 1.5

From these figures it is obvious that emigration solved a poletarization problem in the agriculture areas. The rural wage in 1890 would have been 10 percent lower than in our base run. The effect in the urban areas is reversed: a slight increase (+1.5 percent) in 1890 compared with our base run. Emigration thus had a positive effect on the standard of living in the rural areas. But should this effect remain over time, or should a larger rural-to-urban migration (which increased in the case of no emigration) offset the downward pressure of no emigration later on? The role of rural-to-urban migration will be discussed in the following two counterfactual simulations.

Counterfactual Simulation II: No Emigration, and No Rural-to-Urban Migration

One way to evaluate the effects of migration on industrialization is to ask what would have happened if no migration had taken place. Such a path of development canbe generated by simulating our model economy without any possibility of migration. This dynamic counterfactual simulation is designed in this way. It has been simulated only over the 1870s and some results are displayed in Table 8.

The most notable effect is demographic. Total population increases with 1.2 percent compared with 1.0 in the base run. This is a result of no possible emigration and a somewhat higher natural increase of population because of a larger concentration of rural population. (The natural increase is higher in rural areas compared with urban.) The different degree of urbanization is, of course, significant. In our reference run the urban share of total population is around 32 percent in 1880, and without a possibility to migrate the share decreases to 26.8 percent.

Table 8. Counterfactual Simulation II: no emigration and no rural-to-urban migration (average annual growth rate in percent).

	1880	
Variables	Base run	No migration
Total population	1.0	1.2
Urban population	2.9	0.8
Rural population	0.2	1.3
Total capital stock	1.9	1.1
Urban capital stock	2.9	2.7
Rural capital stock	0.6	0.9
Degree of urbanization[a]	0.327	0.268
Degree of industrialization[b]	0.636	0.634
GDP	3.1	2.6
GDP per capita	3.2	1.4

[a]Share of urban population out of total population.
[b]Share of value-added of urban sectors (in fixed prices) out of GDP (in fixed prices).

The larger rural population has its most significant effect on the development of the agricultural wage. In 1880, it is almost 17 percent lower than in the base run solution for 1880.* The decrease in wage is larger than the increase in the labor force and the income of rural households out of labor will therefore diminish. The effect on capital is similar. Return on capital goes down as well as the capital stock resulting in a decreased income out of capital. This is an effect mainly via the agricultural commodity market. The new equilibrium price is 11 percent lower. When summarizing the effect on rural households the outcome of a no migration case is a disaster. A 7 percent higher population should be supported by a lower income.

For the urban households the effect is reversed. Urban labor force is almost 12 percent lower, and even though urban capital stock is somewhat lower (-3.2 percent), labor is becoming relatively more scarce and urban wage will increase by 14.7 percent.

*All the figures in this section are compared with our reference solution for 1880.

The lower income that is generated in a counterfactual simulation without the possibility of migrating generates less savings and thus the growth of capital stock is smaller. Total capital stock is 2.5 percent lower in 1880. Even though the agricultural output grows at a faster rate when no migration takes place, it is not enough to outweigh the slower growth of the urban sectors. Thus a slowdown in the rate of industrialization occurs. GDP increases by 2.7 percent annually in our base simulation and by 2.2 percent in the counterfactual simulation with no migration. And this slower economic performance results in a 6 percent lower gross domestic product per capita at our terminating year.

It is clear from our analysis that rural-to-urban migration has a significant growth-creating effect. The reallocation of labor force to the more dynamic and high-wage urban sectors, with its modern technology and higher rate of productivity change is of large importance for the economic performance.

Counterfactual Simulation III: Higher Rural-to-Urban Migration

In the first counterfactual simulation we saw that an increased rural-to-urban migration counterbalanced the downward pressure on the economic performance when there was no possibility of emigration and, in the second simulation, that stopping the migration to urban areas slowed down growth. However, will these indirect indications on the positive effect of rural-to-urban migration remain if the response to a certain wage differential between rural and urban areas really increases, i.e., if there was higher migration, *ceteris paribus*? Migration as such is influenced by economic changes as well as causing them. This question will be analyzed in the third and last counterfactual simulation by changing the migration function to increase the response to a certain difference between rural and urban wages. The parameters d and η (see Appendix I) have been changed by 25 percent.

The most notable change is, of course, the allocation of population. Rural population declines immediately and during the first decade the average rate of decline is 0.5 percent, declining even faster during the second part of the period (see Table 9). Urban population grew at 4.2 percent during the first

Table 9. Counterfactual Simulation III: higher rural-to-urban migration (average annual growth rates in percent).

Variables	1880 Base run	1880 Higher migration	1890 Base run	1890 Higher migration
Total population	1.0	1.0	0.7	0.7
Urban population	2.9	4.2	2.7	3.2
Rural population	0.2	-0.5	-0.2	-0.6
Total capital stock	1.9	2.2	1.5	2.8
Urban capital stock	2.9	3.3	3.3	3.8
Rural capital stock	0.6	0.8	1.1	1.3
Degree of urbanization[a]	0.327	0.336	0.297	0.440
Degree of industrialization[b]	0.636	0.661	0.672	0.793
GDP	2.2	3.5	2.2	3.2
GDP per capita	3.1	2.5	2.9	2.5

[a] Share of urban population out of total population.
[b] Share of value-added of urban sectors (fixed prices) out of GDP (in fixed prices).

decade (compared with 2.9 percent in the base run) and 3.2 percent during the entire period (compared with 2.7 percent in our reference path). Thus there is a strong effect on migration in the first part of the simulation period but this is much less pronounced in the second. The question now is which economic forces cause this "boomerang" effect of migration?

In agriculture the growth of output is lower in 1880 (+1.6 percent) compared with the base run (+2.0 percent). Demand for agricultural goods is relatively income inelastic, and therefore the lower supply pushes the price upwards. This price effect strengthens the increase in rural wage and over the course of time rural wages increase and migration slows down. This process is also enhanced by a lower wage increase in the urban sector.

Higher migration augments the supply of urban labor and thus enhances the capacity of this sector. The export-oriented sector inceases output from 5.2 percent (average growth rate in the base run) to 6.9 percent in 1880, a tendency that continues in 1890. This sector absorbs relatively more of the increase in the labor supply and even though the export-oriented sector is a high wage sector, average urban wage rises at a slower rate than in the base run. Thus the effects on wages in both the rural and urban areas has the same impact on rural-to-urban migration— it slows down.

Higher migration also affects the growth of capital. Rural saving increases more than the decrease in urban saving, but the main cause of this is the increase in governmental saving. The total effect of a higher migration is a growth in total income, thus increasing taxes and government savings. The effects on the growth of capital are displayed in Table 9.

A higher rural-to-urban migration generates larger domestic production. Gross domestic product increases by an annual rate of 3.2 percent between 1871 and 1890 in the counterfactual simulation and by 2.2 percent in the base run. However, the growth-creating effect of a higher migration also has a tendency to diminish over time. The effect on GDP is higher during the 1870s than during the 1880s (see Table 8), because migration slows down. In 1890 migration is almost back on the same level as in our base run. Thus a higher rural-to-urban migration has a temporary growth-creating effect, but in the long run this effect disappears because it also decreases the wage gap between rural and urban areas and thus has a "boomerang" effect on itself.

6. CONCLUDING REMARKS

The analysis discussed in this paper has shown the fruitfulness to use a simulation model within the general equilibrium framework to study the problems of urbanization and development. Especially notable is the importance of the interaction of supply and demand (domestic as well as foreign) on the commodity markets for the development of wages, income, and migration. The magnitude of these interacting forces is revealed and captured within a general equilibrium model. The results from the dynamic simulations also show the importance of undertaking the analysis within a dynamic framework and with a rather long time horizon. This is especially significant for a study highlighting the role of migration, internal as well as external, in the process of industrialization.

APPENDIX I: THE EQUATION SYSTEM OF THE MODEL

PRODUCTION SECTOR SUBSCRIPTS

1 Agriculture, forestry, and fishing

2 Export-oriented industry

3 Homemarket-oriented industry

4 Services

5 Building and construction

HOUSEHOLD SECTOR SUBSCRIPTS

A Households in the agricultural sector (i.e., production sector, 1)

U Households in the urban sector (i.e., production sector, 2-5)

ENDOGENOUS VARIABLES

P_i domestic production cost of commodity i = 1,...,5

P_i^D domestic price of commodity i = 1,...,5

P_j^* value-added prices in sector j = 1,...,5

X_j gross output in sector j = 1,...,5

X_{ij} deliveries of intermediate goods from sector i to sector j

H composite of labor and capital input in the agricultural sector

L_j employment in sector j = 1,...,5

L_u employment in urban sectors

W_u index of the level of wages in the urban sectors

W_j wage rate in sector j = 1,...,5

Π_1 rent in the agricultural sector

RC_j rate of return on capital in sector j = 2,...,5

RC_u index of rates of return in the urban sectors

S_A savings in the agricultural sector

S_U savings in the urban sectors

Y_j^{Dl} disposable income by workers in sector j = A,U

Y_j^{Dc} disposable income by capitalists in sector j = A,U

D_{ij} consumption of commodity i = 1,...,5 in sector j = A,U

C_j total consumption in sector j = A,U

EX_j export of commodity i = 1,...,3

IM_i import of commodity i = 1,...,3

S^G savings by the government

M total amount of net migrants from the rural areas

I total investment

I_j investment in sector j = A,U

I_j^B investments in buildings and plants in sector j = A,U

I_j^M investments in other capital equipments in sector $j = A,U$

K_j capital stock in sector $j = 2,\ldots,5$

Q_j user cost of capital in sector $j = 2,\ldots,5$

EXOGENOUS VARIABLES AND PARAMETERS

K_j capital stock in sector $j = A,U$

P_i^W price level expressed in Swedish currency, on international markets on commodity $i = 1,\ldots,3$

h_j labor augmenting technical change in sector $j = 1,\ldots,5$

g_j capital augmenting technical change in sector $j = 1,\ldots,5$

f_1 net natural rate of population increase in the rural areas

f_u net natural rate of population increase in the urban areas

F net capital inflow

C^G consumption by the government

R total land acreage

N_1 total population in the rural areas

N_u total population in the urban areas

RE remittances from emigrants

E total number of emigrants

p_j^h sex-specific labor participation rate in sector $j = A,U$ $h = \Gamma$ (female), Ω (male)

z_j^h share of population in working ages, $j = A,U$ $h = \Gamma,\Omega$

l_j share of females in total population, $j = A,U$

ϕ_i	*ad valorem* custom duty of imports of commodity $i = 1,\dots,3$
a_{ij}	input of commodity $i = 1,\dots,5$ per unit of output in sector $j = 1,\dots,5$
$\alpha, \delta_j, \gamma_j$	distribution parameters in the production function of sector j
ρ_j	substitution parameter in sector $j = 1,\dots,5$
ω_j	index of the relative wage rate in sector $j = 2,\dots,5$
β_{ij}	marginal propensity to consume commodity $i = 1,\dots,5$ by household in sector $j = A,U$
b_{ij}	subsistence consumption of commodity $i = 1,\dots,5$ in sector $j = A,U$
s^l, s^c	rate of savings out of labor income (l) and capital and land income (c)
ε_i	price elasticity parameter in the export demand for commodity $i = 1,\dots,3$
μ_i	price elasticity parameter in the import demand for commodity $i = 1,\dots,3$
σ_i	annual rate of change of world market trade with commodity $i = 1,\dots,3$
ψ	annual rate of change in import of commodity 2
τ^l, τ^c	tax rate out of labor income (l) and capital and land income (c)
κ^B, κ^M	annual rate of depreciation of buildings and plants (B) and other capital equipment (M)
ζ_j	share of buildings and plants in the capital stock of sector $j = 1,\dots,5$
ξ	share of total investment in agriculture
r	annual rate of growth in land acreage
λ_j^g, λ_j^h	annual rate of technological change in sector $j = 1,\dots,5$
d, η	parameters in the migration function
A_j	constant in the production functions $j = 1,\dots,5$

υ export share in sector 4

v_j^h growth rate in labor participation j = A,U h = Γ,Ω

q_j index of the relative rates of return in sector j = 2,...,5

PRICES

$$P_i^D = \frac{im_i}{1 + im_i}\left(1 + \phi_i\right) P_i^W + \frac{1}{1 + im_i} P_i \qquad i = 1,3$$

$$P_2^D = P_2^W$$

$$P_i^D = P_i \qquad i = 2,4,5$$

PRODUCTION AND TECHNOLOGY

$$P_i^* = P_i - \sum_{j=1}^{5} P_j^D a_{ij} \qquad i = 1,\ldots,5$$

$$X_1 = A_1 R^{\alpha} H^{1-\alpha}$$

$$H = \left\{\delta_1\left(g_1 K_1\right)^{-\rho_1} + \gamma_1\left(h_1 L_1\right)^{-\rho_1}\right\}^{-\frac{1}{\rho_1}}$$

$$X_j = A_j \left\{\delta_j\left(g_j K_j\right)^{-\rho_j} + \gamma_j\left(h_j L_j\right)^{-\rho_j}\right\}^{-\frac{1}{\rho_j}} \qquad j = 2,\ldots,5$$

$$X_{ij} = a_{ij}\ X_j \qquad i = 1,\dots,5;\ j = 1,\dots,5$$

$$\frac{W_1\ L_1}{P_1^*\ X_1} = (1 - \alpha)\ \gamma_1 \left[\frac{H}{h_1\ L_1}\right]^{\rho_1}$$

$$\Pi_1 = P_1^*\ X_1 - W_1\ L_1$$

$$Q_j = P_2^D\ (RC_j + \kappa^M)(1 - \zeta_j) + P_5^D\ (RC_j + \kappa^B)\ \zeta_i \qquad j = 2,\dots,5$$

$$\frac{W_j\ L_j}{P_j^*\ X_j} = \gamma_j \left[\frac{X_j}{h_j\ L_j\ A_j}\right]^{\rho_j} \qquad j = 2,\dots,5$$

$$\frac{Q_j\ K_j}{P_j^*\ X_j} = \delta_j \left[\frac{X_j}{g_j\ K_j\ A_j}\right]^{\rho_j} \qquad j = 2,\dots,5$$

$$RC_j = q_j\ RC_u \qquad j = 2,\dots,5$$

$$W_j = \omega_j\ W_u \qquad j = 2,\dots,5$$

FACTOR MARKETS

$$L_A = \left[p_A^{\Gamma}\ z_A^{\Gamma}\ l_A + p_A^{\Omega}\ z_A^{\Omega}\ (1 - l_A)\right] N_A$$

$$L_u = \left[p_u^{\Gamma}\ z_u^{\Gamma}\ l_u + p_u^{\Omega}\ z_u^{\Omega}\ (1 - l_u)\right] N_A$$

$$\sum_{j=2}^{5} L_j = L_u$$

$$\sum_{j=2}^{5} K_j = K_u$$

HOUSEHOLD DEMAND AND INCOME

$$\frac{P_i^D D_{ij}}{N_j} = b_{ij} P_i^D + \beta_{ij}\left(\frac{C_j}{N_j} - \sum_{i=1}^{5} b_{ij} P_i^D\right) \qquad i = 1,\ldots,5 \quad j = A,U$$

$$C_j = (1 = s^l)\ (Y_j^{Dl} - \sum_{i=1}^{5} b_{ij} P_i^D N_j) + (1 - s_c) Y_j^{Dc}$$

$$+ \sum_{i=1}^{5} b_{ij} P_i^D N_j \qquad j = A,U$$

$$Y_A^{Dl} = (1 - \tau^l)\ W_1\ L_1 + RE$$

$$Y_A^{Dc} = (1 - \tau^c)\ \Pi_1$$

$$Y_U^{Dl} = (1 - \tau^l) \sum_{j=2}^{5} W_j\ L_j$$

$$Y_U^{Dc} = (1 - \tau^c) \sum_{j=2}^{5} Q_j\ K_j$$

EXPORT AND IMPORT

$$EX_i = EX_i^o \left(\frac{P_i}{P_i^w}\right)^{\varepsilon_i} \exp(\sigma_i\ t) \qquad i = 1,3$$

$$EX_4 = \upsilon \sum_{i=1}^{3} EX_i$$

$$im_i \equiv \frac{IM_i}{X_i - EX_i} = im_i^o \left(\frac{P_i}{(1 + \phi_i)\ P_i^W}\right)^{\mu_i}$$

$$i = 1,3$$

$$im_2 \equiv \frac{IM_2}{X_2 - EX_2} = im_2^o \exp(-\psi t)$$

$$P_2\ EX_2 = P_1^W\ IM_1 + P_2^W\ IM_2 + P_3^W\ IM_3 - P_1\ EX_1$$

$$- P_3\ EX_3 - P_4\ EX_4 - F - RE$$

SAVINGS AND INVESTMENTS

$$S_j = s^l \left(Y_j^{Dl} - \sum_{i=1}^{5} b_{ij}\ P_i^D\ N_j \right) + s^c\ Y_j^{Dc} \qquad j = A,U$$

$$S^G = \sum_{j=1}^{5} \tau^l\ W_j\ L_j + \tau^c \Pi_1 + \sum_{j=2}^{5} \tau^c\ Q_j\ K_j$$

$$+ \sum_{i=1}^{3} \phi_i\ P_i^W\ IM_i + F - C^G$$

$$I_1 = \xi I$$

$$I_U = (1 - \xi) I$$

$$I_1^B = \zeta_1 I_1$$

$$I_1^M = (1 - \zeta_1) I_1$$

$$I_U^B = \zeta_U I_U$$

$$I_U^M = (1 - \zeta_U) I_U$$

BALANCING EQUATIONS

$$X_1 = D_{1A} + D_{1U} + \sum_{j=1}^{5} a_{ij}\ X_j + EX_1 - IM_1$$

$$X_2 = D_{2A} + D_{2U} + \sum_{j=1}^{5} a_{2j}\ X_j + I_U^M + I_1^M + EX_2 - IM_2$$

$$X_3 = D_{3A} + D_{3U} + \sum_{j=1}^{5} a_{3j} X_j + EX_3 - IM_3$$

$$X_4 = D_{4A} + D_{4U} + \sum_{j=1}^{5} a_{4j} X_j + C^G + EX_4$$

$$X_5 = D_{5A} + D_{5U} + \sum_{j=1}^{5} a_{5j} X_j + I_U^B + I_1^B$$

$$GDP = P_1^D X_1 + P_2^D X_2 + P_3^D X_3 + P_4^D X_4 + P_5^D X_5 - \sum_{i=1}^{5} \sum_{j=1}^{5} P_i^D X_{ij}$$

DYNAMICS

$$K_j(t) = K_j(t-1) + I_j(t-1) - \left[\kappa^B \zeta_j + \kappa^M (1 - \zeta_j) \quad K_j(t)\right] \qquad j = A,U$$

$$N_1(t) = N_1(t-1)(1 + f_1) - M(t-1) - E(t-1)$$

$$N_U(t) = N_U(t-1)(1 + f_U) + M(t-1)$$

$$\frac{M}{N_1} = d + \eta \frac{W_u}{W_1}$$

$$R(t) = R(t-1) \exp (r)$$

$$g_j(t) = g_j(t-1) \exp (\lambda_j^g) \qquad j = 1,\ldots,5$$

$$h_j(t) = h_j(t-1) \exp (\lambda_j^h) \qquad j = 1,\ldots,5$$

$$p_j^h(t) = p_j^h(t-1) \exp (\nu_j^h) \qquad j = A,U \quad h = \Gamma,\Omega$$

APPENDIX II: RESULTS FROM THE COMPARATIVE STATIC EXPERIMENTS

Table II1. Rural experiments (percentage difference compared with base run).

Variables	Base run million of Skr.	Experiments I R+10%	II K1+10%	III h_1+10%	IV H1+10% P_1^w+10%
X1	601.0	1.9	0.9	6.9	6.9
X2	161.1	-2.0	-1.0	- 7.2	-12.1
X3	325.0	1.1	0.5	3.6	2.3
X4	441.9	0.2	0.1	0.8	1.3
X5	85.1	-0.4	-0.2	- 1.1	1.9
PD1	1.0	-2.5	-1.2	- 8.5	- 3.0
PD2	1.0	0	0	0	0
PD3	1.0	-0.12	-0.1	- 0.4	0.2
PD4	1.0	1.9	0.9	6.5	3.3
PD5	1.0	1.2	0.6	4.0	1.5
PRO	116.1	-2.3	-2.7	- 4.9	2.6
RCU	1.0	1.2	0.6	4.2	3.4
W1	0.26	-2.0	-0.2	- 7.4	- 0.1
WU	1.0	1.4	0.7	4.7	0.9
EX1	52.2	7.3	3.5	27.3	40.3
EX2	92.0	-3.5	-1.6	-12.4	-21.3
EX3	15.0	0.3	0.2	1.1	- 0.4
EX4	28.0	0.4	0.2	1.9	0.9
IM1	50.1	-2.8	-1.3	- 9.2	-15.4
IM2	16.0	0	0	- 0.1	0.2
IM3	115.0	1.0	0.5	3.2	2.7
I	72.2	-0.9	-0.6	- 2.9	2.0
GDP	966.7	0.5	0.2	1.5	2.7

Table II2. Population experiments (percentage difference compared with base solution).

Variables	Base run million of SKr	Experiments I N1 + 6.9%	II ρ_1 + 6.9%	III N1 + 3.3% Nu + 9.1%
X1	601.0	4.8	4.8	2.4
X2	161.1	-2.8	- 8.0	9.4
X3	325.0	1.2	2.6	2.4
X4	441.9	0.3	0.5	1.9
X5	85.1	-0.2	- 0.8	6.7
PD1	1.0	-3.8	- 6.1	3.0
PD2	1.0	0	0	0
PD3	1.0	-0.2	- 0.3	1.9
PD4	1.0	2.8	4.6	4.2
PD5	1.0	1.8	2.9	- 1.1
PRO	116.1	0.1	- 3.5	6.5
RCU	1.0	1.8	2.9	10.2
W1	0.26	-8.1	-11.4	2.0
WU	1.0	2.1	3.3	- 6.2
EX1	52.2	11.1	18.6	- 7.7
EX2	92.0	-4.9	- 8.6	11.9
EX3	15.0	0.5	0.8	- 5.1
EX4	28.0	0.9	1.2	3.9
IM1	50.1	-2.2	- 6.6	8.5
IM2	16.0	-0.1	- 0.1	6.2
IM3	115.0	0.9	2.3	5.4
I	72.2	-0.9	- 1.5	9.9
GDP	966.7	1.4	1.1	5.5
GDP/capita (1000 Skr)	0.230	-3.5	0.9	0.4

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