8 SECOND ORDER EFFECTS IN POPULATION MIGRATION

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Abstract

Migration becomes a more and more significant process that triggers various types of complex behavior. After analyzing the process, especially with regard to the occurrence of nonlinear behavior, a model is build to include the features that may lead to the occurrence of cycles of migration reverse. The results of a simulation are showing patterns of behavior similar to the Italian case of large ex-migrations in the fifties that were reversed in mid seventies. A set of potential applications on migration from newly entrant countries in the EU to EU-15 is possible especially related to actions that may speed up the moment of migration cycle reverse.

Key words: nonlinear, migration, cycles, complexity

JEL classification: C5, D4

Nonlinear migration behavior

Nowadays the population migration is becoming an increasingly important process with wide-ranging impacts. Migration is described in or between various areas, in relation to economic characteristics (such as GDP, infrastructure, etc.) that are likely to generate nonlinear behavior at least regarding the occurrence of cycles where the flow of ex-in migrants from a country may be reversed.

Let us build a model of migration which contains some of the features that give it a nonlinear character. The most frequent type of migration, occurring in peace time, is the one driving people from poor countries to ex-migrate to rich ones. The difference in GDP per capita from North to South or East to West creates people movement toward increasing GDP per capita.

Taking into account that there is an intensive internal immigration inside areas like the EU, or, even al a lower level inside countries, we may identify a typical behavior such as the one described in the scheme below:

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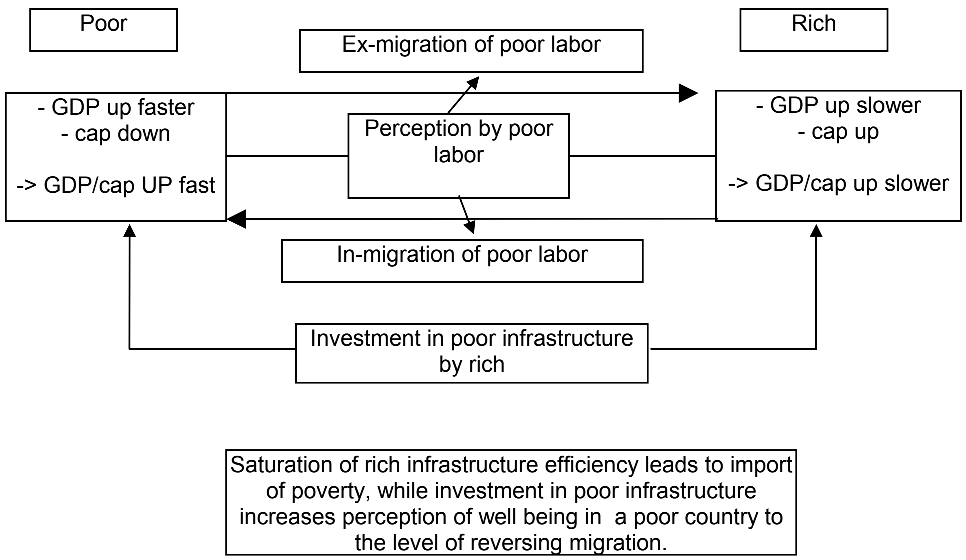
Diagram 1

Migration behavior process



The quality of an economic infrastructure is determined by the efficiency with which an economy is able to make labor (active population) produce GDP, expressed in GDP per capita.

The population increase because of migration represents an increase in labor. Beyond a certain saturation limit of the infrastructure the rate of population increase will overcome the one of GDP. Thus, GDP per capita will diminish, this being perceived as poverty. We may say that massive increase of migrants into rich economies may over a certain limit bring an infusion of poverty.

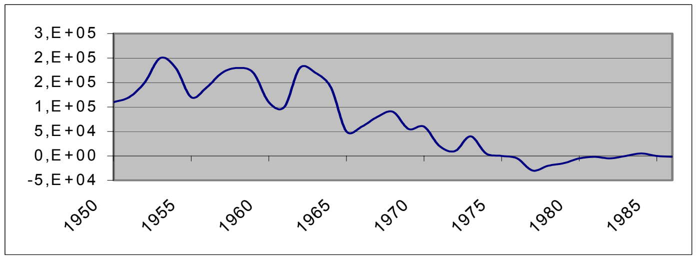
Simultaneously, the investments made by rich economies to create/develop infrastructures in poor economic areas contribute to the increase in efficiency of those areas. Consequently GDP per capita will increase, being perceived as an import of well being into the poor economies.

Migration reversed cases

If this perception is great enough the emigrational flux from the poor economy to the rich may reverse. Several cycles of this sort may show up on ex-in migration from initially poor countries. A conclusive example is the one of Italy, where, migration waves of the fifties were reversed in mid seventies (Figure1.) this being a sign that more efficient infrastructures were set up and operational (partially an effect of the Marshal Plan during that period).

Figure 1

Italy Ex-In patriated



Source ISTAT.

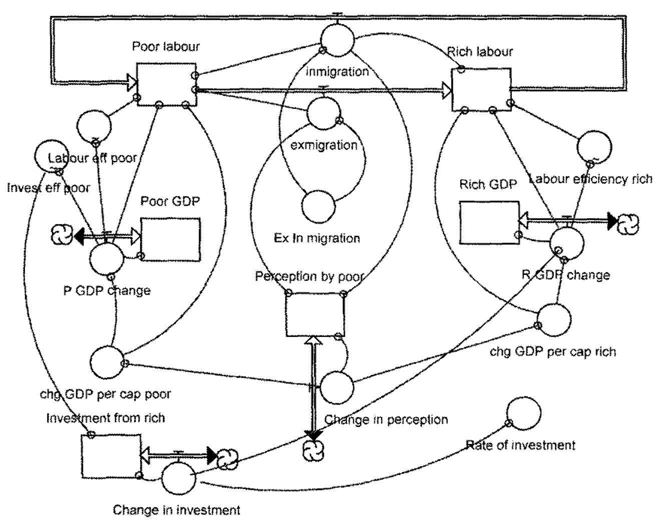
Another typical example is the South of Italy where 25 years ago emigration was the rule for the workers in the area. Investments done by the Government lead today to a significant slowdown or even a reverse of migration (which may have seemed impossible to an old Italian 30 years ago. Probably it would have been as unbelievable as the fall of communism 20 years ago. Obviously, the enlarged EU is witnessing a similar process from poorer Eastern Europe to richer Western Europe.

A (not so) simple model

A behavior such as the one described above may be included into a scheme like the one below, done based on the 'I Think' software

Diagram 2

Migration model



The relations among various model components were defined to reflect the comments made in the previous paragraphs and are listed in the equations below:

Equations for Ex-In migration

INIT Poor_labour = 5E6

INIT Rich_GDP = 40E9

INIT Poor_GDP = 2.5E9

INIT Perception_by_poor = (Rich_GDP-Poor_GDP)/Rich_GDP

INIT Rich_labour = 2E6

exmigration = Poor_labour*Perception_by_poor

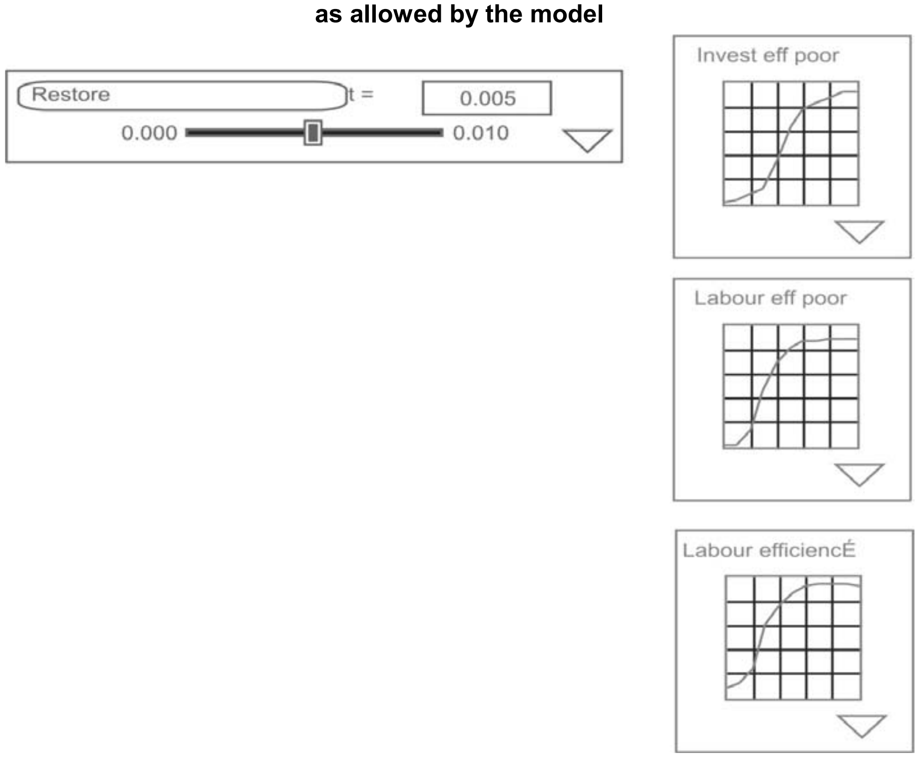
inmigration = (Rich_labour-Poor_labour)*Perception_by_poor

INIT Investment_from_rich = 0.001*Rich_GDP

The following parameters are given in graphic form reflecting thesaturation trend mentioned above. The graphs are described numerically in the three equations that follow.

Figure 2

The parameters in graphic format and the control panel for 'Rate of investment' as allowed by the model



Invest_eff_poor = GRAPH(Investment_from_rich)

(0.00, 900), (5e+006, 1350), (1e+007, 2700), (1.5e+007, 4200), (2e+007, 11100), (2.5e+007, 19650), (3e+007, 23850), (3.5e+007, 25350), (4e+007, 26700), (4.5e+007, 27900), (5e+007, 28350)

Labour_eff_poor = GRAPH(Poor_labour)

(0.00, 0.00), (700000, 750), (1.4e+006, 4650), (2.1e+006, 14100), (2.8e+006, 21300), (3.5e+006, 24750), (4.2e+006, 26700), (4.9e+006, 26700), (5.6e+006, 26850), (6.3e+006, 27150), (7e+006, 27000)

P_GDP_change = (Invest_eff_poor+Labour_eff_poor)*Poor_labour-Poor_GDP

Labour_efficiency_rich = GRAPH(Rich_labour)

(0.00, 3000), (700000, 4050), (1.4e+006, 7950), (2.1e+006, 18600), (2.8e+006, 23250), (3.5e+006, 26250), (4.2e+006, 28200), (4.9e+006, 28500), (5.6e+006, 28500), (6.3e+006, 28500), (7e+006, 28200)

R_GDP_change = (Labour_efficiency_rich-Rich_GDP/Rich_labour)*Rich_labour

chg_GDP_per_cap_poor = P_GDP_change/Poor_labour

chg_GDP_per_cap_rich = R_GDP_change/Rich_labour

Change_in_perception = (chg_GDP_per_cap_poor-chg_GDP_per_cap_rich)/ Perception_by_poor

Rate_of_investment = 1E-3

Change_in_investment = Rate_of_investment*R_GDP_change-Investment_from_rich

Ex_In_migration = exmigration-inmigration

Poor_labour(t) = Poor_labour(t - dt) + (inmigration - exmigration) * dt

Rich_GDP(t) = Rich_GDP(t - dt) + (R_GDP_change) * dt

Poor_GDP(t) = Poor_GDP(t - dt) + (P_GDP_change) * dt

Perception_by_poor(t) = Perception_by_poor(t - dt) + (Change_in_perception) * dt

Rich_labour(t) = Rich_labour(t - dt) + (exmigration - inmigration) * dt

Investment_from_rich(t) = Investment_from_rich(t - dt) + (Change_in_investment) * dt exmigration = Poor_labour*Perception_by_poor

inmigration = (Rich_labour-Poor_labour)*Perception_by_poor

Invest_eff_poor = GRAPH(Investment_from_rich)

(0.00, 900), (5e+006, 1350), (1e+007, 2700), (1.5e+007, 4200), (2e+007, 11100), (2.5e+007, 19650), (3e+007, 23850), (3.5e+007, 25350), (4e+007, 26700), (4.5e+007, 27900), (5e+007, 28350)

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P_GDP_change = (Invest_eff_poor+Labour_eff_poor)*Poor_labour-Poor_GDP

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R_GDP_change = (Labour_efficiency_rich-Rich_GDP/Rich_labour)*Rich_labour

chg_GDP_per_cap_poor = P_GDP_change/Poor_labour

chg_GDP_per_cap_rich = R_GDP_change/Rich_labour

Change_in_perception = (chg_GDP_per_cap_poor-chg_GDP_per_cap_rich)/Perception_by_poor

Change_in_investment = Rate_of_investment*R_GDP_change-Investment_from_rich

Ex_In_migration = exmigration-inmigration

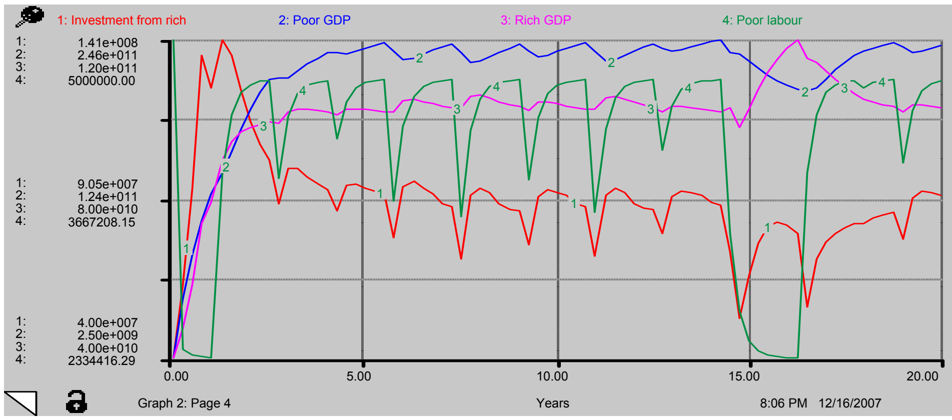
The values chosen for the parameters above are arbitrary but they obey the behavior trends described, e.g. saturation of GDP generated by increasing labor.

Results

The dynamic regimes resulting from solving the equations in the model (using a 4-order Runge-Kutta method) are given in Figure 2 below.

Figure 2

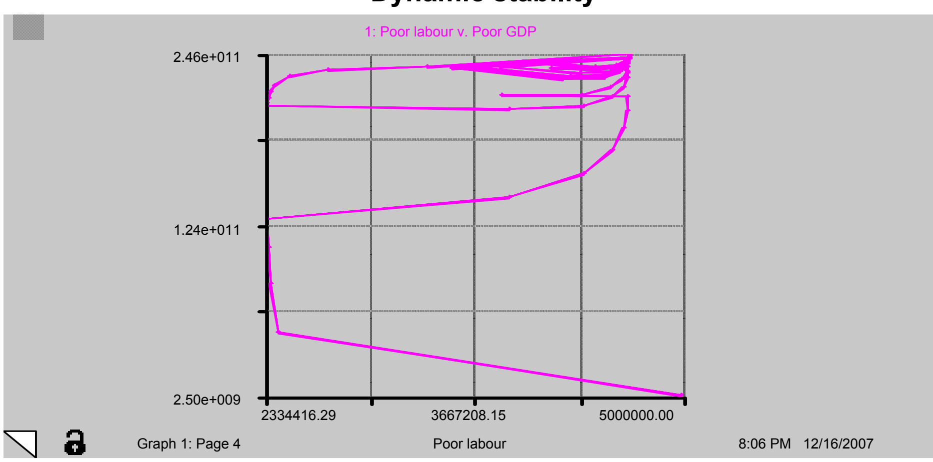
Migration cycles



One may see that a large out-migration from the poor country is followed by a 'return home' and then, by more cycles driven by the investment from the rich and by attaining the saturation of efficiency in the rich economy. Looking at the evolution of poor labor and Poor GDP depicted below (Figure 3) one may see the occurrence of an attractor for the evolution trajectory of the system.

Figure 3

Dynamic stability



The fact that dynamic stability may be shown to exist in such systems is leading to the conclusions presented in what follows.

Conclusions

After having described the migration behavior of population between poor and rich economic areas, we were driven to a model having nonlinear behavior generating features.

Solving the resulted system of first order differential equations lead us to regimes of dynamic stability and cycle occurrence of the ex-in migrations from the poor country that replicate the behavior that had been described and analyzed for the case of Italy (as a living example where the cycle has closed in the last 50 years).

Finally, this paper is only showing that by analyzing economic processes that are showing nonlinear, complex, behavior, one may generate models having a higher degree of predictability, that encompass natural behavior, observed as real cases, for countries whose evolution may bring hope that, with appropriate action, we may witness reversed migration cycles for newly entrant countries in the EU.

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