Urbanization and growth. Why the splendor of the Italian cities in the sixteenth century did not drive to the transition?

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Very preliminary draft

Abstract

In this paper we investigate the quantitative relation between population, real wages and urbanization in the Italian economy during the period 1320-1870. In this period the prevailing conditions were those of a poor, mainly agricultural economy with limited human capital and rudimentary technology. However, these centuries witnessed the considerable growth of urban centers, which was not only a significant demographic phenomenon in itself. The multiplication of such agglomerations had a striking influence on mortality and hence on the general course of the economy in this period.

Among the main results of the paper we show that the dynamic of the rural productivity after the mid of the XVI century plays a key (and puzzling) role in the falling trend of economic "efficiency". The rise of the productivity in the agricultural sector curbs the urbanization rate in the short run, whereas in the long run the relationship becomes positive. In the short run a substitution effect is at work, whereas in the long run the high rural labor productivity means that each farmer worker can feed many non-farm workers located in town and cities. However, when looking at the relative wage in the agricultural and urban sectors, the urbanization is no longer affected by wages. As to the role played by urbanization, we find that population reacts positively to shocks in the urbanization rate, with long lasting effects. Interestingly, it is confirmed that urbanization play an important role in economic development. An increase in the urban population implies a decline in the rural productivity, and, what is more important, also a decline in the relative productivity in the rural sector.

Finally, we find that a better standard of living (measured as an increase in rural real wages) does not positively affect population: one of the key elements to restore the equilibrium in the Malthusian scheme does not operate in the epoch considered.

Key words: Urbanization; Cities; Malthusian dynamics, pre-industrial labor productivity; population trend, demographic changes, agricultural and urban wages.

JEL: N33; N53; N93; J11; C32

1. Introduction

Bencivenga and Smith (1997) stress as a prominent aspect of actual economic development is typically omitted from conventional neoclassical growth model. Ancient and modern economic development has invariably been accompanied by pronounced migration from rural to urban sectors of employment. Over the last two centuries all the countries that have experienced the transition from traditional-agricultural economies to market economies have increased persistently urbanization, reduced fertility and increased the growth rate of per capita output in the market sectors.[1]

The rise of urban population in Europe indicates the extent to which specialization, associated with the division of labor, accompanied economic development. Per capita product rises as production shift from primitive (or households economy) processes to market based specialization techniques and the pace of this process reflects the rapid urbanization.[2] Moreover, key functions for economic development such as banks, notaries, legal, dealing, business and commerce were necessarily carried out and developed in cities and grew with urbanization.[3] The engine, however, is the population which must grow so that it can support with its migration an urban market sector.

The urbanization figures show as some European countries, which first have abandoned the primitive o rural technology, quickly progressed in the urbanization rate between the 15th and the 17th century. The three countries which played a decisive role in the European economy, each gained dominance in sequence and in parallel to the process of urbanization: Italy (central-northern), Netherlands and England.[4]

Starting from preliminary statistical analysis based upon the decennial frequencies data set provided by Malanima (2002; 2003; 2005) and Federico and Malanima (2004), we perform a time series

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[1] See, amongst others, the classical Bairoch (1981), (1988), Wrigley 1969, and amongst the new literature, Goodfriend and McDermott (1995), Zhang (2002), Sato and Yamamoto (2005),

[2] See amongst others, the Goodfriend and McDermott (1995)'s model which explains how early industrialization was associated with an acceleration of the pace of urbanization. . For an historian analysis see Cipolla (1974; 1980).

[3] In 1341, Florence suffered the first great financial crisis which quickly carved on domestic and international trade spreading its effects not only at European level. Before the XV century was there again ab oversize bank, that of the Medici. See the works in the Cambridge Economic History, Vol. II and III. For the rise of the professions see Cipolla (1973).

[4] See Malanima (2002). In particular data reported in Figure 2.17 pg. 91. Of course there are others factors (changes in education, property-rights, preferences across social classes, culture and so on) that have had an impact on economic outcomes in a country undergoing the transition from stagnation to growth. See, for instance, Jones (2001) and the survey of Doepke (2006). The view that the transition from a traditionalist and religious-minded society to the individualistic and mobile world of the market society which originated and developed in towns, has been credited to many authors. See, amongst others, Hicks (1969), Hohenberg and Hollen Lees (1985), Blockmans (1989), Tilly (1990). Moreover, in some cases, the boom in urbanization could also be associated to that of the greatest building booms. A striking labor supply which flooded the towns and cities allowed ecclesiastical and military architecture to flourish.

analysis and attempt to study the aggregate relationship between population, urbanization and wages. [5]

The nonstationary nature of the series is known to have crucial economic and statistical implications.[6] To this end we estimate and simulate VAR cointegrated models which allows us to study "short-run" impacts, long-run wage-population-urbanization rate relationships, and feedback paths.[7]

The objects of this paper is carry out an aggregate time series analysis in order to evaluate empirically the role of urbanization and its relationship with the rural labor productivity in the Italian pre-industrial epoch. This aspect is important, since the relatively slow pace of urbanization may be one of the conditions to delay industrialization. This hypothesis is particularly interesting for Italy whose towns and cities already in the early Middle Ages represented splendid cultural, economic and financial centers.

Of course some qualifications should be taken into account. In this context, it is important to be sufficiently precise about the main events and historical facts, and it is naïve to suggest that the relationship may be affected by myriad of other factors. We are aware that the observable data (wages, population, output, urbanization rate etc) in the form of time series, have undergone insurmountable difficulties, nevertheless, these time series are the only possible candidates for measuring these variables and providing some aggregate results.

Among the main results of the paper we show that the dynamic of the rural productivity after the mid of the XVI century plays a key (and puzzling) role in the falling trend of economic "efficiency". The rise of the productivity in the agricultural sector curbs the urbanization rate in the short run, whereas in the long run the relationship becomes positive. In the short run a substitution effect is at work, whereas in the long run the high rural labor productivity means that each farmer worker can feed many non-farm workers located in town and cities. However, when looking at the relative wage in the agricultural and urban sectors, the urbanization is no longer affected by wages.

As to the role played by urbanization, we find that population reacts positively to shocks in the urbanization rate, with long lasting effects. Interestingly, it is confirmed that urbanization play an

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[5] Although data pose unavoidably serious problems, there is a large and growing body of literature which studies economic-demographic relations in preindustrial Europe. See Weir (1991); Lee (1997); Lee and Anderson (2002); Malanima (2005); Clark (2006); Craft and Mills (2007). Eckstein et al (1986), Bergtsson and Brostrom (1997) and Nicolini (2006), amongst others, use VAR analysis for investigating on demographic and economic relationships.

[6] Bailey and Chambers (1993) and other authors claim for England that real wages and population are integrated to a different degree and thus cannot be analyzed in relation to one another.

[7] Obviously a caveat is called for. The history of the Italian economy is orders of magnitude more complicated and dramatic than this simple time series description. Many features of the history of growth are omitted. Of undeniable importance are the evolution of physical and human capital, property rights, new ideas and institutions, and religious constraints to their diffusion, foreign dominance, and many other factors and events. Here we quote the papers in Storia d'Italia (1974), Luzzatto (1961),

important role in economic development. An increase in the urban population implies a decline in the rural productivity, and, what is more important, also a decline in the relative productivity in the rural sector.
Finally, we find that a better standard of living (measured as an increase in rural real wages) does not positively affect population: one of the key elements to restore the equilibrium in the Malthusian scheme does not operate in the epoch considered.

The paper is organized as follows. Section 2 discusses the data set. Section 3 analyses the dynamics of population and real wages in agriculture. In this section we study the statistical characteristics of the time series available. Section 4 reports the long-run estimates and short-run dynamics of the real wage-population-urbanization relationship using a VAR cointegrated model. A detailed summary of results and implications ends the paper.

2. A brief history of the urbanization in Europe and Italy in the pre-industrial epoch

At the time when the Italian population is at the peak (between the end of 200 and half 300), the situation of the Italian urbanization is outstanding compared to the European, although highly differentiated on its territory. In Europe, cities with over 40 thousand inhabitants were no more than 9 (Paris, London, Cologne, Barcelona, Ghent, Tournai, Rouen and Montpellier) and their sizes were considered exceptional (Géants). In Italy there were 11 cities with more than 40 thousand people, and 4 of these also exceeded the 100, 000 inhabitants.
We fully realize the extreme importance of the Italian urban network if one consider the ranges between 20 and 40 thousand inhabitants and, in particular, between 10 and 20 000 inhabitants. Cities larger than 20,000 inhabitants were 13 and 59 well above the 10,000. Also, during the period, there were over 100 cities with a population between 5,000 and 10,000 inhabitants. Dimensions that were defined at European level medium-sized cities.[8]
In Italy the urbanization process was much more important that Europe not only for the larger cities, but also for a lively connective network composed of 59 urban centers with 10-20 thousand inhabitants and 67 centers with 10.6 thousand. Regional differences were quite evident, with major urban centers concentrated in the Northern areas and in Tuscany. Keeping the threshold of 10,000

[8] On the history of medieval Italian cities and the urbanization process, there is a huge bibliography, carefully proposed and adequately supported by data and documents in Ginatempo and Sandri (1990) and Pini (1996). Data on European cities are taken from these authors from works of L. Genicot, H. Amman, C. Haase, J. Le Goff, C. Dury, E. Ennen and several others. The data are carefully documented and compared.

inhabitants, the urbanisation rate was 18 percent in Italy –as in Flanders[9] --, while the European average was 5.3.[10]

After the first few decades of 300, however, began a dramatic demographic transformation, with repeated and convulsive mortality crises (Black Death) which have caused a general lowering of urban population. Lucca, Pistoia, Verona, Padova, Treviso, Como and Pavia, L'Aquila, Sulmona lost half the population, most of Tuscany was under an extreme decrease of urban populations; Arezzo and Prato lost three-quarters of the inhabitants, Pisa, Massa and many other cities came to lose four-fifths of the population. Cities of Emilia Romagna, Piemonte and Sicily lost less, but for many of them about half the population was decimated. Very considerable losses also involve the Kingdom of Naples and the States of the Church. Many small and medium-sized towns in Central and Southern Italy disappear.[11] When the first Black Death appeared (1348-49), in Italy the population was 12-13 million; the plague killed 3.5 million (about 27-30% of the population). Major diseases were the Black Death and especially bubonic plague (the main cause of death for about 300 years), but also typhus, dysentery and smallpox.

In the next phase, clearly emerge a reduced resilience of the urbanization process with an overall downsizing of the urban system, in particular in some regions (Tuscany, Central and Southern regions). However, this was not uniform, Florence and Rome are experiencing a wonderful renaissance season, the cities of Sicily and of the Po river valley show a lively revival between the XV and XVI century.

In the 1560 no more than five European cities had reached a population figure of 100.000. Except Paris, the others were Italian (Naples, Genoa, Venice and Milan). Other large cities were Bologna, Verona, Palermo Rome and Messina. They created conditions favourable to new epidemic outbreak. The concentration and the "mushroom growth" of large and small urban centers seems to give up after the Italian epidemic of 1656-57.[12]

It follows a long-term trend characterized by greater dynamism of the rural population and urban stagnation: an unusual development on the European scene, where urban percentage was slowly rising.[13] Around 1870, while the European urbanization rate had grown to 15.2 (cities with at least 10,000 inhabitants), the Italian one had fallen to 16.2. At that time European cities numbered 1,299.

[9] But in Belgium there were only 11 cities with more than 10,000 inhabitants.
[10] Malanima (forthcoming b).
[11] Malanima (2002) reports a fascinating and dramatic reconstruction of the evolution of the plague and the fatal diseases of the age. Among the vast literature we cite the data reconstructed by Del Panta (1980) and Bellettini (1973). See Helleiner (1967) , Ziegler (1969), McNeil (1977) and Benecictow (2004) for an analysis of the plague in Europe.
[12] See Lopez and Miskimin (1962) and the papers in Miskimin, et al. (1977).
[13] De Vries (1984).

In the centre and north of Italy they were 66. From being the most urbanized region of Europe during the Renaissance, this part of Italy was then among the least urbanized.[14]

3. Urbanization, wages and population. The stylized facts.

The following Figures 1-4 show the dynamic of population, urbanization rate, wages and productivity in Italy during the XIV-XVIX centuries.

First note the growth of population and urban communities across the period. Before the mid of the 500s, the trend of the two demographic variables begins to differentiate with a progressive improvement of the population and urbanization stagnation. This explain also the swing in the trend of efficiency in agriculture and the productivity slowdown in the last 150 years of the sample.

Figure 2, indicates that the significant gains in urbanization in Italy after 1470 and 1670 are preceded by increases in output per worker, with the latter following plague years. The figure also points out how gains in urbanization are followed by reduction in agricultural productivity and wages. Figures 3 and 4 show that, after the Great Plague" of 1347-48, wage gains in agriculture were large but the rapid population growth reversed them before the 1550. High wages sustained a higher proportion of population living in cities which, however, start to drop before 1550. Figure 2 stresses haw the similar trend of rural productivity and urbanization rate.

[14] See also Bosker, Brakman, Garretsen, De Jong, Schramm (2008).

Figure 1. Population and Urbanization Rate

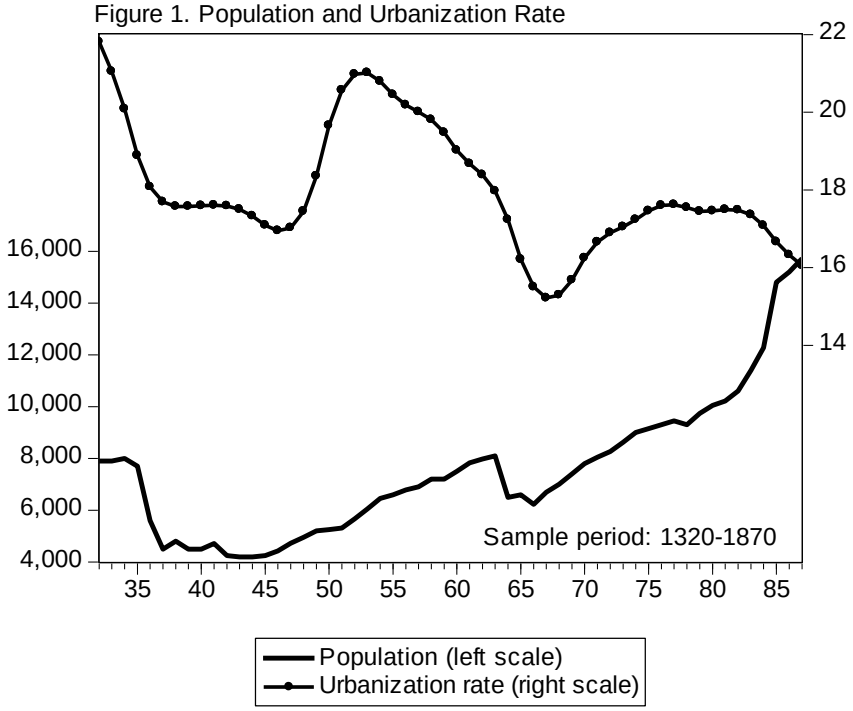
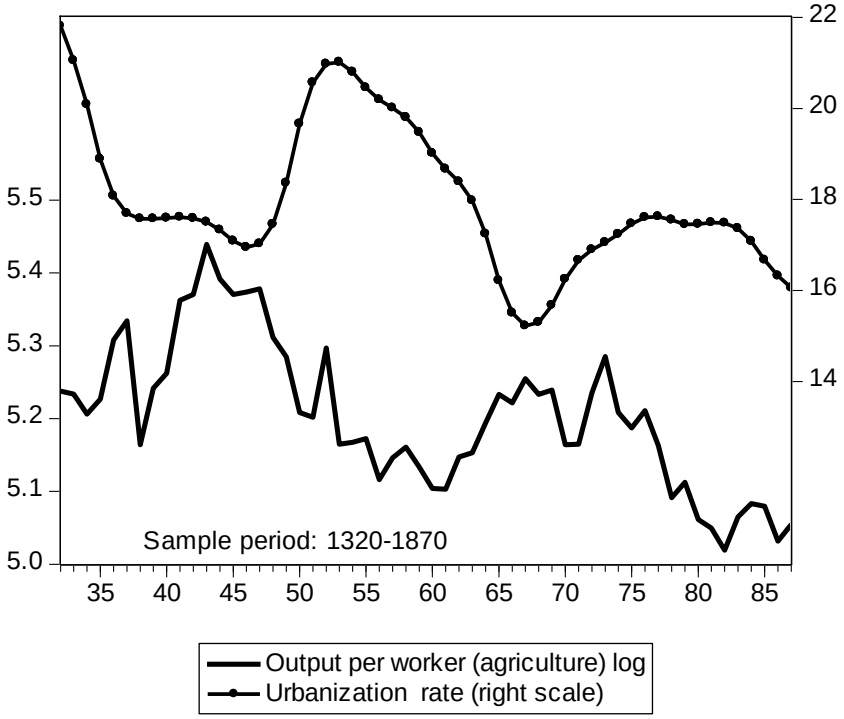


Figure 2. Output per Worker in Agriculture and Urbanization Rate



A possible measure of the level of efficiency of the Italian economy is the relative wage, i.e. the ratio of the rural to the urban wage. When we examine the path of this ratio along with the urbanization rate, shown in Figure 3, the complex dynamic interaction already discernible in Figure 2 is confirmed. Actually, while the contemporaneous correlation between the two variables is -0.09, it peaks to -0.59 when lagging the urbanization rate by 6 periods (decades, in our case) whereas it becomes positive, +0.73, when we consider the relative wage lagged by 9 periods.

Figure 3: real relative wage (right axis) and urbanization rate (trend HP, log transformed, left axis)

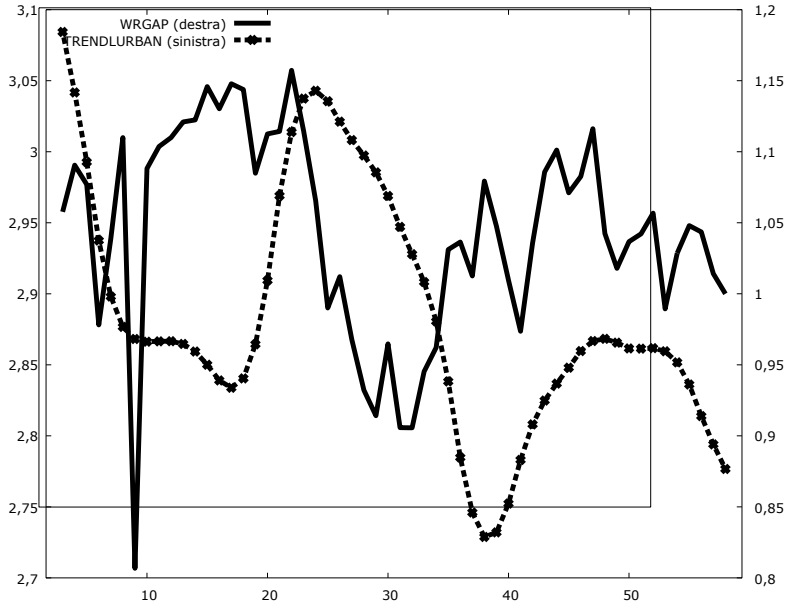
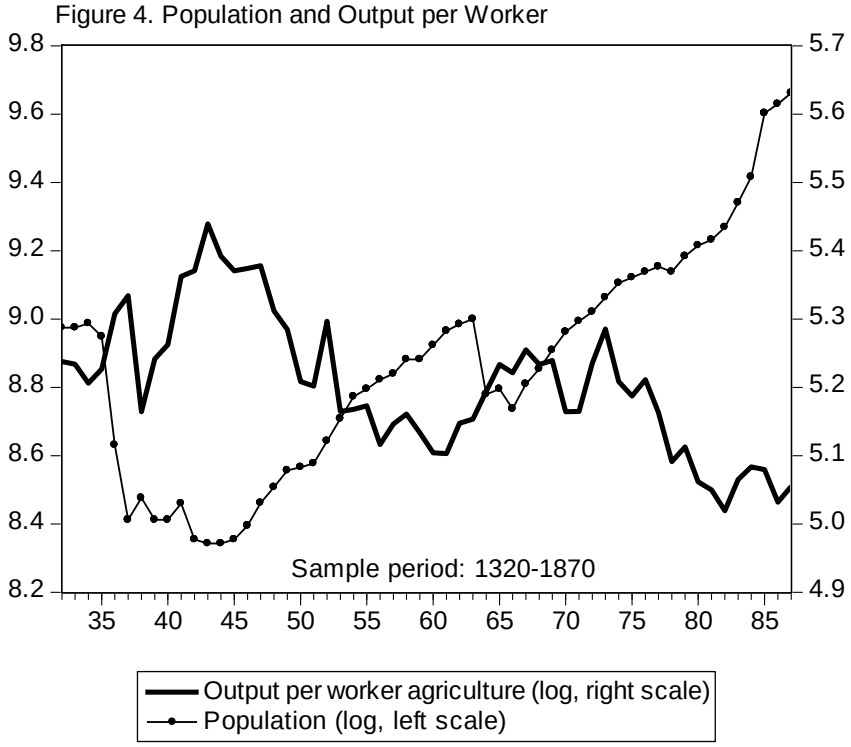


Figure 4. Population and Output per Worker



As Figure 4 clearly shows, factors that reduce population lead to high agriculture labor productivity. This means that farm workers may feed many non-farm people living in cities and towns, stimulating urbanization and, hence, with a lag of several decades, a fall in rural wages (with respect to urban wages), and hence a reallocation toward more efficient production. Whenever an adverse demographic shock impinges upon population and urbanization, this generates, after some decades, a decrease in economic efficiency .

The post-plague decades shows a significant upwards movement in population reducing the efficiency of the rural economy and swinging down the wages in agriculture. The initial rise in productivity and rural wages after the Black Death was not made permanent by the "horsemen effect" (rise in war frequency, in deadly disease outbreaks and urbanization) which pushed up mortality rates and produced higher per capita income.[15]

Contrary to what happened in most of Europe, in Italy wage decline after 1500 is more noticeable.[16] What had been a dense network of urban centers in the medieval epoch reduced to emptied urban nuclei by 1700. [17] Thus, urbanization rates mimic agricultural productivity but, against the

[15] See Voigtlander and Voth (2009) states that war and trade-related mortality shift the death schedule upward and together with the effect of urbanization, this created a new mortality regime, reducing population pressure and making the initial income gains after the Black Death sustainable. Trade, war and urban centers, "the horsemen", pushed up the mortality rate spreading plague, typhus, smallpox and other disease across Europe.

[16] See, Allen (2001), Acemoglu at al. (2005), Malanima (2003) and Voigtlander and Voth (2009).

[17] See De Vries (1984) and the data on European urbanization based on Bairoch, Batou and Chevré and reported by Voigtlander and Voth (2009).

Northwestern Europe, Italy in had higher per capita GDP in 1300s than in 1700-1800. Rural labor productivity and the rural-urban wage gap had limited the transition to self-sustaining growth.

3.1 Univariate statistical properties (to be completed)

In this section we investigate the main characteristics of our variables of interest: population, urbanization rate, wages, and relative wage.

Table 1 presents unit root tests. The augmented Dickey- Fuller (ADF) test examines the null hypothesis of a unit root against a trend-stationary alternative; whereas the KPSS test examines the null hypothesis of trend-stationarity (Kwiatkowski et al., 1992). The lags included in the ADF test are consistent with the lag order selection criteria and with the evidence provided by the Partial Autocorrelation Function, whereas in the KPSS test we considered 3 and 10 lags.[18]

Table 1: Augmented Dickey Fuller Test for unit root. Null Hypothesis: unit root

	Level		First Difference	
	Test statistic	Deterministic (lags)	Test statistic	Deterministic (lags)
Relative wage	-3.89**	Constant (0)	-	-
Urbanization rate	-3.16*	Constant,trend (3)	-3.31**	Constant (2)
Rural wage	-2.25	Constant,trend (0)	-7.54***	Constant (0)
Urban wage	-2.56	Constant,trend (0)	-8.25***	Constant (0)
Population	-4.05***	Constant, trend (2)		

Thresholds (constant and trend): 1% (-3.96) 5% (-3.41) 10% (-3.13)
Thresholds (constant): 1% (-3.43) 5% (-2.86) 10% (-2.57)

Table 2: KPSS Test for unit root. Null Hypothesis: no unit root

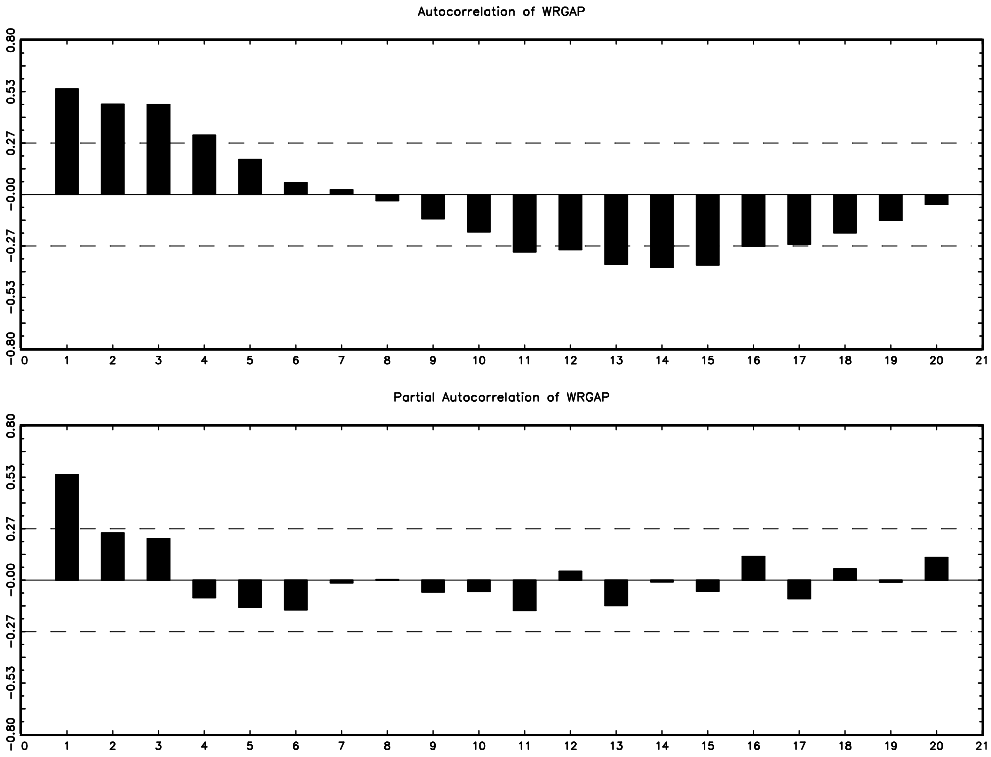
	Level		First Difference	
	Test statistic: 3 (10) lags	Alternative hyp.	Test statistic: 2 (9) lags	Alternative hyp.
Relative wage	0.21 (0.13)	Level stationariy	-	-
Urbanization rate	0.10 (0.06)	Trend stationariy		
Rural wage	0.12* (0.07)	Trend stationariy		
Urban wage	0.12* (0.07)	Trend stationariy		
Population				

Thresholds (constant and trend): 1% (0.216) 5% (0.146) 10% (0.119)
Thresholds (constant): 1% (0.739) 5% (0.463) 10% (0.347)

[18] Suitable choices of the lag length for the computation of the so-called long-run variance may be: $l_4 \approx 4(T/100)^{1/4}$ and $l_{12} \approx 12(T/100)^{1/4}$.

The main point to be commented upon is the stationariy nature of the relative wage, provided that either rural and urban wage are driven by stochastic trend, and the ADF tests suggest they are I(1) processes. The results of the KPSS and ADF tests for the relative wage is fully consistent, and, an intuitive support to the idea of relative wage to be a stationary process, is given by the inspection of the correlogram, shown in Figure 5.

Figure 5: autocorrelation function for the relative wage series, periods 1320-1870



The ACF show low persistence and the coefficient calculated in the partial autocorrelation function is by far lower than unit, supporting the view of a stationary process. This implies that rural and urban wages share a common stochastic trend (possibly the population trend). Moreover, the fact that the relative wage is a mean reverting process (it oscillates around its long-run equilibrium level) also implies that demographic and technological shocks produce only temporary deviations.

4. The VEC model: urbanization, population and wages

In this section, we investigate the effects of urbanization in the wage-urbanization relationship. In the pre-market period, the appearance and the developments of cities were a condition for industrialization and economic development. Economists and historians such as Boserup (1981),

Goodfriend and McDermott (1995), Acemoglu at al. (2005) and Malanima (2005; 2008), amongst others, have highlighted this aspect, that emerges eloquently from the data.

We use Johansen's (1995) technique to estimate and test the time series models. The estimation is carried out over the period 1320-1870 using a two stage procedure (S2S).[19]

This procedure is a tool for checking the validity of the weak exogeneity hypothesis and to investigate the strength of feedback coefficients to disequilibrium. All the variables are in log. Precisely, we estimate and simulate two models to capture the main relationships between wages, population and urbanization. The first model aims to investigate on the Malthusian hypotheses and how these relates to the urbanization. The second models focuses on the rural-urban relative wage to describe the inflows-outflows of people in the urban communities.

4.1 A population-urbanization-rural wage model

-*Cointegrating space*:

The cointegrating space contains an intercept and Trace, and Maximum Eigenvalue tests indicate that it is characterized by two stationary relations at the 0.05 level.[20]

Using decennial data for 1320-1870, the analysis supports the choice of one common stochastic trend and two stationary relations. The space within which the cointegrated variables move (the attractor set) is a hyperplane with a dimension determined by the three endogenous variables and two cointegrating relationshis:

$$\begin{aligned} \beta_1' y: \quad & pop + \underset{(4.90)}{5.11}\, Urban - \underset{(7.72)}{23.18} \\ \beta_2' y \quad & wa - \underset{(3.68)}{11.38}\, Urban + \underset{(3.40)}{30.23} \end{aligned} \tag{1}$$

In (1), *t-values* are given in parentheses underneath the coefficient estimates. The cointegrating vectors are overidentified as 2 restrictions are imposed on each of them.

[19] See Lutkepohl and Kratzig (2004). Diagnostic tests show a good descriptive power of the system.

[20] The following restrictions identify all cointegrating vectors. In the first cointegrating relation we normalized on the population variable and restricted the wage variable to zero. The second cointegrating relation has a zero restriction on population and is normalized on the rural real wage. The model performs quite well; residuals are stationary. Further tests confirm this hypothesis. The VEC residual serial correlation LM Test indicates that there is no serial correlation up to the lag order of 4, with probabilities that range from 34 to 93%.

We recall that the cointegration vectors cannot be interpreted as representing structural equations because they are obtained from the reduced form of a system where all of the variables are jointly endogenous. Thus, although these relations taken alone as well as each single equation taken alone may seem economically meaningful structures, they are only indicative.

-*Adjustment coefficients*:

Using a two-stage procedure in which the beta vectors are estimated first and then fixed in the second stage, we may threat alphas in the same way as the short run parameters. The strategy chosen is a sequential elimination of the short run parameters and loading factors, based on model selection criteria (AIC).[21] The search for zero-restrictions on loading factors provides the following set of coefficients:

$$\begin{aligned} \alpha_{pop1} &= \underset{(1.0162)}{-0.016} & \alpha_{pop2} &= 0; \\ \alpha_{w1} &= \underset{(4.11)}{-0.979} & \alpha_{w2} &= \underset{(3.49)}{-0.293}; \\ \alpha_{urb1} &= 0 & \alpha_{urb2} &= \underset{(3.97)}{0.002} \end{aligned}$$

The α coefficients relate the error correction terms β_1, β_2 (the long-run) with the first differences (the short-run) of the endogenous variables *pop*, *wa* and *urb*. Thus, α_{pop1} is the first long-run relation (error correction) in the population equation; α_{pop2} is the second error correction described above (β_2) in the population equation and so on. The loading factors estimates emphasize how population and urbanization rate adjustments are rather sluggish whereas wage adjustments to deviations from disequilibria are more rapid.

-*Conditioning*:

The VAR is augmented by a shift dummy variable to account for the effects concerning the plagues. A second exogenous variable (*Temper*) is included in the VAR to allow for the temperature effects

[21] Akaike Information Criterium.

on the endogenous variables.[22] Below we report the coefficient and the *t-values* which are statistically significant for the respective equations:

$$Pop\ equation: \quad Dummy_{\,black-D} = -\underset{(6.99)}{0.252}; \quad Temper = -\underset{(5.04)}{0.167}$$

$$Urban\ equation: Dummy_{\,black-D} = -\underset{(2.534)}{0.012}$$

As expected, plagues have a negative short-run effect on demographic variables. The short-run effect of the temperature change is negative for population.[23]

For the population-wages-urbanization system, the innovation correlation matrix (given in Table 3) shows that there are very low correlations among residuals (they are orthogonal) and, therefore, impulse response analysis may be performed.

Table 3. ***Innovation Correlation Matrix: "Urbanization Model"***

	pop	*Wage*	*Urban*
pop	1.0000	-0.0457	0.0921
wage	-0.0457	1.0000	-0.2105
urban	0.0921	-0.2105	1.0000

Simulation Results

The following plots in Figure 6 show the reaction of each variable to the one standard innovation shock of each other. The dynamic responses of population, rural wages and urbanization rate are depicted, respectively, in Figures 6.A, 6.B and 6.C.

[22] The data set is taken from Crowley (2000), which reports the phases in the temperature of the Northern Hemisphere. However, the inclusion of these data may be a valid approximation. A detailed analysis of climate change for different epochs and their possible effects on the economy is in Malanima (2002).

[23] It is not clear how fluctuations in temperature may affect the economy. For instance, in Mediterranean regions, an increase in temperature may give rise to drought and therefore negatively impact on harvesting and population.

Figure 6 A. Response of **POP** to WAGES and URBAN (right). VECM Orthogonal I-R.

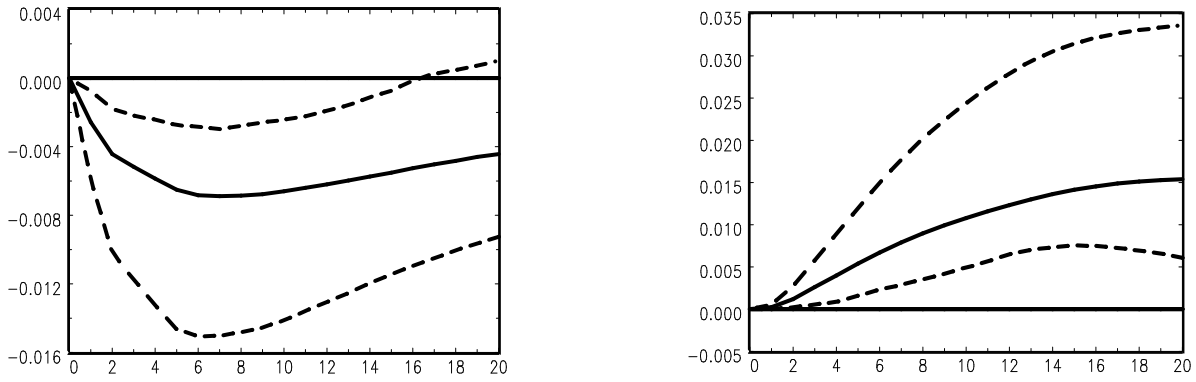


Figure 6 B. Response of **WAGES** to POP and URBAN (right). VECM Orthogonal I-R.

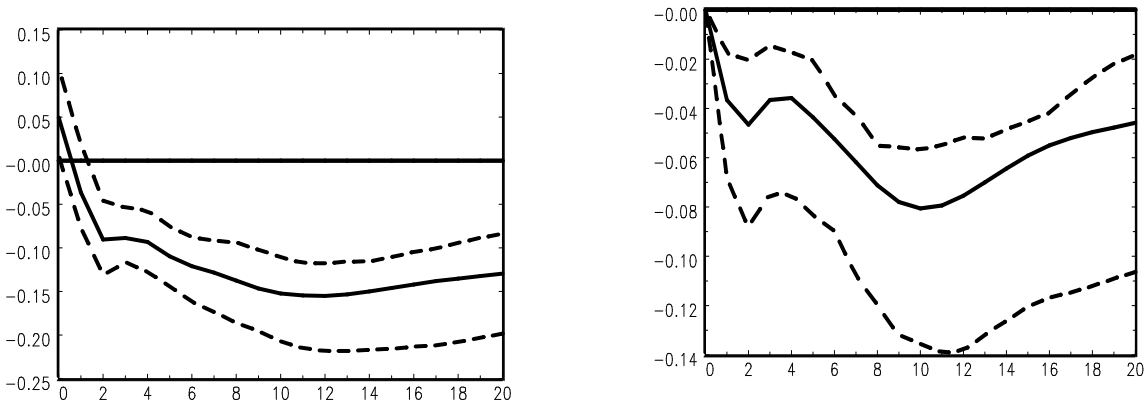
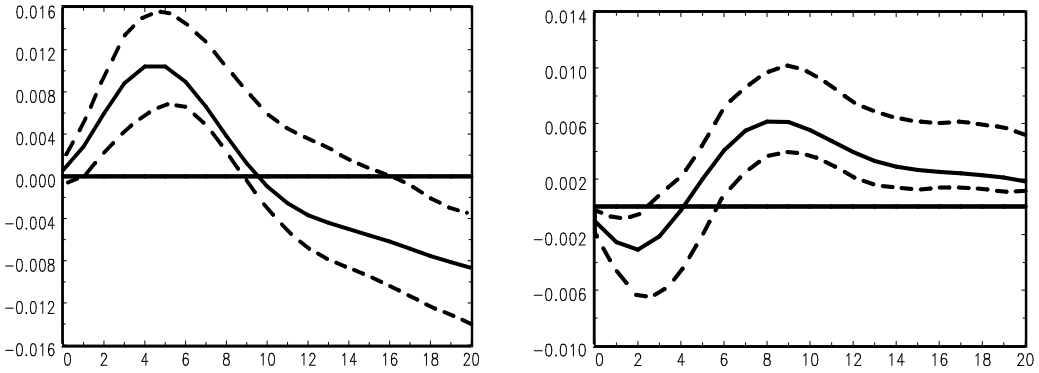


Figure 6 C. Response of **URBAN** to POP and WAGES (right). VECM Orthogonal I-R.



There are a number of features worthy of comment.

i) The response of population to itself provides a new permanent equilibrium level.

ii) Against the Malthusian scheme, in Italy before industrialization the income-population feedback is reversed.

iii) A rise in the urbanization rate provides an increase in population.

iv) Both positive changes in population and urbanization entail a drop in rural real wages.

v) The urbanization rate rises after an increase in population size. Thus, after, for instance, a plague, or during a war, death rates increase above birth rates and population size decreases, emptying towns and cities.

vi) A further interesting characteristic concerns the dynamic path of urbanization: after a change in the population the urbanization rate slowly converges to the previous equilibrium after about 40-50 years.

vii) There is an inverse relationship between rural real wages and the urbanization process: reductions in agricultural wages lead people to leave the countryside and agricultural sectors for towns and new crafts and jobs.

The impulse responses reveal a clear and statistically significant reaction of wage (negative) and urbanization (positive) to a positive shock in population. The reduction in wages along with a decline in agricultural output per worker could not support a context of rising urbanization. The response of rural wages after a positive shock in urbanization rate is negative because an upsurge of urban inhabitants drains farmers and agricultural surplus needed to feed the people that locate in town and cities. Like in the model of Goodfriend and McDermott (1995), this does not allow that the economy will deviate much from primitive production equilibrium.

The explanatory scheme may be compatible with the fact that the negative trend of the urbanization rate in Italy was effectively one of the factors which curbed the transition from stagnation to growth. After a massive urbanization from the tenth century to 1300, the successive epoch, which span from 1300 to 1870, saw a declining urbanization (Figure 1 and 2 above). As pointed out by many, the rise of urban population in Europe indicates the extent to which specialization associated with the division of labor accompanied economic development.[24]

*4.2. The VEC model: urbanization, population AND RELATIVE WAGES***(to be completed)**

The model outcomes deserve further attention. First, the model with rural wages shows that the urbanization rate may be one of the factors that determined the swings in population and efficiency levels described by the stylized facts. An increase in the population brings about an increase in urbanization rate and a fall in rural wages. Both these effects impinge on labor productivity, reducing rural income and increasing the labor force.

A drop in the urbanization rate raises rural wages and reduces the population. Overpopulated urban centers were periodically struck by epidemic waves, social disorder and invasions,[25] reducing population levels and increasing the real wages in the agricultural sector. Whenever this happened, higher income and a lower population pushed economic efficiency upward (pro capita output). The higher income per head, in turn, meant resources to finance re-population in cities and towns, pushing rural immigrants toward urban concentrations and new crafts and jobs. These people were attracted by the higher urban wages paid in manufacturing and commerce. Thus, the appearance of disease, warfare and famine, which for about 400 years had been the main "agents" of demographic dynamics, were the real engine of this economy.

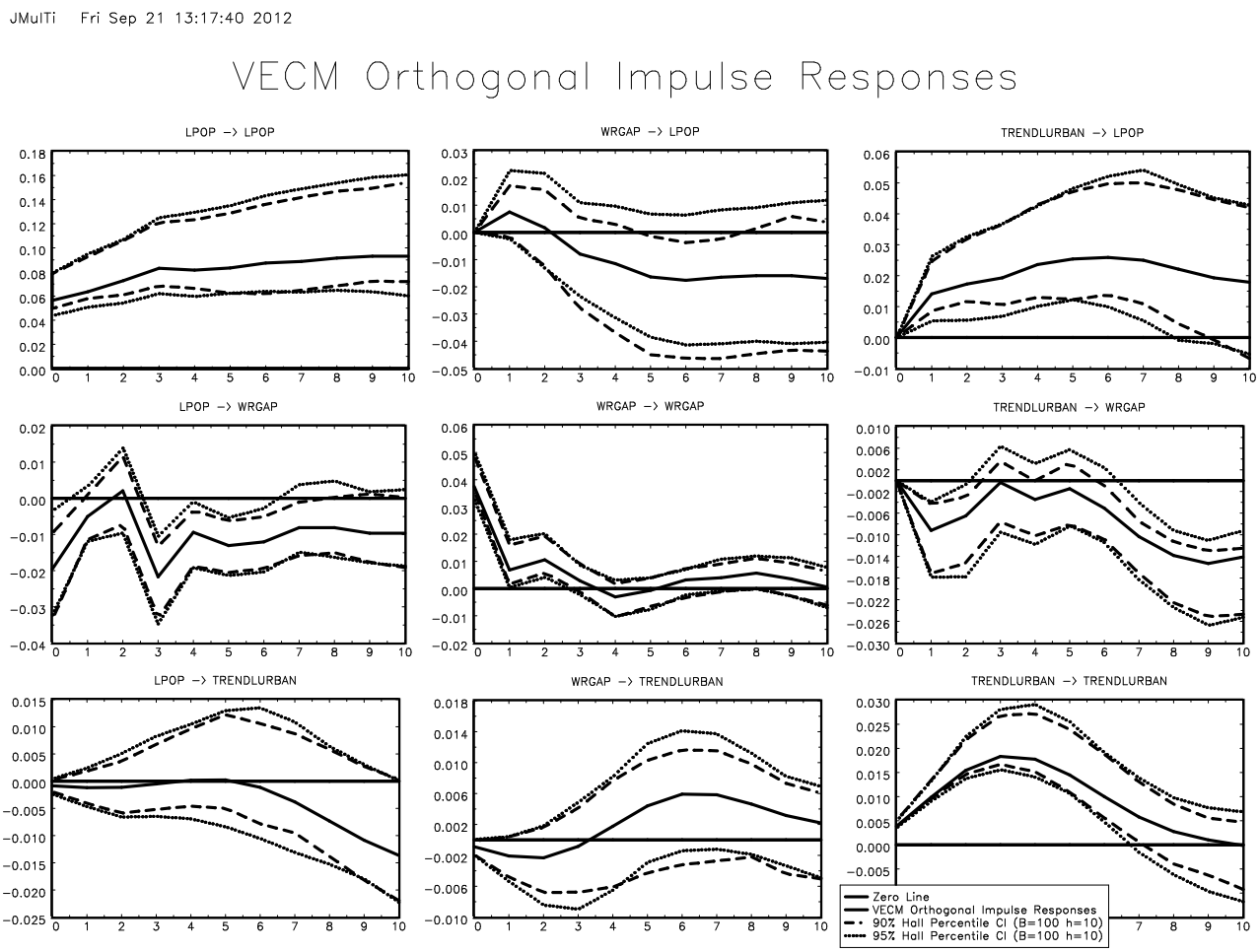
To better appreciate the role of urbanization on economic efficiency we show the results of a VEC model similar to the one described in the previous section, but including the relative wage instead of

[24] Well-known discussions on these issues appear, amongst others, in Goodfriend and McDermott (1995), Bairoch (1988), Hohenberg and Lees (1985).

[25] Of the most important destructive events occurring in the 16th century, we should mention the French sack of Brescia (1511) and Pavia (1528); in 1527 Rome was sacked by the mutinous troops of the Emperor Charles V, and Spanish troops sacked Genoa in 1532.

the agricultural wage. Provided that the relative wage is a stationary variable, we expect to find at least two cointegrating relationship: one describing the stationary relationship between population and urbanization; the other one accounting for the stationary variable relative wage.

In Figure 7 we report the full set of impulse responses. In the first column we can read the effect of a shock into population on respectively: population, relative wage, urbanization. Similarly, in the subsequent columns we read the effect of shocks to relative and urbanization.



Compared to the evidence provided by the model with rural wage, here we find some results to be supported, such the non Malthusian effect of income-population feedback. Some other results are no longer verified, in particolar no one of the esamine variables play a singifcant role in affecting the level of urbanization. What is remarkable, is the negative effect of the urnìbanization rate upont the relative wage. Though it is less powerful compared to the one recorded for the rural wage, it is still strong and significant, especially in the medium-long run. Though this model is not able to provide evidence about the determinants of the urbanization process, it can add usuful insights

about its consequences: an increase in population and a drop in the relative agricultural wage. This latter effect supports the idea of urbanization driving PROCESS OF ECONOMIC TRANSITION.

5. Concluding Remarks (to be completed)

-Improvements in productive potential are neutralized by population growth. A large population can be sustained at a constant or even lower real wage. Data and simulations show that over the period from the 14th to the 19th century, increases in the size of the population were absorbed with a deterioration in the rural real wage.

-On examining the responses of our multivariate models, we stress that fertility and mortality did not respond to changes in real wages in a Malthusian way. An increase in real wage does not produce a decline in the death rate or an increase in the birth rate. Rather, our simulations show that there is a statistically significant reduction in population growth. Thus, Malthusian income-population feedback appears to be rather weak. In Italy, before industrialization, living standards and population growth were not positively related.

-Equilibrating tendencies were extremely weak (and slow) in a context where shocks of different nature were large.

-The economy seems to be characterized by primitive aspects which do not allow primitive technology to raise economic efficiency along with a continuous reduction in output per worker.

-The urbanization process may be a factor in explaining the empirically observed reduction in efficiency. This result crucially relies on the endogeneity of the urbanization rate. Indeed, conditioning the model on the urbanization rate, as in the wage-population model, provides a negative effect on population.

- We find support to the claiming of urbanization driving PROCESS OF ECONOMIC TRANSITION, though the identification oc the causes of low urbanization observed in the recent part of the sample are less clear
- We find evidence that rural and urban wages share a common stochastic trend (possibly the population trend). Moreover, the fact that the relative wage is a mean reverting process (it oscillates

around its long-run equilibrium level) also implies that demographic and technological shocks produce only temporary deviations. .

Appendix (to be completed)

The data set

Empirical evidence for a long-run economic-demographic equilibrium, as discussed by Classical theory, is investigated using data provided by Malanima (2002; 2003; 2005), where data are reconstructed for population, nominal and real wage rates in both urban (for master masons) and rural contexts (for agricultural workers), GDP and per capita GDP (total and agriculture), prices of agriculture goods; urban population density. Output variables, population and urbanization rates are measured for central-northern Italy. The measure of urbanization used in the models below is the proportion of the population in towns of 5,000 or more.[26]

As regards the notation used for wage variables, *W* represents wages in the agriculture sector. To obtain the real aggregate we used the price index for agricultural goods *P*. In the paper, whenever we refer to wages we mean real wages in the agriculture sector. With regard to output, *Y* stands for the GDP, *Ypc* is the per capita output, *Yapc* is the per capita output in agriculture and *Ya* the agricultural product. Demographic variables are *Pop* for population, *FLa* which stands for the agricultural workforce and *Urban* for urbanization rates in central-northen Italy from 1300-50 to 1860-70. The measure of urbanization is the proportion of the population in towns and cities of 5,000 or more.

The data series are in decennial frequencies. The data in ten-year intervals present two problems. First we cannot study short-term interaction but the results will reflect longer term tendencies. Second, the sample size (55 observations) is not large enough to render analysis of subsamples possible. Statistical series on these variables might be thought to lack reliability. Direct and official estimates are available for Italy as well as many other countries from the mid-19th century onward.[27] However, analysis of data construction seems accurate, well-documented, and rich in detail with many verifiable assumptions. Moreover, statistical series may be compared with other studies and estimates (see in particular Malanima 2002). That said, it constitutes the best available data set for the period.

[26] See Malanima (2002; 2005) for detailed analysis and a reconstruction of the rates of urbanization in Italy.
[27] See McEvedy and Jones (1978); De Vries (1984).

Trend characteristics

The order of integration of macroeconomic variables has crucial consequences for appropriate modeling of time series data and for proper understanding of the aggregate phenomenon. It is widely acknowledged that the form of nonstationarity in a time series may well not be evident from examination of the series. Moreover, deterministic rather than stochastic trends have important economic implications. A trend-stationary time series evolves around a deterministic trend, i.e. around some specified and predictable function of time. Conversely, a series with a stochastic trend has no clear long-run pattern, since its longer term movement is affected by stochastic disturbances, which have an enduring effect on the future path of the series. In our context, this means that a shock occurring to the estimated series of population and real wages due, for instance, to weather, harvest, epidemics etc., may have permanent or, conversely, temporary impacts on the long-run movement of the series.

Trends, whether stochastic or deterministic, may give rise to spurious regressions; they provide, if erroneously identified, uninterpretable or misleading results.

Results from ADF, DF-GLS, PP and KPSS test are reported in Chiarini (2010) for population and real wages.[28] All tests fail to reject the null hypothesis of a unit root in the time series at 5 percent significance level, implying that the levels of population and real wages are non-stationary. Notice that the ADF test for both real wages and population may appear less clear, but we can reject the non-stationarity of the series at first differences.

Stationarity test ADF: The Null H0 of Unit Root			
Variable	*Deterministic term**	*t-statistic (probab.)*	*Critical val: 1% (5%)*
Population	*G*	-2.14 (0.94)	-3.56 (-2.91)

[28] **ADF**=Augmented Dickey-Fuller; **PP**= Phillips-Perron; **DF-GLS**=Elliot-Rothenberg-Stock DF-GLS; **KPSS**=Kwiatkowski-Phillips-Schmidt-Shin test. Note that the KPSS test output provides the asymptotic critical values tabulated by the KPSS. The series is assumed stationary under the null hypothesis. The PP test uses an alternative method of controlling for serial correlation when testing for a unit root. The DF-GLS test modifies the ADF. Data are detrended in the presence of a constant and/or linear trend.

Real Wage (Agriculture)	*G*	-0.64 (0.85)	-3.56 (-2.91)
Real Wage (Urban)	*G*		
Urbanization Rate	*G*	-1.64 (0.45)	-3.56 (-2.91)

The Models

Estimated equations are derived by a two-variable system with one cointegrating equation and a lag structure *p*. Consider the following VAR (ECM error correction) model, written in the usual notation:[29]

(1) $$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma \Delta y_{t-i} + Bz_t + \varepsilon_t$$

where $$\Pi = \sum_{i=1}^{p} A_i - I; \quad \Gamma_i = -\sum_{j=i+1}^{p} A_j$$

In our case, y is a *k*-vector and contains three nonstationary variables (wages, population and urbanization rate), *z* is a vector of deterministic variables and ε_t is a vector of innovation. A_i and *B* are matrices of coefficients to be estimated. It is well known that if the coefficient of the matrix Π has a reduced rank *(r<k=1* the number of cointegrating relations in our case), there exists 2x1 matrices α and β such that $\Pi = \alpha\beta'$ where β is a cointegrating vector and α are the adjustment parameters.

We have seen that our series are characterized, other than by stochastic trends, by nonzero means and deterministic trends. In a similar way, the stationary relations may call for intercepts and trends. For the population-real wage model we cannot rule out the following assumption (the level data have linear trends; the cointegrating equation has only one constant): [30]

(2) $$H(r): \Pi y_{t-1} + Bz_t = \alpha(\beta' y_{t-1} + \mu_0) + \alpha \perp (\gamma_0)$$

[29] See, for instance, Johansen (1995).

[30] As in Johansen (1995), $\alpha \perp$ is orthogonal to α and serves to define and distinguish the (unrelated) constants from the cointegration space and the constants from the data.

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