PATTERNS OF STRUCTURAL CHANGES IN CONSTRUCTION?

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Abstract

The changing role of construction at various stages of development has been at the core of debate in the field of construction economics. It has been argued that the construction industry should follow the pattern of manufacturing, its primary supplier, rather than services, even if early studies suggested an S-shaped relationship with GDP per capita. The presented analysis stems from this well known literature and again it focuses on the link between construction share in value added and development measures. The conventional view that GDP per capita suffices is critically discussed and new variables that help the explanation of such a relationship are introduced. Discussion builds upon the comparison of standard cross country regressions in the 1970 and in 2005. Even if explicative power is quite weak it is shown that in recent years construction has been linked with new variables such as market size and population density.

Keywords: Construction, development stages, structural change.

INTRODUCTION

Structural analysis is a central tenet in growth economics since the seminal work by Lewis (1954) and the many contributions by Kuznets (1956, 1957), and Chenery and his collaborators (Chenery, 1960, Chenery and Taylor, 1968, Chenery and Syrquin, 1975). One research thrust follows a micro approach that focuses on market structure, income and resource allocations among individuals or price differences (Leamer, 1984). Differently most of early literature focused on macroeconomics and long run processes (Chenery, 1986). Chenery and Syrquin referred to development pattern as "any significant aspect of the economic and social structure associated with a rising level of income or other index of development" (1975, p. 4). For instance, Agénor and Montiel (2008) argue that developing countries tend to be more open and capital importers, while advanced ones have a larger public sector. Furthermore, as development develops further, current account deficits and capital account surpluses usually decrease, while openness increases. Value added and employment growth and shares, in addition, have been extensively analyzed. Fisher (1939) and Clark (1940) predicted a sequence of stages in the course of development. First of all, the share of agriculture should decrease as industrialization takes place. The primary sector produces basic goods whose demand is quite income inelastic. When an economy takes off

Engel curves show how demand is diverted from basic to luxury goods as durables. The potential of service industries in modern society is also reputed to be very good. Therefore even in the early stages of development, manufacturing and informal sectors begin rapidly to grow as a result of the rural-urban migration. Some sectors can absorb this new urban labour supply in basic service and manufactured good production. In this embryonic stage, food production and housing should meet most of the basic needs of these low income migrants. At the intermediate stage, a network of production and consumption linkages start developing with increasing final and working capital demand. Agglomerative economies push urbanization further. Construction would continue to play a relevant role in this phase, maybe with a decreasing rate of growth. Only in the last stage, when deindustrialization takes place, smokestack industries start moving to less developed regions or countries, and urban areas change their shape with new landscapes and construction technologies.

BASIC MODELS AND STYLIZED FACTS

The very first issue is to define economic development. The most widely used measure is either GDP or GNI per capita. Country data can be made comparable by converting them into in a single currency, say US dollars, by using exchange rates. Current exchange rates are an imperfect measure of the purchasing power of the various national currencies. The alternative to market rates is to re-price the local components of income in every country at a uniform set of prices. Hence, non tradable goods are reflected in these conversion factors. This approach uses the Purchasing Power Parity (PPP) that is the weighted average of the ratio of domestic price to the price of the very same good in the considered country, say the USA. An alternative is the Atlas conversion factor, which uses the three-year average of exchange rates to smooth the effects of transitory exchange rate fluctuations, adjusted for the difference between the rate of inflation in the considered country (using this country's GDP deflator), and that in a set of developed countries (using the weighted average of the countries' GDP deflators in Special Drawing Right terms). According to the World Bank differences between PPP and Atlas figures are not remarkable.

Nonetheless, the use of GDP as a measure of development has been widely questioned (Stigliz and Fitoussi, 2009). The best alternative perhaps is the Human Development Index (HDI) developed by the United Nations (2010) or the Physical Quality of Life Index (PQLI) by Larson and Wilford (1979). The HDI was created to emphasize that people and their capabilities should be the ultimate criteria for assessing the development of a country, rather than economic growth alone. For instance, the Bahamas and New Zealand have similar levels of income per person, but life expectancy and expected years of schooling differ greatly between the two countries. HDI is a composite index that measures progress in the three basic dimensions: health, knowledge and income. At first, health was measured according to life expectancy at birth; education according to adult literacy rate, and income or standard of living according to GDP per capita adjusted for purchasing-power parity (PPP US$). Currently level of education is measured according to the expected years of schooling for a school-age child in a country today with the mean years of prior schooling for adults aged 25 and older. Income measurement also has changed from purchasing-power-adjusted per capita Gross Domestic Product (GDP) to purchasing-power-adjusted per capita Gross National Income (GNI). However problems remain. Consistency is hardly achieved among countries and over time. The availability of comparable time series and likely correlation between in built variables pose well known statistical problems. The PQLI is the average of basic literacy rate, infant mortality, and life expectancy at age one, all equally weighted. This is not a meaningful alternative as there is a considerable overlap between infant mortality and life expectancy and there is no measure of income.

Defining economic structure is far from being easy. We follow the traditional approach stemming from the path breaking Clark's contribution (1940), who considered labour force, consumption patterns and income distribution, while Kuznets (1957) added the shares of GDP. We address the latter by focusing on the contribution of construction to value added. This study revisits the classical analysis that was initiated by Turin (1969) and Strassman (1970). According to this last scholar, construction is a major force that replaces manufacturing in driving economic growth after the first stage of development (the so called "middle-income country bulge"), while Turin postulated a causal relationship between construction and economic growth. In his first study Turin (1969) did not find any statistically significant link. This result perhaps reflected the rather small considered sample (46 countries in 1958). In his subsequent study (1978) Turin claimed that an S-shaped curve fitted better the new data set (87 countries). This is to say that construction share in GDP is always positively related with GDP per capita, initially at an increasing rate and later on at a decreasing pace. Size matters too as construction accounted for between 3 and 5 per cent of GDP in most developing countries, whilst it was twice as much (5 - 9 %), in advanced ones. Lewis (2009), however, shows that this pattern is no longer the case, while Bon (1992) argued that the inverted U-shaped relationship should hold for both the share of construction in GDP and its volume. In other words, there is an absolute decline of this industry in the very long haul. These issues have been extensively discussed in the literature and there is a growing consensus about Bon's conjecture. Analyses by Wells (1985), Crostwaite (2000) Yiu, et al. (2004), Ruddock and Lopes (2006) support his view. Most of these contributions are rather descriptive and only few consider an appropriate statistical model in the Chenery's style. This model is based on a reduced form of a general equilibrium where domestic production in each sector is due to intermediate and final demand, including net export. Since a large sample is needed and each demand component is a function of income level Chenery decided to adopt single functions of income and population. His main specification is a linear logarithmic regression equation as the following one:

$$\ln C = \beta_0 + \beta_1 \ln Y + \beta_2 (\ln Y)^2 + \beta_3 \ln N + \beta_4 (\ln N)^2 + \beta_5 \ln X \qquad (1)$$

where C is the dependent variable that, in our case, is construction value added over GDP, Y is the income level measured as GDP per capita, N is the country's population and X is another exogenous variable to be addressed later on in the paper. If we eliminate the quadratic terms, parameters β1 and β3 can be interpreted as growth and size elasticities. When these factors are considered, multi-collinearity and parameter interpretation arise, but β2 and β4 are useful to detect non linear income and size effects and assess upper and lower asymptote in Turin's fashion. Crostwaite (2000) presents a similar specification where construction spending over GDP is regressed over income alone. Actually Crostwaite acknowledges that there is no linear relationship between C (he does not take into account ln C) and ln Y and only when the quadratic term is included, both parameters become (weakly) significant at 5% confidence. However the model specification suggests that the least square estimator provides biased and inconsistent results by casting doubts on parameter estimates and, above all, the coefficient of determination (R^2) is close to zero (only 2,7%). It is pretty clear that more regressors were needed in his sample. The most obvious one is the population that was supposed "to allow for effects of economies of scale and transport costs on patterns of trade and productions" (Chenery and Taylor, 1975, p. 17). Actually controlling for size through population is questionable as the size of a country can be measured by land area o resource availability. However, population appears to be an important source of housing demand, thus it should be included in our setting. Kessing and Sherk (1971) suggested that population density serves as an imperfect proxy for the availability of natural resources per head. According to these authors, densely populated countries are expected to have economies more oriented toward manufactured than primary goods, along the lines of a land-labour Heckscher-Ohlin theory. Even if this statement is disputable, there is no doubt that land scarcity can constrain building activities and we include it as a candidate regressor. Economic deepening, in fact, differs from primary factors availability. Hence we would like to differentiate between large and small countries by using another size variable, not including population. A simple solution is to introduce an output measure. Lastly we follow Branson et al. (1998) and regress separately an equation with quadratic terms only in order to avoid multi collinearity. This is to say that the explanatory variables, ln Y and $(\ln Y)^2$, are in two separate regression specifications, as our task is to provide evidence about non linear elasticities only.

DATA AND FEW SIMPLE EXAMPLES

In the past empirical research was constrained by data availability. Early studies assessed of long-term series in developed countries and later on shifted the focus on cross country analyses of less developed economies. In comparing the results of time series and cross countries it is customary to interpret the latter as partial short term adjustments and the former as long term changes in exogenous variables. However, lack of data forced scholars to use a sample of countries in a given year with the hope that it was a good substitute for relations within countries over time, as they add "an insight into current structural differences, viewed partly as points in the process of growth, caught, as it were, at different stages and phases" (Kuznets, 1959, p. 174). Kuznets himself was aware that cross section estimates tend to underestimate inter-temporal trends because they "are not likely to provide a firm basis for estimating the relevant inter-temporal pattern (1959, p. 197). This is due to the "vast and rapidly changing flow of innovations in material and social technology (1959, p. 179). Additional reasons for these differences are institutional settings, the impact of varying policies and, above all, omission of dynamic effects as propagation mechanisms. These differences explain diverse levels of development. Since the task of this study is to provide a stylized fact and not to clarify why more advanced countries have larger or smaller construction sectors, the Kuznets methodology is used. In a future paper the authors will focus on the joint estimation of cross-section and time series analysis in order to improve the efficiency of estimates and develop a dynamic model. For time being, only the two extremes of the considered sample are considered to test differences that are to be explicated in future research. Population, construction and total gross value added are obtained from the UN data developed by the United Nations Statistics division. Urban population and population density are drawn from the WorldBank database, while GDP per capita (in constant terms) is based on the PennTables. As stated above, only cross section data of the years 1970 (or 1971 when 1970 are not available) and 2005 are used. The first data consists of 139 countries. First of all, it is difficult to detect any relationship between the (log) of GDP per capita and value added construction share. Actually only when advanced countries are considered, a negative relationship seems to appear (Quatar being an outlier).

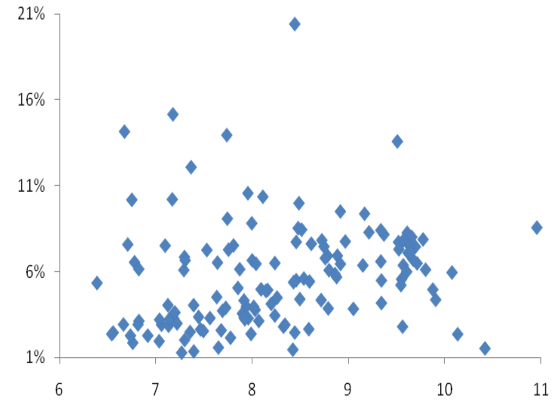


Figure 1: *Const. shares and GDP per capita,1970*

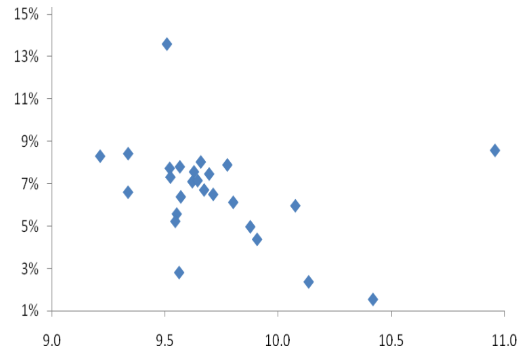


Figure 2: *Only advanced countries, 1970*

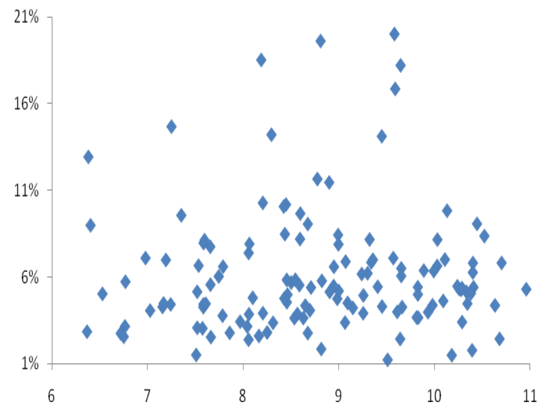
Several regressions, none of which was satisfactory were executed. The ”best” one is the following:

$$\ln C = -1.689 + 0.1580 \ln Y - 0.0511 \ln N \qquad (2)$$
$$(-9.642) \quad (3.648) \qquad (-2.380)$$
$$\text{Adj } R^2 = 0.112;\ F[2,136]\ (\text{prob}) = 9.69\ (.0001)$$

The coefficient of determination is very small, even for cross section analysis and most of the variability of construction share is left unexplained. However, all the variables are statistically significant, according to t values (shown in brackets) and F test, but surprisingly population has a negative effect. As put forward by Branson et al. (1998), the quadratic term have been verified in the following way:

$$\ln C = -1.484 + 0.0213 (\ln Y)^2 - 0.0073 (\ln N)^2 \qquad (3)$$
$$(-16.489) \quad (3.573) \qquad (-2.399)$$
$$\text{Adj } R^2 = 0.1089;\ F[2, 136]\ (\text{prob}) = 9.43\ (.0001)$$

Elasticities seem to be not linear. The shape is not the one advocated by Bon (1992) but quite the opposite. Only the negative relationship with population is lessened. These signs do not change if the share of urban population and/or population density is added. The results are not presented, as estimates are not significant at 5% confidence. Finally, dummies are used to differentiate Less Developed Countries , Lower Medium Countries, Upper Medium Countries and advanced ones, but, as expected, the model performance is poor. Hence GDP per capita is enough to identify stages of development. Population, in addition, was replaced with value added to assess economic size, but the negative relationship persisted.
The equivalent analysis for the year 2005 was then addressed. The considered sample is larger with 176 records, but no clear pattern is recognizable in the scatter plots of Figure 3 and 4, even in the subsample of advanced countries is considered.



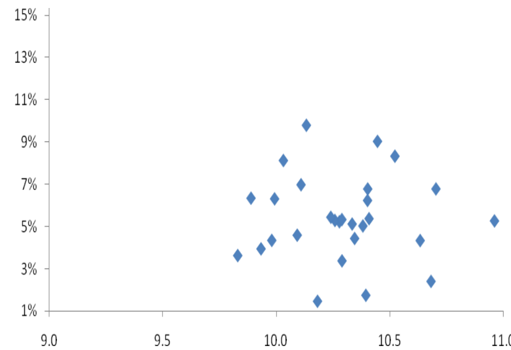


Figure 3:*Const. shares and GDP per capita,2005* ***Fig 4:*** *Only advanced countries,2005*

According to the same regressions that were presented earlier, the outcome is surprising:

$$\ln C = -2.727 + 0.0335 \ln Y - .0607 \ln N \quad (4)$$
$$(-7.353) \quad (0.965) \quad (-3.029)$$
$$\text{Adj } R^2 = 0.06; \; F[2,173] \text{ (prob)} = 5.52 \; (.0048)$$

The coefficient of determination is smaller, but GDP per capita is no longer an explicative variable, as shown by the t and F tests. The estimated quadratic form is:

$$\ln C = -2.872 + 0.002 (\ln Y)^2 - 0.003 (\ln N)^2 \quad (5)$$
$$(-14.61) \quad (0.977) \quad (-2.542)$$
$$\text{Adj } R^2 = 0.033; \; F[2, 173] \text{ (prob)} = 4.03 \; (.0195)$$

Thus, it is doubtful that development can explain construction share. However GDP per capita can be included with another specification that has at least the same (weak) power than the 1970 data. Moreover we tried several specifications using variables discussed in the previous section. Unfortunately just a few proved satisfactory. Actually value added appears to be a better measure of economic size and only population density is statistically significant:

$$\ln C = -2.634 + 0.1064 \ln Y - 0.0652 \ln VA + 0.0673 \ln PopDensity \quad (6)$$
$$(-6.511) \quad (2.641) \quad (-3.435) \quad (2.342)$$
$$\text{Adj } R^2 = 0.103; \; F[3,173] \text{ (prob)} = 6.61 \; (.0002)$$

This equation performs much better than the “standard” model seen above. Hence this very exploratory analysis appears to show that non classical variables, such as population density, i.e. people per sq. km of land area, and market size, measured by valued added, should be considered to explain the behavior of the construction sector in the year 2005, while total and urban population are not significant.

CONCLUSIONS

Even if the interest in structural analysis has considerably decreased in the last decade due to new endogenous growth models, classical structural analysis is the core of development theory. Patterns of economic development are indeed a key issue during transition from a low income, rural economy towards an industrialized urban one with a large income per capita. Accumulation of physical capital has always been at the core of these analyses, but construction often has been neglected as a driver of sustained growth. Maddison's remarkable book on long run performance by 16 advanced capitalistic countries since 1820 (1991) should be considered. This author states "there are three main kinds of physical capital: non-residential, residential, and inventories. The first is the biggest and has the greatest influence on growth; the second is substantial, but much more limited in its impact" [Maddison 1991, p. 65]. Moreover Maddison presents interesting data about gross residential capital stock per head and as a ratio to GDP in leading economies from 1950 to 1987 (table 3.11 and 3.12) but he does not provide any attention at all to the remarkable data of Germany and Japan. The field of construction economics filled this gap. Turin postulated a causal relationship between construction and economic growth, while Strassman argued that building activities can even replace manufacturing after the initial stage of development. Since these fundamental contributions there has been a significant debate about the role of construction in a given economy. It has been argued that building technology is shifting towards the service sector. Bon has argued that construction per se is less dynamic than other major economic industries, when abundant physical capital is already in place (Bon, 1992). Little statistical analysis has been put forward in this regard. In this paper this old debate has been revised by providing same explorative regressions that link construction value added share to GDP per capita. The contribution of this paper is the introduction of new variables, such as total value added and population density, that should help the understanding of these relationships. Our outcome is still tentative, as explanatory power is quite weak. Additional longitudinal analysis is needed, but this very preliminary analysis shows that the worldwide construction role in the Seventies appears to be very different from the current one and, therefore, new variables should be used for analyzing this changing role.

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