A Note on the Measurement of Output in the Construction Sector

by

Mr. Anton Belgrave
&
Mr. Warrick Ward
Research Department
Central Bank of Barbados

Presented at the Annual Review Seminar, Research Department, Central Bank of Barbados
July 28-31, 1998

Authors: Anton Belgrave and Warrick Ward

In addition to employing a significant proportion of the male workforce, the construction sector is key component of the non traded sector in the economy of Barbados. Generally, a continually robust growth in the construction sector has also tended to be a precursor of a future balance of payments crisis. Despite this, several problems exist in the measurement of output within the construction sector. This note examines the current methodology employed and suggests areas of improvement. At least one other relevant indicator is currently available and we will seek to incorporate this into the output measure.

The Construction Sector: An Overview

In Barbados, the construction sector is an important element of non-traded activity, but receives a degree of attention, which is disparate with its contribution to gross domestic product (GDP), both directly and indirectly. Its relative importance stems from three factors; its value to the investment process, the concentration of male employment within this sector, and the tendency for persistent buoyance in this sector to be a signal of possible future balance of payments problems. The importance of the construction sector is not only limited to its direct impact on output, but it also instrumental in enhancing overall development, through the provision of more socially desirable infrastructure. Brathwaite (1980), notes ".... construction contributes directly to improving the quality of life in the form of new housing, better transport and communications, and improved educational and recreational facilities."

The demand for construction services is shared by both the private and public sector, with the public sector infrastructural development including road maintenance and rehabilitation. Unfortunately,

there is not always harmony in the use of resources and the scheduling of projects from both the private and public sectors. On some occasions the construction sector has been overheated primarily by the surge in public sector demand. One such period was in 1979-1980, where there was the simultaneous execution of large projects such as the Bridgetown Sewerage project, the Samuel Jackman Prescod Polytechnic, and the Heywoods Resort, among others. This stimulus led to some overheating in the sector, through notable labour shortages.

As a percentage of total output, the construction sector has been relatively constant, from approximately 6.5% in 1978, peaking at 7.05% in 1988, and then declining marginally to 6.46% by 1996. This relatively small contribution of the construction sector to gross domestic product (GDP) masks its real economic importance, since building activity has averaged approximately 68% of gross investment since 1975.

Over time the output per employed person (productivity) in the sector has risen relatively slowly, with the rate of growth slower than the economy's growth as a whole. In Table 1, productivity[1] in the construction sector has grew at an average rate of 2.9 % each year, from $13,175.44 in 1978 to $17,011.24 in 1996. The sector in terms of gains in productivity has been bettered by all of the more sectors in the economy. The sector which produced the highest gains over the period was the transportation and communications sector, whose value added contribution has grown sharply over the 1978-1996 period.

The construction industry in Barbados remains the single largest industry almost totally dominated by men. In the labour survey taken at the first quarter of 1998, the sector represented nine percent of the total employed labour force. Of this approximately ninety-seven percent of the persons employed in construction and quarrying were males. In the services, government, finance and business, tourism, and general services combined, women outnumber men by approximately twenty five percent. These sectors collectively account for almost half of the total labour force, and approximately fifty five percent of the employed labour force in Barbados.

The measurement of construction sector activity is vital to the Central Bank's estimation of real non-traded output. Typically, the non-traded sector accounts for two thirds of total output, and the estimation of construction activity is key to the output measurement of the wholesale and retail sector. In addition, one of the largest components of the non-traded sector, business and other services, is also partially determined, though indirectly, by construction output. This occurs because wholesale and retail is one of the variables employed in estimating business and other services.

The Current Methodology: A Critique.

The measurement of economic growth is infinitely more complicated than the estimation of population growth, which is ultimately reduced to counting heads. Economic growth is measured by the concept of value added, which is defined as the value of output of an industry less the value of the intermediate inputs consumed. Value added at constant prices is defined as the difference between gross output and total intermediate inputs, each measured at some base price. This method which involves the measurement of outputs and inputs at constant prices is known as the double deflation method. Let VA_r represent real value added. Thus

$$VA_r = \frac{\sum P_0 Q_t - \sum P_0 q_t}{\sum P_0 Q_0 - \sum P_0 q_0} \qquad \text{..... (1)}$$

where P_0 and p_0 represents the price of the final and intermediate goods while Q_0 and q_0 represent the quantities of final and intermediate good.

While conceptually elegant, the double deflation method is often impossible to apply in practice since it requires price and quantity input and output data. Furthermore as Hall (1971) states " There is clearly no necessity whatever to use price deflation; it is equally satisfactory in principle to measure output and inputs at constant prices by extrapolating base year figures by appropriate

[1] Measured as nominal gross domestic product (GDP) per person employed in the construction sector.

volume indices derived from quantity data."

Let the output volume index (ϵ) be defined as;

$$\epsilon = \frac{\sum P_0 Q_t}{\sum P_0 Q_0} \quad \text{..... (2)}$$

Similarly, let the volume index (γ) for intermediate inputs be defined as;

$$\gamma = \frac{\sum P_0 q_t}{\sum P_0 q_0} \quad \text{..... (3)}$$

the total value of intermediate input to total output in the base year (λ) can also defined as;

$$\lambda = \frac{\sum P_0 Q_0}{\sum P_0 Q_0 - \sum P_0 q_0} \quad \text{..... (4)}$$

Following Hall (1971) it can be shown that;

$$VA_r = \lambda\epsilon - (\lambda - 1)\gamma \quad \text{..... (5)}$$

This system demonstrates that the value added index may be regarded as a linear combination of the input and output volume indices. Single indicator methods are invariably biased, as they fail to take into account any divergence between the movement of input and output indices. However, this does not preclude the use of single indicators, since the index of real product derived by the double deflation also depends on the difference between the errors in the output and input indices and these errors would be cumulative.

Given the reality of possible data limitations, the Central Bank's general approach to estimating real output is to use a weighted series of volume indicators. Real output is calculated by extrapolating a base year real value added table based on changes in these volume indices. The key problems which the researcher faces are; (i) what are the appropriate indices to use and, (ii) for any given combination of indices what weights should be used in constructing these indices.

Estimating Output in the Construction Sector

Real output of the construction sector is estimated by weighting cement consumption, the quarrying index, and real imports of construction materials. Thus we have,

$$\Delta RCO = 0.25RICM + 0.5QI + 0.25CC \quad \text{..... (6)}$$

where, RCO = Real construction output

RICM = Real Imports of construction materials

CC = Cement consumption

QI = Quarrying index

Lewis (1997) has noted a number of difficulties with these measures. These can be summarised as;

1. The weights are arbitrarily chosen and are not grounded in any formal or scientific basis.
2. The fixed weight approach does not allow for changes in the types of construction activity being undertaken. Road construction would for example uses a relatively greater proportion of lower value added products (aggregate) than housing or building construction.

Failure to account for these factors may lead to an index which is unreliable and unduly sensitive to the large changes which occur in the amount of quarrying material used. Consider the trends of the indices employed in estimating construction sector output using the current methodology (Charts 1 and 2).

Cement Consumption

Cement consumption is actually the quantity of cement sold locally. Generally cement imports have been negligible compared to domestic production since 1986. In 1990 however 52,000 tonnes of building cement was imported, representing approximately 55% of domestic production. To avoid a repeat of this distortion, the use of the concept of cement absorption which is defined as cement produced and sold locally plus imports of building cement is preferred. This not only prevents the possibility of production shortfalls distorting the series, but also allows the use of a longer data series since the Arawak cement plant was opened only in 1984.

Quarrying

Changes in the output of the quarrying sector are weighted as 50% of the output of the construction sector. This weight overstates construction output during "booms" and understates it during contractions, since large volume changes in the quarrying index occur frequently. The high variability of this series also frustrates the aim of producing useful output estimates.(Chart quarrying). Rather than the amount of quarrying material produced, a better guide to quarrying consumption would be sales of quarrying material. This would avoid the problem of stock adjustment and stockpiling, which is evident in the quarrying industry (Chart 3).

Real Imports of Construction Material

The construction materials imported consists of lumber, timber, deal board, steel, iron and structural parts. Additionally, some cement imports comprise the remainder of this group. However, as the Table 1 below demonstrates, the major portion of the imported value is consited of products either wooden products or metallic in nature.

Table 1: Components of Imports of Construction Materials (in percentages)

Construction Material	1990	1992	1994	1996
Wooden Products	53	55	55	47
Steel & structural parts	46	35	35	41
Cement	1	10	10	12

While there is not much disquiet with either the valuation or the classification of construction materials, there is some concern as to the appropriateness of the deflator used. Two components of the retail price index table; housing and household operations and supplies are used to deflate nominal values of imports of construction materials. Thus, we have,

$$V = Pm * Qm \quad \text{..... (7)}$$

Where, V = Value of imports,
Pm = Price of imports, and
Qm = Quantity of Imports

Therefore, real import = $Qm = Vm/Pm$ ..... (8)

Using the current CBB methodology (method 1), the deflator (Pm) is defined as;

$Pm = 0.58HI + 0.42HOS$ ..... (9)
where HI = the housing index,
HOS= Household operations and supplies
Both of these series are drawn from the retail price index.

The main difficulty with using the index of housing prices as the deflator stems from the fact that its major components are not predominantly raw materials. Raw materials (pitch pine and deal board, paints, galvanise sheets) only comprise about six percent of this index. The major items in

the housing RPI index are mortgage interest (23%), labour charges (36%), and the cost of rental housing (19%). The use of housing operations is less defensible, since none of the major elements of housing operations and supplies could be classified as construction materials.

Table 2: Components of Housing Index

Housing Index	**Housing Operations**
Mortgage Interest (23.8%)	Furniture & Soft Furnishings
House Rent Private (14.3%)	Housing Appliances
Labour Charges (36.3%)	Radios, TV's and hi-fi's
House Rent Government (4.7%)	Other
Home Insurance (4.2%)	
Galvanise Sheets (1.2%)	
Pitch pine & deal (1.8%)	
Paint (1.2%)	
Other (12.2%)	

Recall that the value of construction imports is divided principally between imports of processed metal and wood products. Using a subset of the United States producer price index derived from the Bureau of Labour Statistics, the index of steel mill products and lumber prices was compared with Barbados's RPI housing index. While the housing index appears to capture some of the significant jumps in timber prices between 1990 and 1992, there has been significant divergence between the indices for most of the period suggesting that real imports is currently underestimated (Chart 4).

Suggested Changes

The most substantive change which could be made to improve the central bank's methodology is the inclusion of non-metallic mineral products to the index. This category contains cement bricks, as well as the production of other building related products, such as tiles etc. Its inclusion is merited because the principal objective of the index is to measure residential and commercial building activity, and bricks constitute one of the most significant material costs of a building. The index of non-metallic mineral products is closely patterned to the quarrying index, but with less variability.

The inclusion of the non-metallic mineral index required a rethink of the weighting structure. In consultation with a quantity surveyor, the material component of a building was approximated. Using a standard 60% material and 40% labour breakdown, we disaggregated the material cost of the house into the following components; cement (10%), imports of construction material (15%), aggregate (15%), and bricks (60%).

The use of this weighting structure has however explicitly biased the index toward housing and building construction and away from road construction. This aspect would therefore merit further research in order to incorporate road construction into the weighting structure.

Our preferred estimation equation thus becomes;

$$\Delta RCON(3) = 0.6NMM + 0.15RICM + 0.15QI + 0.1CC \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (10)$$

Results

The results can be summarised as follows:

1. Output correlations measured on the basis of our preferred methodology, RCON(3) tend to be correlated with employment changes (Chart 5).
2. The size of these changes is often of the same order of magnitude as the employment variable.

While there is some correlation between real output using the alternative methodology (equation 6) and employment, changes in the output are implausibly large due to the large changes in the quarrying index. The percentage changes in output generated by RCON3 are also high, but not unacceptably so. The evidence which we present to support this contention is based on the following supporting evidence;

1. The variance of the independently produced nominal GDP series is also very high.
2. The degree of variability in the amount of labour employed in the construction sector changes dramatically with general economic conditions.
3. Building activity, estimated by the Statistical Department dominates the investment function (averages over 65% of investment). The investment function is in turn highly cyclical in nature, and further emphasize the special nature of construction output.

There is room for the adjustment of the indices which would account for the stock adjustment (sales data). However, the use of explicitly mathematical techniques should probably be avoided , since this would diminish the overall ability of the macro model to predict large divergences between traded and non-traded sector growth.

Conclusion

Given the data availability, it is believed that the approach outlined provides the best possible approach to the estimation of changes in the construction sector. This approach provides the following key propositions:

1. It remains within the system of using a linear combination of single indicators.
2. By reducing the weighting of quarrying, and including non-metallic mineral products, there is some diminution in the variability of the series which plagued the previous approach.
3. The approach can be consistently applied since in 1980 and is non-subjective.
4. Output estimates produced are consistent with other independently produced variables (See Chart 6).

However, there are two issues which need to addressed in the future. For more accurate estimation, there is a need to include in the estimation procedure the sales data of quarrying materials, as opposed to its production, and secondly the inclusion of an import price index. One of the primary purposes of the Central Bank's model is to provide policy makers with due notice as to any large divergence which may occur between the tradeable and the non-tradeable sectors of the economy. This therefore underscores the importance for seeking increasingly relevant indicators and measurement.

References

Brathwaite, Carlos, "The Construction Industry in the Economy of Barbados 1960 - 1980", Central Bank of Barbados *Economic Review* September 1982, IX (3), pp. 10-29.

Hill, T.P., The Measurement of Real Product - A Theoretical and Empirical Analysis of the Growth Rates, for Different Industries and Countries. OECD Economic Study Series, February 1971.

Lewis, Denny, "The Construction Sector in Barbados: The Measurement of its Contribution to Gross Domestic Product of Barbados", Central Bank of Barbados, *Working Papers 1997, Vol. 1*, pp. 197 - 206.

Chart 1
Changes in the Construction Indicator Indices

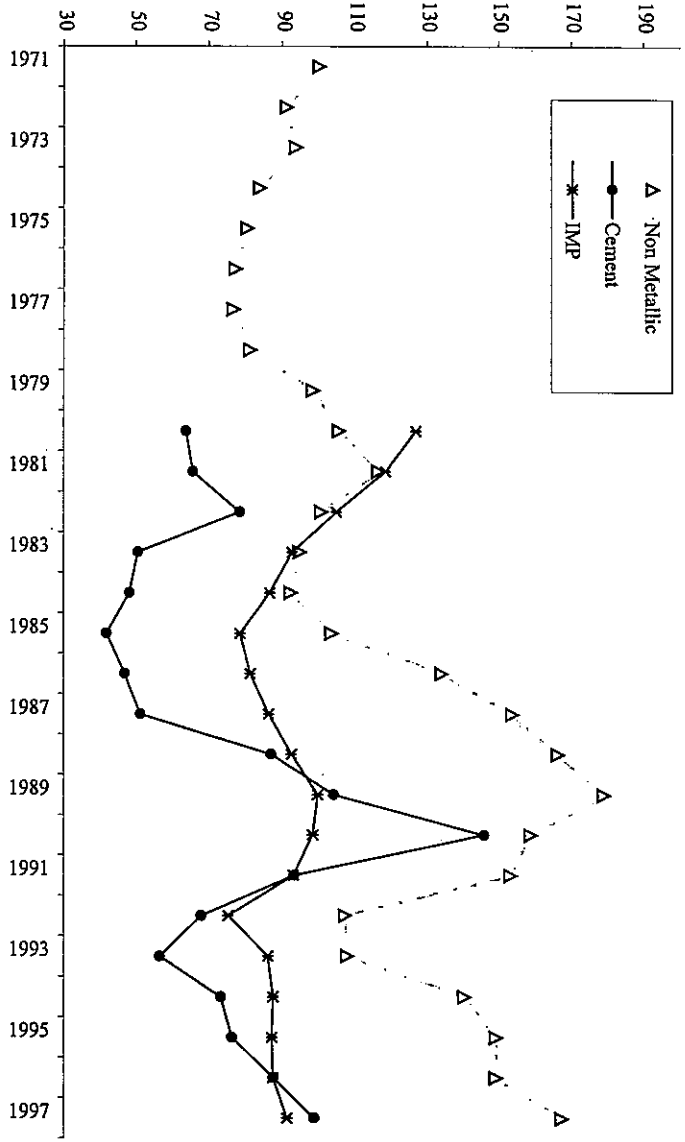

Chart 3
Mining & Quarrying
(Monthly)

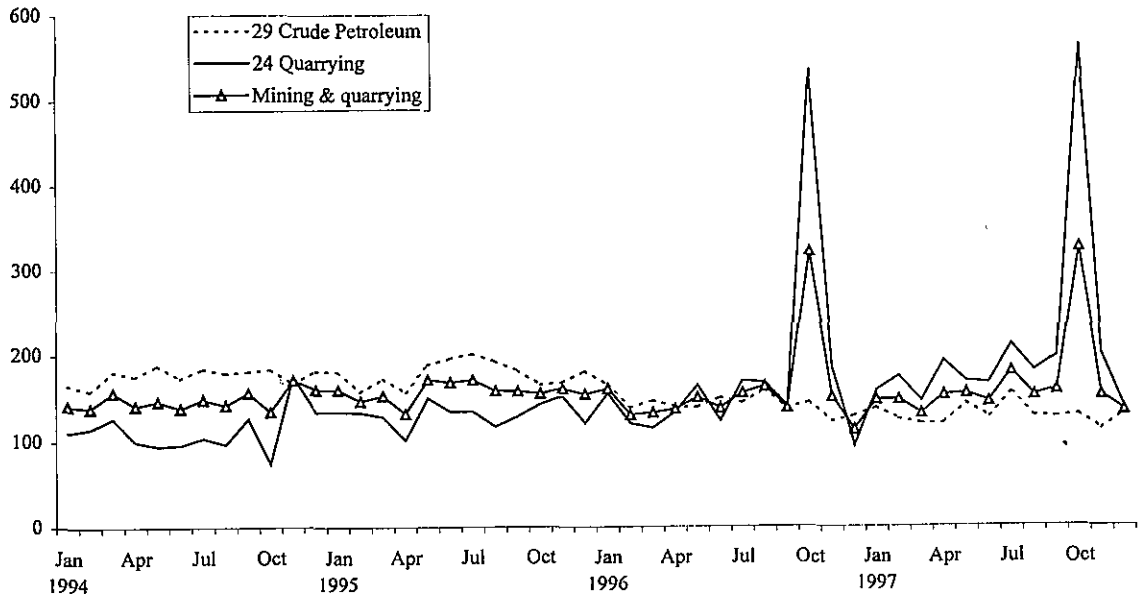

Chart 2
The Quarrying Index

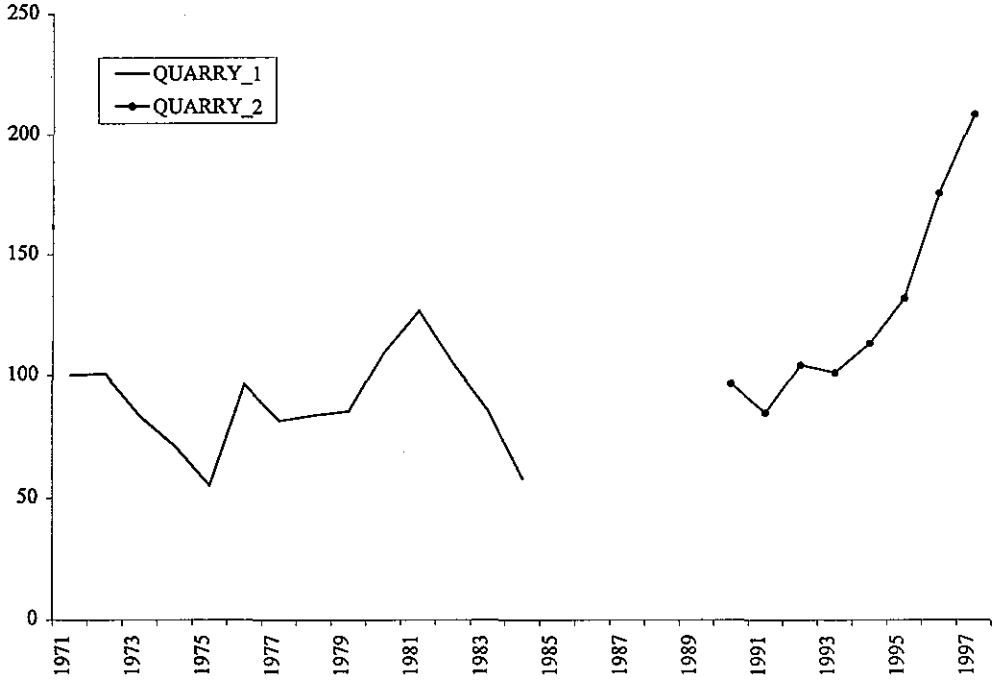

Chart 5
Growth Rates and Employment

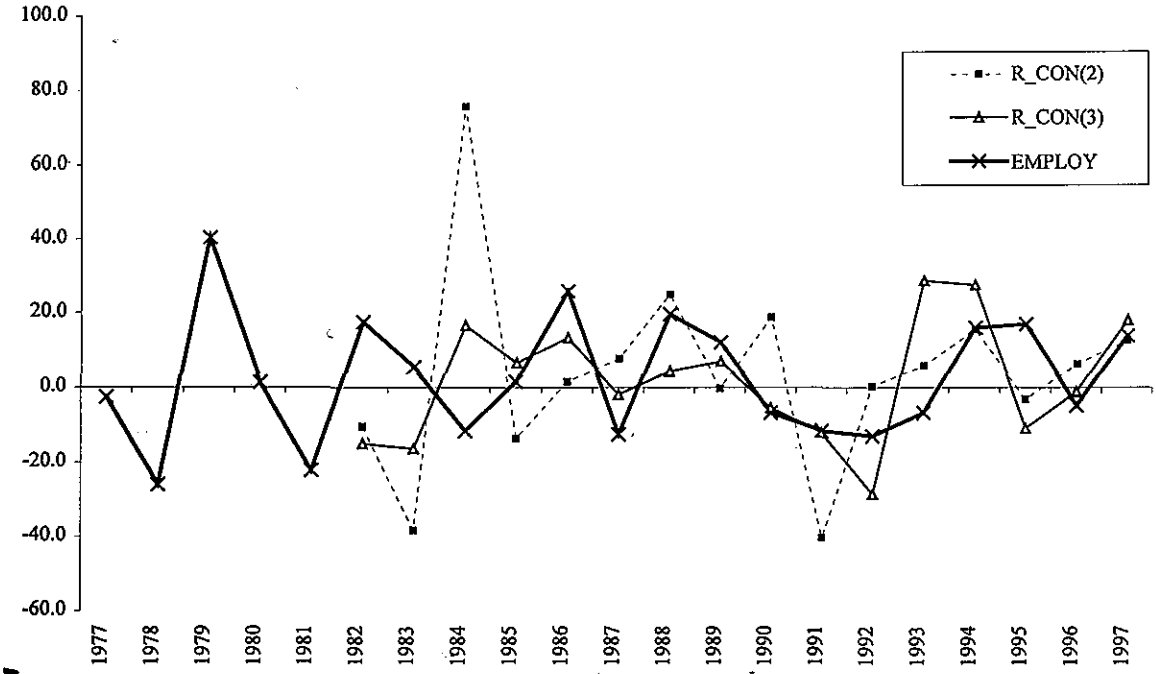

Chart 4
A Comparison of Real Import Measures

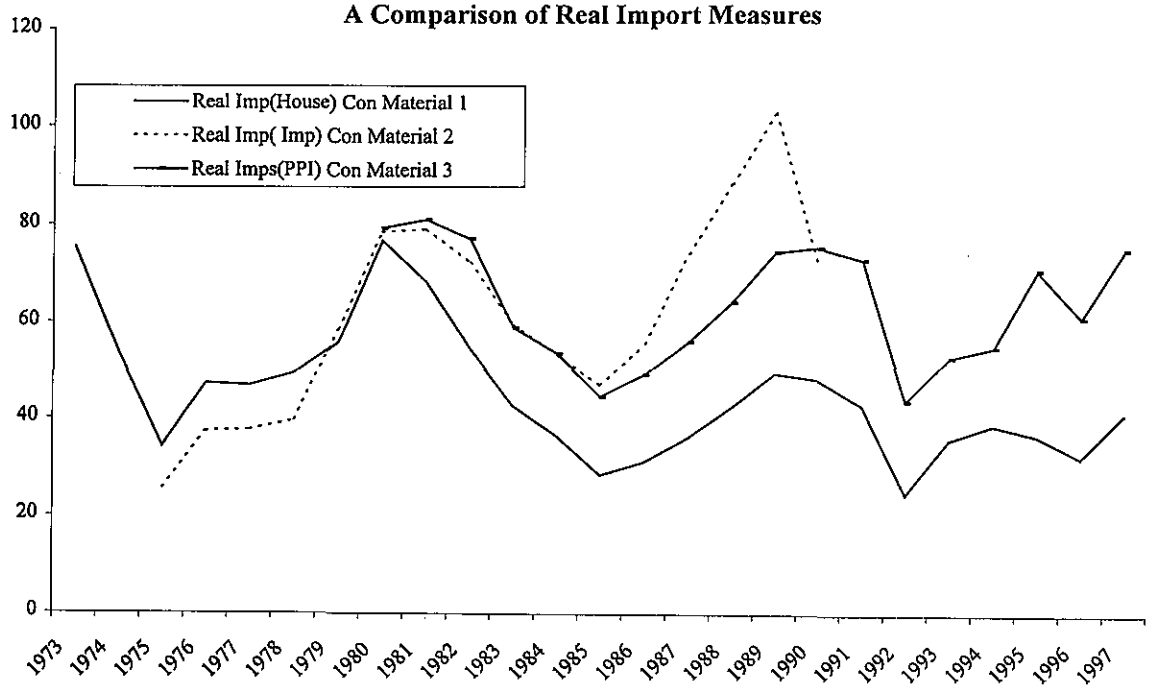

Chart 6

Changes in Real Construction(3) & Nominal Construction GDP Compared