Measuring the Deviations from Perfect Competition: International Evidence (second version)

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Abstract

We use aggregated macroeconomic data for 43 countries plus the EU19 and EU27 from 1970 to 2022 to test the microeconomic condition for Perfect Competition, whereby the price level is equal to the marginal cost in the long run. We postulate two forms of Perfect Competition in the macro data: a weaker-form and a stronger-form. The former exists if the price level and the marginal cost share a common long-run trend; i.e., cointegrated. The latter exists if the market price and the marginal cost are *equal* in the long run. There is more evidence for a weak-form competition than for strong-form competition. Macroeconomic interpretations of the deviations depend on whether the ratio of the price to marginal costs is equal to, greater, or lower than 1. The ratios vary significantly across countries and over time. A ratio of price to marginal cost >1 implies non-competitiveness. We interpret a ratio <1 to imply inefficiencies.

JEL Classifications D01, D41, C12, C13, C22
Keywords: Perfect Competition, price level, marginal cost, time series, cointgration, nonparametric

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1. Introduction, Motivation, and Literature

Perfect Competition is an important theoretical microeconomic market structure of the firm, and the industry, whereby a large number of firms offer a homogeneous product. *Free entry* and exit of firms from the market and *perfect* information will allow for normal profits to be made while prices will be kept low by competitive pressures. Perfect Competition is characterized by (1) a market which consists of a large number of firms that produce homogeneous goods; (2) these firms freely enter and exit the market; (3) they have symmetric information about factor input prices and quantities, government policies, etc., and; (4) the firm is relatively small such that it is a price taker (exact opposite of the monopolistic firm).

There are two fundamental theorems of Welfare Economics, which establish that, in the absence of the usual imperfections, the unregulated free-market maximizes social welfare, at least up to the initial exogenous distribution of ability. These results reflect the natural tendency of markets to move toward the social optimum precisely because in free markets firms maximize profit by providing customers with their needs of goods and services. The first theorem predicts Pareto Optimality in an equilibrium set of complete markets with complete information, and in perfect competition. Pareto optimality says that no further exchange would make one person better off without making another worse off. The requirements for perfect competition are: (1) there are no externalities and each actor has perfect information, and (2) firms and consumers are price-takers. The first requirement might be very hard to hold in today's economies. The second theorem, which is more plausible to hold in many markets assuming monopolistic competition, is not exactly a monopoly in the sense that substitution in goods and services is possible because such producers produce non-identical goods and services.

Furthermore, a Pareto optimal state in the economy is the most efficient point and can be attained if: (1) The marginal rate of substitution between any two goods be equal for all consumers; (2) The marginal rate of technical substitution between any two inputs be equal in the production of all commodities, and (3) the marginal rate of product transformation be equal to the marginal rate of substitution for any two goods. The

theorem is sometimes seen as a logical confirmation of Adam Smith's *invisible hand* principle, namely that competitive markets ensure an efficient allocation of resources, which is controversial to say the least (see Stiglitz 1994, for example, among many who argued against this). Note that there are arguments against the underlying assumptions of the first fundamental law, e.g., against non-satiation; rationality, and convexity. Acemoglu (1995) argued that the welfare theorems fail to hold in the canonical overlapping Generations Model. A further assumption that is implicit in the statement of the theorem is that the value of total endowments in the economy, whereby some of which might be transformed into other goods via production, is finite. In the OLG model, the finiteness of endowments fails. The second theorem states that any Pareto optimum can hold as a competitive equilibrium for some initial set of endowments. The implication is that any desired Pareto optimal outcome can hold; Pareto efficiency can be achieved with any redistribution of initial wealth. However, attempts to correct the distribution may introduce distortions, and so full optimality may not be attainable with redistribution. For proof see Mas-Colell, Andreu *et al.* (1995).

Intriguingly, most governments care about competitiveness. In the United States, and many other Western capitalist economies, anti-trust laws are set up to make sure those monopolies (sometimes described as market power) and anti-competitive practices do not spread and dominate the economy. Ironically, many government regulations, fiscal, and monetary policies, trade barriers, and labor policies, could stand in the way of Perfect Competition. Imagine that goods and services tax (GST) or sales tax etc, whereby such taxes raise the market price, create a wedge between the price level and the marginal cost, which would nudge the markets away from equilibrium. Regulations could abstract free entry and exit from certain markets. And, labor policy could affect wages, consequently the cost of production. Monetary policy could affect the real interest rate (the rental price of capital), hence affecting the cost of production. So, while governments care about competition on one side, their interventionist policies may inadvertently cause deviations from competitive equilibriums. Although policymakers may have some sense of competitiveness in the economy or industry, and in some cases they investigate certain noncompetitive behaviors; they do not have a readily available indicator of the degree of competitiveness of their economies.

Perhaps it is best to examine the competitiveness in an economy using Input-Output tables because the tables include data of prices and costs by firm and industry levels. However, such Tables are unavailable in many countries. As far as we are aware of, there is no macroeconomic indicator, which could describe or measure the degree of competitiveness in the economy in order to inform the policymakers about the status of the economy over time.

The narrow related empirical literature includes one notable contribution, Hall (1988). He examined output and labor input data and argued that they reveal that some *U.S. industries* have marginal cost well below price. The conclusion rests on the finding that *cyclical* variations in labor input are small compared with variations in output. In booms, firms produce substantially more output and sell it for a price that exceeds the costs of the added inputs. This paper documents the disparity between price and marginal cost, where marginal cost is estimated from annual variations in cost. It considers a variety of explanations of the findings that are consistent with competition, but none is found to be completely plausible. Note that Hall examined *cyclical variations* not the long-run relationship between the price and the marginal cost.

A relatively new study is Loecker *et al.* (2020), which examined the evolution of market power (i.e. price markup), which is one cause of deviations from competitiveness, based on *firm-level data* for the U.S. economy since 1995 and provided measures for both markups, and profitability. They discuss the macroeconomic implications of an increase in average market power and test for Perfect Competition in the U.S. Their micro-level firm-data indicate that there is evidence of non-competitive price setting in the U.S.

The objective of this paper, therefore, is to confront macroeconomic aggregated data with the microeconomic theory of Perfect Competition. We test for Perfect Competition in 43 countries. To be precise we examine the *long run relationship* between the price level and the marginal cost because we assume that this relationship is a steady-state equilibrium condition. We postulate and test two forms of Perfect Competition: a weaker-form and a stronger-form. A weaker-form of Perfect Competition exists if the price level and the marginal cost share a common long-run trend; i.e., cointegrated. We

test the null hypothesis of "no cointegration" between the price level and the marginal cost. In other words, the price level is not equal to the marginal costs *per se* but they are cointegarted. A stronger-form of Perfect Competition is one for *equality* between the market price and the marginal cost in the long run. Note that the equilibrium between the price level and the marginal cost is only theoretically consistent in the long run, i.e., not over the business cycle. For this reason we do not test for common cycles. When the price level and the marginal cost in any country pass the two tests of weak and strong forms of Perfect Competition, we deduce that there is evidence of Perfect Completion. If the data are only cointegrated we infer that there is evidence of a relatively weaker-form of Perfect Competition. And, when the data fail the two tests we conclude that the market is uncompetitive. It is important to understand that the deviations of the price from the marginal costs, i.e. $P > MC$ or $P < MC$, have different macroeconomic interpretations; only $P > MC$ implies non-competitive price setting behavior.

We use macroeconomic data for 43 countries representing the OECD, the EU, Australasia, the BRICS, Asia, and South America, and we also test the EU19 and the EU27, hence 45 cases. We also tested Saudi Arabia because it is a major oil producer and as the second largest oil reserve in the world. The countries are Australia, Austria, Belgium, Canada, Chile, Colombia, Costa Rica, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungry, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Türkiye, U.K., U.S., China, Russia, Brazil, Indian, Saudi Arabia, South Africa, Hong Kong and Singapore. The sample consists of annual data from 1970 to 2022, except for some countries the time series are shorter. The data source for real GDP in local currencies is the OECD statistics and the Consumer Price Index for all items (CPI) is the Bank for International Settlements (BIS).[2]

Our analysis show that there is more evidence that a weaker-form of Perfect Competition is present in macroeconomic data in almost all countries, i.e., the price level and the

[2] See OECD Statistics https://stats.oecd.org/ and the Bank for International Settlements online https://www.bis.org/statistics/cp.htm?m=236

marginal costs are cointegrated. And, there is evidence that a stronger-form of Perfect competition may exist in three cases; the U.S., India, and Germany appear to have the smallest deviations of the price from the marginal cost. Slightly larger deviations are apparent in Australia, Austria, the Netherlands, Norway, Slovakia, and the EU-27. These results still could not be interpreted that these economies are more competitive than others because the relative deviations of the price from marginal cost could be either greater or smaller in magnitude.

However, we find weak evidence for Perfect Competition in the data. We find evidence that $\frac{P}{MC} \approx 1$ in the U.S. (2011-2022), Hungry (2013-2022), and Australia (2003-2006). Over the sample and in all countries the price is either higher or lower than the marginal cost. We interpret $\frac{P}{MC} > 1$ as evidence of non-competitive price setting, monopolistic behavior. Cases, where $\frac{P}{MC} < 1$ do not imply non-competitiveness; they imply more inefficiency, which arises from interventionist government policies that affect output and factor input prices; from regulations that affect output and input prices, and trade barriers, among many interventions.

The next section presents a brief of the microeconomic theory of Perfect Competition in a production model. Section 3 presents the methodology and measurements. Section 4 is the time series tests of the trend of the price level and the marginal cost, and the long-run common trend, i.e. cointegration (Weaker-form of Perfect Competition). Section 5 is a test for the long-run equality of the price level and the marginal cost (stronger-form of Perfect Competition). Section 6 is a conclusion.

2. Microeconomic Theory

Theoretically, in a model of pure exchange market, there is a fixed total stock of a good. Consumers decide how many goods they want at some given price and use the market to either increase or decrease their stocks. There is equilibrium in the market when all consumers are able to make the net purchases or sales such that the consumer holds the desired stock of goods. This analysis must add the production sector for completeness.

However, such an addition is daunting and it is not a straightforward extension to the theory of pure exchange. Note that there is a crucial distinction to be made between stocks and flows. Production is a process of making a flow of goods over time. Therefore, the desired supply is also a flow. In a pure exchange model, the consumer desires to hold a stock of goods. The time element must be specified. One could think of the hour or the day as the smallest unit of time, hence production would be an hourly or a daily flow. In other words, there is a flow of goods demanded hourly or daily and there is a flow of goods supplied hourly or daily. The market would determine the price to clear to balance these two flows. There is another crucial issue in the case of production and that is the supplier makes continuous adjustments to the quantity of goods produced and there must be a time unit greater than an hour or day for such adjustment to be completed. This is crucial for the determination of the cost of the production and market adjustment. The producer must make such decisions. At the start of the period, at time $t = 0$, the producer chooses the quantity of goods to produce given information available at time $t = 0$ for the *current* price P, and fixed capacity. The producer also decides on the capacity and the output rate for the next period, $t = 1$, given forecasts (expectations) of market price. The time required is influenced by capacity adjustment - i.e. the time required to vary the quantity. This period is greater than an hour and a day in this case.

On day 1 of year 1, for example, the firm decides on the rate of output y, which was planned in the previous period. The firm finds out the price P when it sells the goods in the market. In the case that the price P is different from what was expected, the firm is unable to vary output in one day; therefore, the supply on day 1 year 1 is fixed. Output may vary on day 2, 3, and so on. If the market settles at a daily equilibrium, the firm will forecast the price of the next year, and plans its daily output and capacity for that year. In the theory of markets, the very short-run aspect is crucial for equilibrium. These short run adjustments are verified in Vernon Smith's work, see for example Smith (1962).

Assume that $x_i$denotes the ith consumer's rate of demand per day for the good and let the market demand be:

$$x = \sum_i x_i = \sum_i D_i(P) = D(p) \qquad (1)$$

where P is the market price. Assume that the demand adjusts to market prices and quantities within a day, i.e. there is no lengthy adjustment lags like the supply.
Let y_j be the daily rate of production, where $j$is the firm $j = 1, 2, \cdots m$

$$y_j = s_j(P) \qquad (2)$$

and

$$y_j = S_j(P), \qquad (3)$$

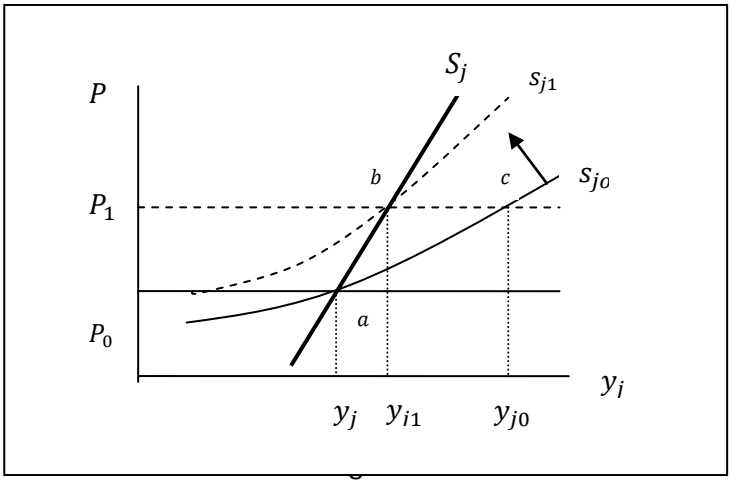
where (2) is the short-run supply and (3) is the long-run supply function.

As we explained earlier, the short-run supply $s_j$is subject to fixed capacity and the long-run supply S_j is not. There are m firms in year 0 and m'(equal, greater, or smaller) than m firms in year 1. It implies that under Perfect Competition, firms enter and exit in year 1.

The Short Run Supply

In Diagram (1), the price increases from P_0 to P_1. The firm's initial supply is the short-run marginal cost curve SMC is s_j. If the effect of expansions of all firms at the same time raises input prices, the marginal cost curve and the short-run supply curves of each firm in the industry must rise. Sketch (1) depicts a potential case of expansion of firms in response to the higher price.

Diagram (1)
The Short Run Supply Curve Adjustment



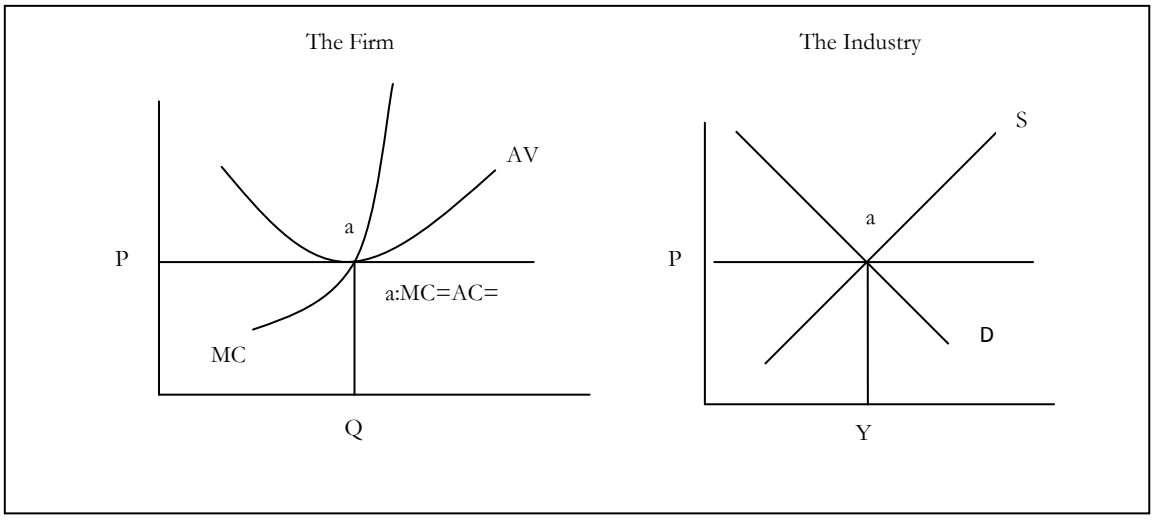
The short run supply curve has increased from s_{j0} to s_{j1} and hence the price is P_1 and the firm will supply y_{j1} instead of y_{j0}. So when all firms expand, the points on the firm's supply curve corresponding to P_0 and P_1 are points a and b respectively and S_j is the locus of all such price-supply pairs. The firm's effective market supply curve is S_j is less elastic than its s_j supply curve, everything else held constant. These two curves would be the same if (1) input prices do not increase by simultaneous expansion of output by all firms, and (2) there are no technological externalities. The market supply function is found by aggregating the *effective* supply functions $S_j(P)$, which are based on *actual* output adjustments rather than $s_j(P)$.

The market supply curve, which accounts for input price changes, is:

$$y = \sum_j S_j(P) = S(P), \qquad (4)$$

where $s(P)$ is zero, greater than zero, or less than zero. The slope of this market supply curve depends on the extent that the increases in input demand increase input prices, and the resulting increases in the marginal costs at all output levels. When input prices rise, and the marginal cost rises above the market price of output, firms would adjust by producing less output; some firms may exit the market. When the input prices fall, and the marginal cost falls below the market price, firms produce more output, and some new firms may enter the market. When market price is equal to the marginal cost we have a competitive long-run equilibrium in the market.The textbook Diagram for Perfect Competition in the long run is depicted in Diagram (2).

Diagram (2) – Perfect Competition, the Long Run



A competitive market is an efficient one. This entry into the market is a dynamic process, which lasts as long as the market price of the goods produced by the firms is > the marginal cost. The firm keeps adjusting its price in the short run. Entry into the market stops when the price is equal to the marginal cost, and firms exit the market when the price is below the marginal cost because the firm cannot cover its variable costs. Thus, a long run equilibrium condition requires $P = MC$. Such conditions should also indicate whether the market is competitive or not. Whether such conditions hold in macroeconomic data is a testable hypothesis. We do not expect such conditions to hold perfectly because fiscal policy (i.e., tax policy), monetary policy (i.e., the interest rate), regulations (i.e., minimum wage), trade barriers (i.e., tariffs), price subsidies, lack of antitrust power, and state monopolies among other interventionist policies could cause a wedge between the price and the marginal cost in the long run. However, this condition could tell us how far a certain market is from long run efficiency. Empirically, it is an approximate measure of efficiency and undoubtedly an informative one.

In diagram (2), P is the price, Q is the firm's level output, AV is the average cost curve, MC is the marginal cost curve, Y is the industry level output, D is the demand curve, and S is the supply curve. The individual firm maximizes output at the most efficient point of intersection of the marginal revenues and the marginal cost, whereby in the long run the price must be set equal to the marginal cost and the profits will be the normal economic profit. At the industry level, the price is determined by the intersection of demand and supply.

In this paper we want to use aggregated macroeconomic data for country levels to measure the point a, where $P = MC$ on the diagram (2) and to examine the deviations from such point. The closer the data are to this point the closer is the market to Perfect Competition and the more efficient it is.

3. Methodology, Data, Measurements, and Evidence

At the country level, we use macroeconomic aggregated data of the consumer price index, the CPI_t, as a measure of the price level. The total cost curve $TC_t$is assumed to be

a quadratic function of output y_t, and the marginal cost MC_t is the derivative of the total cost with respect to output:

$$TC_t = \alpha y_t + \beta y_t^2 \text{ and the } MC_t = \frac{\partial TC_t}{\partial y_t} = \alpha + 2\beta y_t.^{3} \quad (5)$$

The values of α has no significant effect on the calculation because y_t is a large number so we will set it up equal to one, and one plus a large number is just the large number. And, the magnitude of β is irrelevant to the calculation because we will convert MC_t to an index, MCI_t to compare with the CPI, therefore, we set β equal to one.

4. Weaker-Form Perfect Competition: Do the Price level and the marginal cost share a common long-run trend?

A weaker-form of competition exists when the price level and the marginal cost are cointegrated, i.e., they share a long-run common trend. This is a bi-variat system, therefore, we use the Engle-Granger (1987) test, whereby the null hypothesis is that the CPI and the MCI are not cointegrated, i.e., they do not share a common long-run trend.[4]

Engle and Granger (1987) suggested six tests for cointegration. The test involves three steps. First, we regress one variable on the other using the Ordinary Least Squares method (OLS). One test for no cointegration is that a high $R^2$and a low Durbin-Watson statistic DWsuggests that the regression is Spurious, which implies cointegration. Second, they recommended using the ADF test to test the residuals of the regression in levels for unit root. Rejecting the unit root indicates that the two variables are cointegrated, i.e. the residuals are I(0).[5] Other tests for unit root can also be used; the results will not change

[3] There might other functional forms of total cost, e.g. translog, but we do not examine them. In order to keep things tractable we assume a quadratic cost function.

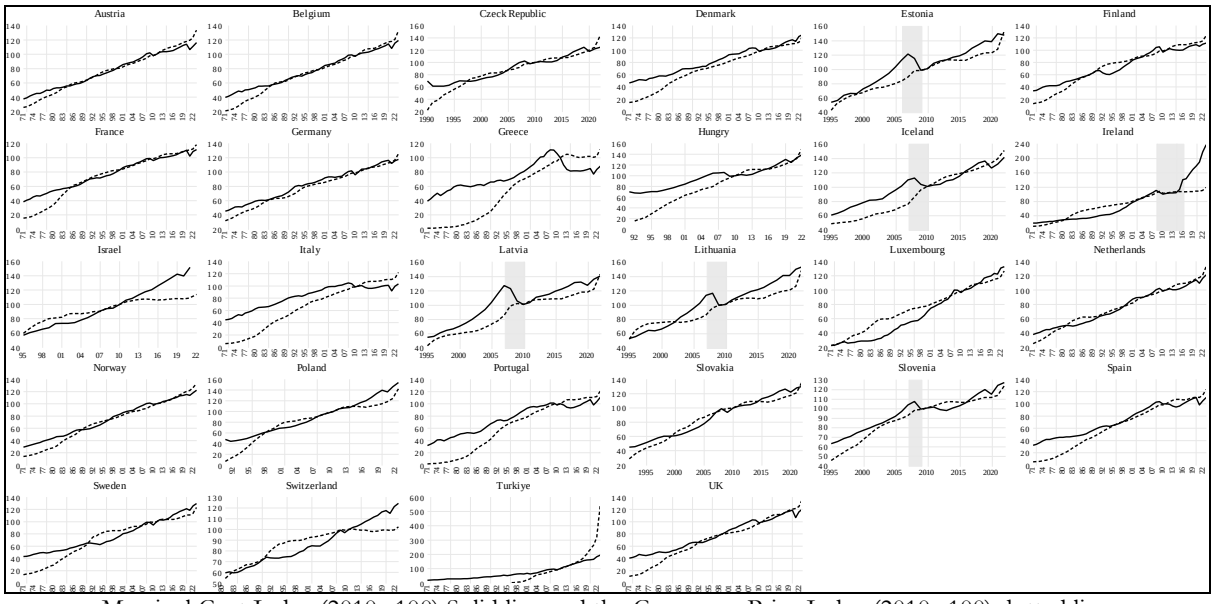
[4] We could use the Phillips-Ouliaris (1990) test but the results would be the same.

[5] The ADF is a weak test for unit root, i.e., it fails to reject more often. However, the power of any weak test is literally meaningless when it reject the null hypothesis.

significantly. Third, the most important test for cointegration is estimating an Error Correction Equation and testing the significance of the coefficient of the error correction term (i.e. the lag residuals from the first stage level regression). A significant coefficient confirms the two variables are cointegrated.[6] For cointegration, we want the error correction term (the lagged residuals from the first stage regression) to have a high t value (zero P-value). Testing for cointegration between the $CPI_t$and MCI_t requires identifying the trends first. The data must be differenced-stationary. In simple terms, each time series must have a unit root.

First we plot the data. Figure (1) plots the time series for the European countries. The samples may vary, but most of the data are from 1970 to 2022. Real GDP data used to compute the marginal cost index MCI_t (2010=100) are taken from the OECD statistics. The CPI_t (2010=100) is taken from the Bank for International Settlements (BIS).

Figure (1) – The European Data



Marginal Cost Index (2010=100) Solid line and the Consumer Price Index (2010=100) dotted line

There are trends in all data. The shaded areas, in a few countries, show potential breaks in the data around the period of the Global Financial Crisis in 2007 and the Great Recession in 2009. Figure (2) plots the U.S., the EU-19, and the EU-27 data. Similar

[6] Note that the distribution of t stat of this *estimated* coefficient is non-standard, therefore, we would only consider a very high t stat (or zero P value) as indicative of statistical significance.

trends and possible breaks in the European data are visible. Figure (3) plots the Australian and New Zealand data. Both countries have similar patterns to the US and the European countries, with the marginal cost above the price level in the 1970s and 1980s. Figure (4) plots two South American countries' data.

Figure (2) – The U.S., EU-19, and EU-27 Data

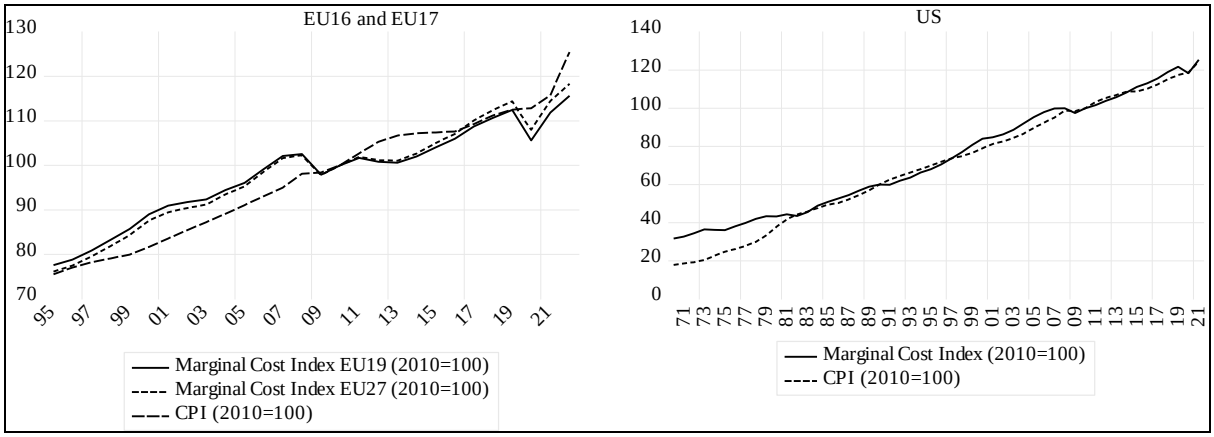


Figure (3) – Australasian Data

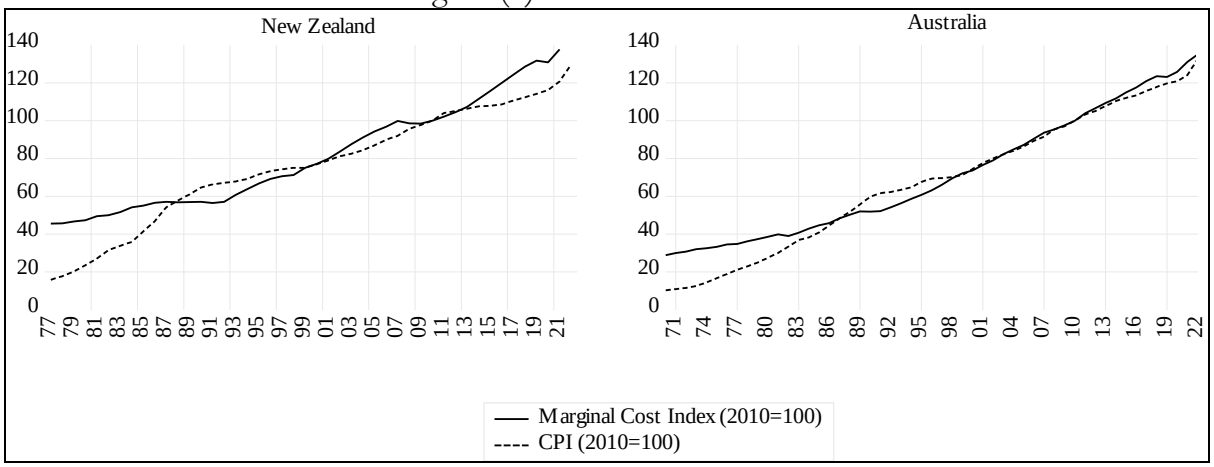
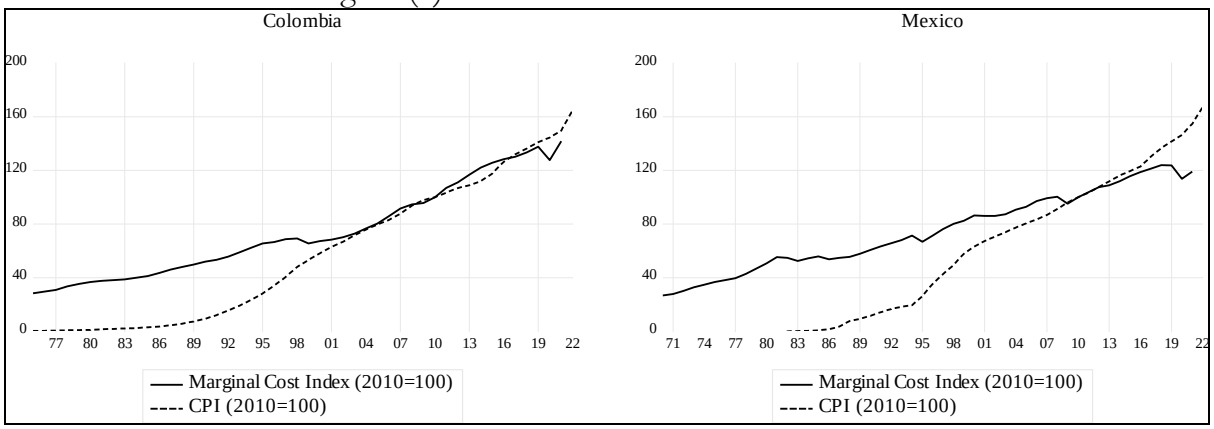
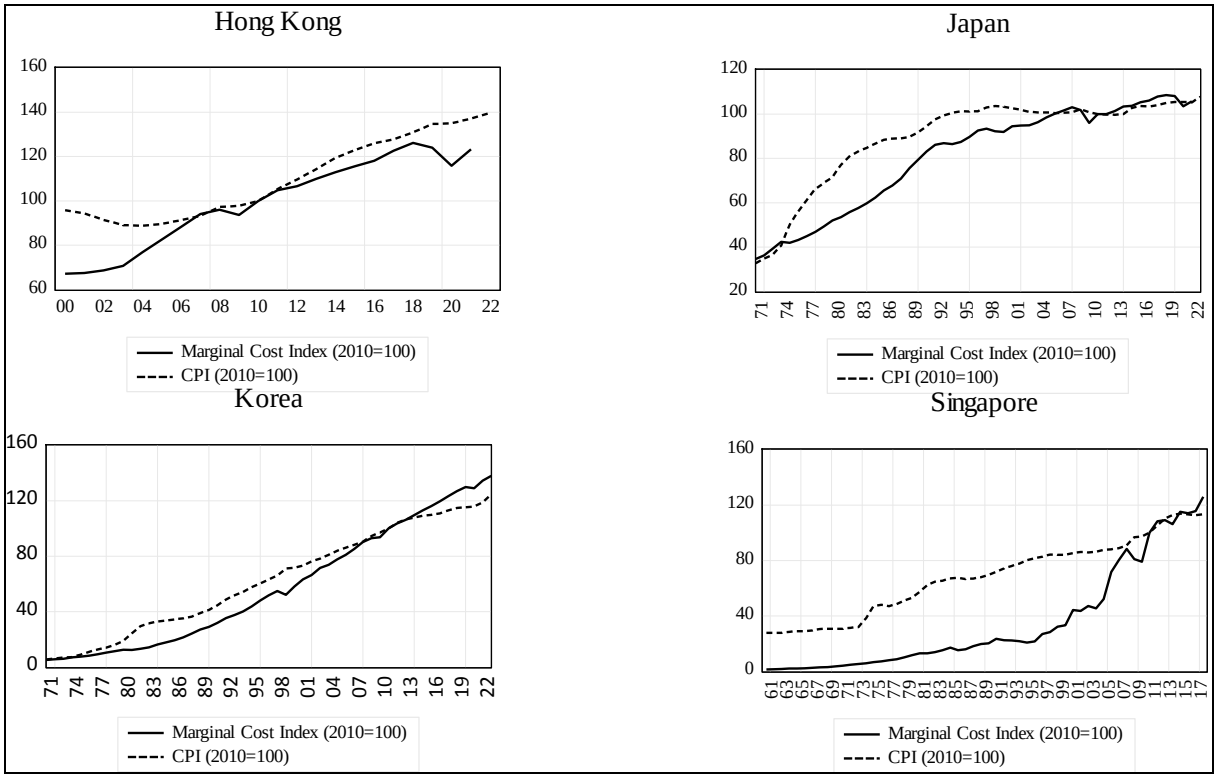


Figure (4) – Two South American Countries



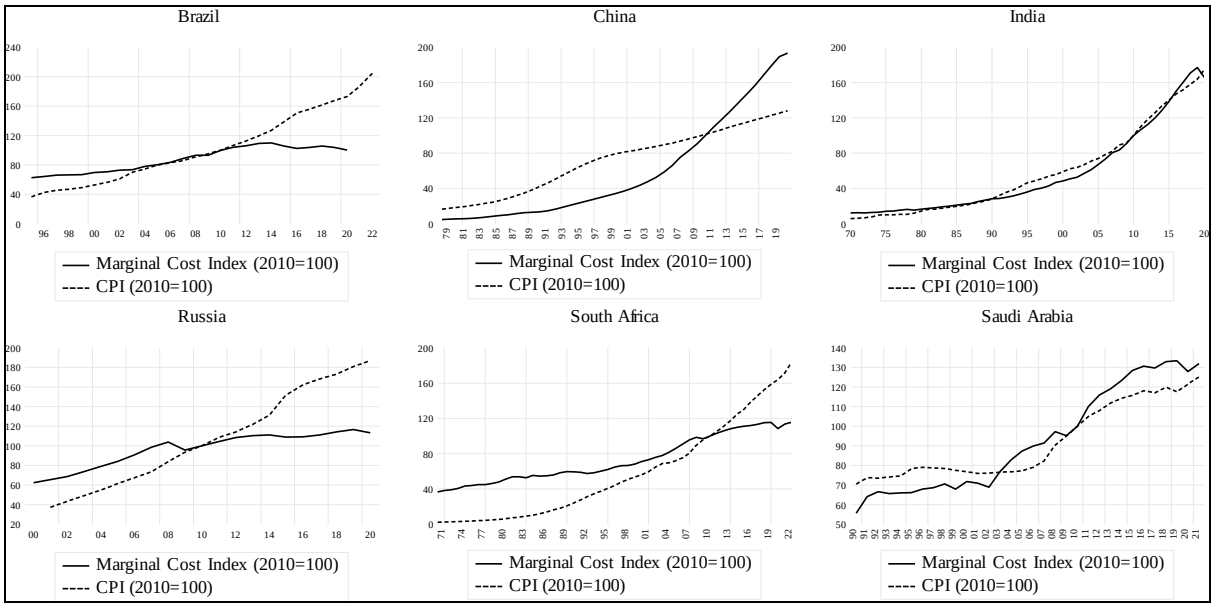
Colombia and Mexico also have the marginal cost above the price level in the 1970s and the 1980s but also in the 1990s. Figure (5) plots the Asian countries in our sample. And finally we plot the BRICS plus Saudi Arabia in figure (6).

Figure (5) – The Asian Data



Data Source for Singapore's real GDP is the Federal Reserve Bank of St. Louis (FRED)

Figure (6) – BRICS Data



The trends are visible in the data. Brazil, Russia and South Africa look more similar than the others, and the marginal cost above the price level like the US, Europe, Australasia

and South American data. India has the marginal cost almost equal to the price level. Note, however, that many developed countries experienced higher marginal costs in the early 1970s. We speculate that oil price shocks and high real interest rates might have contributed to that. The Asian countries data show similar upward trends albeit quite peculiarly the marginal costs are below prices a long time, which is different from the European and the U.S. data. In particular, Japan, China, and Singapore have their marginal costs significantly below the CPIs over a long period. Explaining these trends is beyond the scope of this paper, but we could only speculate that China and Singapore, in particular, and even Japan in the 1970s and 1980s, have strong government interventionist policies.

The Nature of the Trend

Notwithstanding Phillips' (2003) argument about the difficulty to predict the trend, testing for a meaningful long-run common trend requires the CPI_t and MCI_t to have unit roots, i.e. stochastic trends. Put simply, each time series has to be *differenced-stationary.* It is easier said than done, however. For robustness, our strategy is to test for the nature of trend using a number of commonly used tests such as the Dickey – Fuller (1979), the Augmented Dickey – Fuller test (Said and Dickey, 1984), the Phillips – Perron (1988) test, the GLS – ADF Elliot *et al.* (1996), and Ng – Perron (2001. In cases where we are uncertain about the unit root we use the Wiatkowski, Phillips, Schmidt, and Shin (KPSS) Test.[7] We also test for unit root with break in some cases.[8] Keep in mind though that these tests have low powers against stationary alternatives, i.e. they tend not to reject the null hypothesis more often. The other concern is that these tests might have difficulty distinguishing a root of 1 from, say 0.98; see for example Rudebusch (1993) and Cochrane (1991) among many others for example.

[7] We cannot compare the power of these unit root tests with the power of the KPSS because the KPSS test's null hypothesis is "no unit root" or I(0) while the other tests null is I(1), hence power comparison is not inapplicable.

[8] There are more tests for unit root, but we doubt it very much if the results would change significantly. However, the most concerning issue, which we do not address here, is whether the true Data Generating Process (DGP) of either the CPI or MCI is *nonlinear*, thus a nonlinear unit root test is required. We say that because the unit root tests above fit a linear line through the data; they would confuse breaks in the data, if any, with nonlinearity. Nonetheless, nonlinear unit root is a probability, for example see Kapetanios, Shin, and Snell, (2003).

For each test, we use a number of specifications. We use regressions without an intercept and linear trend, with an intercept only, and with an intercept and linear trend but we are more concerned with the last specification because we need to test for unit root and deterministic trend. In each test and each specification, we use a number of Information Criteria to determine the number of lag differences in the regressions. Note that these different specifications have different distributions. We do not report the results of these tests and specifications because the output is very large, some produce exact same results, and the output takes a lot of space; however, the results of the various regressions across all different tests are not different in any significant way. They all indicate that the trend in the data is stochastic, i.e., the time series data have unit root, hence differenced stationary. One thing we are sure about is that neither the CPI_t nor the $MCI_t$is I(0), therefore, it seems defensible to carry on with the conclusion of the unit root in the data.

Cointegration

Table (1) reports the tests for cointegration. The table has three tests: (1) the Spurious regressions in the levels with high $R^2$and low DW, which indicate that the CPI_t and $MCI_t$are cointegarted; (2) the ADF test of the residuals from the first regression in levels, which is statistically significant at the 5 percent level in 29 countries (Australia, Austria, Belgium, Estonia, Finland, France, Germany, Hungry, Iceland, India, Japan, Latvia, Lithuania, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, UK, and the US). The EU-19 and EU-27 also have significant ADF tests. There are four countries where the ADF test is significant at the 10 percent level (Colombia, the Czech Republic, Korea, and Hong Kong). The rest of countries' ADF test is insignificant. These are Ireland, Israel, Italy, Mexico, Switzerland, Turkiye, South Africa, and Russia. The third test (the ECM) is the most important test for cointegration.[9]

[9] The t test of the EC term is non-standard. For example see Kremers *et al.* (1992) and Gonzalo, J., (1994). Note that the power of the ADF test or the ECM test is irrelevant when the test *rejects* the null hypothesis of no cointegration because the weak test (low power) often *fails to reject* the null. Therefore, rejections of the null in table (1) are very strong indications of cointegration. Furthermore, the test for no cointegration between the price level and the marginal cost is grounded in economic theory.

We found 14 countries plus the EU-19 and the EU-27 with significant error correction terms, i.e., high t statistics (Australia, Austria, Belgium, Colombia, the Czech Republic, Denmark, Estonia, Israel, Lithuania, Poland, Portugal, Slovakia, and the U.S. Hong Kong's t statistics is 2.0, which is probably insignificant in this case. The rest of the countries ECM are insignificant.[10] The evidence is mixed, however, indicates that there exists a weaker-form of Perfect Competition in many countries.

Table (1) – The Engle-Granger (1987) Test - H_0: No Cointegration

No	Country	Sample	OLS: $CPI_t = \alpha MCI_t + \varepsilon_t$[i]				ADF ε_t[ii]	$\Delta CPI_t = \beta \Delta MCI_t + \rho \varepsilon_{t-1} + v_t$[ii]	
			α	P-value		DW	(P values)	ρ	(t_ρ/P values)
1	Australia	70-22	0.96 [1.5954/3]	0.0000	0.79	0.02	(0.0199)*	-0.08 [1.9888/3]	(-3.4/0.0014)
2	Austria	70-22	0.99 [4.5793/3]	0.0000	0.91	0.04	(0.0098)*	-0.09 [5.2770/3]	(-2.5/0.0134)
3	Belgium	70-22	0.98 [2.3614/3]	0.0000	0.81	0.03	(0.0845)*	-0.08 [4.6240/3]	(-3.6/0.0006)
4	Colombia	75-22	0.75 [7.6089/3]	0.0000	0.31	0.00	(0.1826)#	-0.04 [3.5123/3]	(-5.1/0.0000)
5	Czech R	90-22	0.98 [3.3769/3]	0.0000	0.64	0.23	(0.1426)#	-0.38 [3.1663/3]	(-5.1/0.0000)
6	Denmark	70-22	0.94 [4.7709/3]	0.0000	0.65	0.02	(0.0031)*	-0.08 [2.4314/3]	(-3.5/0.0011)
7	Estonia	95-22	0.97 [2.1878/2]	0.0000	0.91	0.55	(0.0417)*	-0.29 [1.7453/2]	(-2.6/0.0154)
8	Finland	70-22	0.98 [4.9746/3]	0.0000	0.74	0.03	(0.0060)*	-0.09 [6.6287/3]	(-3.2/0.0024)
9	France	70-22	0.97 [3.5254/3]	0.0000	0.87	0.04	(0.0111)*	-0.06 [5.1955/3]	(-1.7/0.0910)
10	Germany	70-22	1.10 [5.9522/3]	0.0000	0.98	0.49	(0.0024)*	-0.17 [4.5134/3]	(-1.4/0.1639)
11	Greece	70-22	1.93 [5.4016/3]	0.0000	0.74	0.10	(0.0307)*	-0.03 [1.0991/3]	(-1.1/0.2569)
12	Hungry	92-22	1.69 [3.9916/3]	0.0000	0.91	0.34	(0.0006)*	-0.16 [2.6228/3]	(-1.4/0.1603)
13	Iceland	95-22	1.31 [7.0711/2]	0.0000	0.88	0.35	(0.0082)*	-0.11 [5.3915/2]	(-1.1/0.2460)
14	Ireland	70-22	0.78 [4.0803/3]	0.0000	0.43	0.04	(0.3116)	0.03 [3.4046/3]	(1.6/0.1100)
15	Israel	95-21	0.46 [2.8488/2]	0.0000	0.85	0.19	(0.3096)	-0.19 [4.2323/2]	(-2.3/0.0267)
16	Italy	70-22	1.90	0.0088	0.93	0.19	(0.1389)	-0.06	(-0.59/0.5570)

[10] Ireland's ECM is problematic because the error correction term is positive. Switzerland too has very difficult data to fit too and the ECM term is positive. We tried to fit a linear trend and a constant term in the level's regression, but the ECM remained positive.

			[3.8145/3]					[3.8759/3]	
17	Japan	70-22	0.79	0.0000	0.84	0.08	(0.0089)*	-0.08	(-1.5/0.1475)
			[4.3144/3]					[2.2749/3]	
18	Latvia	95-22	0.92	0.0000	0.84	0.39	(0.0372)*	-0.19	(-0.02/0.9838)
			[2.1196/2]					[2.3607/2]	
19	Lithuania	92-22	0.70	0.0000	0.88	0.63	(0.0521)*	-0.29	(-2.6/0.0159)
			[1.6645/2]					[1.2673/2]	
20	Luxembourg	70-22	0.79	0.0000	0.94	0.09	(0.0071)*	-0.07	(-1.2/0.2279)
			[4.0750/3]					[8.4970/3]	
21	Mexico	70-21	1.69	0.0000	0.92	0.14	(0.1140)	-0.05	(-0.66/0.5104)
			[1.5370/3]					[2.7848/3]	
22	Netherlands	70-22	1.08	0.0000	0.96	0.18	(0.0033)*	-0.09	(-1.5/0.1301)
			[3.2258/3]					[3.0240/3]	
23	New Zealand	77-21	1.00	0.0000	0.87	0.06	(0.0144)*	-0.06	(-1.2/0.2488)
			[5.3479/3]					[2.2353/3]	
24	Norway	70-22	1.19	0.0000	0.97	0.12	(0.0640)*	-0.04	(-0.45/0.6531)
			[1.5451/3]					[1.7610/3]	
25	Poland	90-22	0.92	0.0000	0.85	0.10	(0.0315)*	-0.16	(-3.5/0.0015)
			[3.1937/3]					[3.2691/3]	
26	Portugal	70-22	1.67	0.0000	0.96	0.33	(0.0008)*	-0.12	(-2.2/0.0331)
			[4.2780/3]					[3.3162/3]	
27	Slovakia	92-22	0.98	0.0000	0.94	0.33	(0.0255)*	-0.19	(-1.8/0.0749
			[2.0660/3]					[3.9010/3]	
28	Slovenia	95-22	0.95	0.0000	0.88	0.23	(0.0277)*	-0.21	(-1.2/0.2248)
			[3.3056/2]					[3/0592/2]	
29	Korea	70-22	0.95	0.0000	0.97	0.09	(0.0764)#	-0.04	(-1.3/0.1910)
			[4.7712/3]					[5.0053/3]	
30	Spain	70-22	1.45	0.0000	0.96	0.25	(0.0011)*	-0.03	(-0.43/0.6631)
			[3.73030/3]					[4.1074/3]	
31	Sweden	70-22	0.95	0.0000	0.80	0.03	(0.0350)*	-0.05	(-1.3/0.1955)
			[3.3872/3]					[2.2428/3]	
32	Swiss	80-22	0.98	0.0000	0.50	0.04	(0.6194)	0.03	(1.4/0.1656)
			[3.7282/3]					[4.3026/3]	
33	Turkiye	70-22	3.49	0.0519	0.89	0.76	(0.0004)*	-0.16	(-0.18/0.8559)
			[7.8263/3]					[2.4707/3]	
34	UK	70-22	1.32	0.0000	0.94	0.22	(0.0068)*	-0.04	(-0.62/0.5389)
			[2.9208/3]					[3.0548/3]	
35	US	70-22	0.96	0.0000	0.96	0.08	(0.0206)*	-0.09	(-3.5/0.0008)
			[3.2939/3]					[6.3068/3]	
36	EU19	95-22	1.27	0.0000	0.92	0.56	(0.0443)*	-0.16	(-2.5/0.0173)
			[6.2284/2]					[4.1539/2]	
37	EU27	92-22	1.15	0.0000	0.94	0.61	(0.0352)*	-0.21	(-2.5/0.0184)
			[7.8907/2]					[3.2892/2]	
38	China	78-20	0.55	0.0000	0.78	0.04	(0.0463)*	-0.02	(-0.66/0.5094)
			[2.9003/3]					[3.0123/3]	
39	Singapore	60-17	0.63	0.9049	0.77	0.07	(0.0482)*	-0.02	(-0.43/0.6682)
			[5.0311/3]					[4.9071/3]	
40	India	70-20	1.01	0.0000	0.98	0.34	(0.0070)*	-0.09	(-0.39/0.6976)
			[5.0010/3]					[4.7559/3]	
41	Saudi Arabia	90-21	0.96	0.0000	0.94	0.39	(0.0376)*	-0.17	(-1.6/0.1244)
			[2.0678/3]					[2.5853/3]	
42	South Africa	70-22	2.04	0.0000	0.94	0.13	(0.1660)	-0.01	(-0.15/0.8784)
			[4.8174/3]					[4.1374/3]	
43	Brazil	95-20	2.28	0.0484	0.80	0.17	(0.0322)*	-0.04	(-0.14/0.8893)
			[4.5285/2]					[3.5291/2]	

44	Hong Kong	00-21	0.78 [5.3653/2]	0.0000	0.81	0.18	(0.0646)#	-0.17 [2.8191/2]	(-2.0/0.0581)
45	Russia	01-20	2.75 [1.7696/2]	0.0355	0.80	0.30	(0.3479)	-0.10 [1.6132/2]	(-0.36/0.7201)

(i) We removed the constant term when it is found insignificant, and we do not report the constant terms in the first level's regression. The regression's standard errors and covariance are HAC, pre whitening with lags from AIC, Bartlett kernel, Newey-West with an automatic bandwidth **(ii)** ADF is the Augmented Dickey-Fuller test with lag =1 based on AIC **(iii)** The EC regression's standard errors and covariance are HAC, pre whitening with lags from AIC, Bartlett kernel, Newey-West with an automatic bandwidth. Asterisk denotes significant at the 5 percent level and Hash denotes significant at the 10 percent level. Square brackets include the bandwidth/lags used to compute the kernels.

5. Stronger-Form Perfect Competition: Is the CPI equal to the MCI in the long run?

The next test involves extracting the stochastic trend from the data. The trend characterizes the long run as in the Hodrick-Prescott (1997) filter (HP filter), and the Optimal Band-Pass (BP) filter - (Christiano – Fitzgerald, 2003). In the frequency domain, the filtered trend is the fluctuations in the data beyond 8 years. The trend is nearly identical from these two methods even though the BP filter extracts the noise (i.e., high frequency below 2 years), albeit the HP filter has a little more noise (i.e., fluctuations that occur between 0 and 2 years cycles). Figures (7), (8), (9), (10) and (11) plot the 45° line scatter plots. In figure (7), the deviations of prices from marginal costs along the 45° line are large in general, except for a few countries, which have relatively smaller deviations from the 45° line; Austria, Belgium, the Czech Republic, Denmark, Estonia, Germany, Lithuania, the Netherlands, Norway, and Slovakia. Over a very short segment of the 45° line, Hungry price – marginal cost deviations look extremely small.

Figure (7) - 45°- Line Scatter Plots - Europe[11]

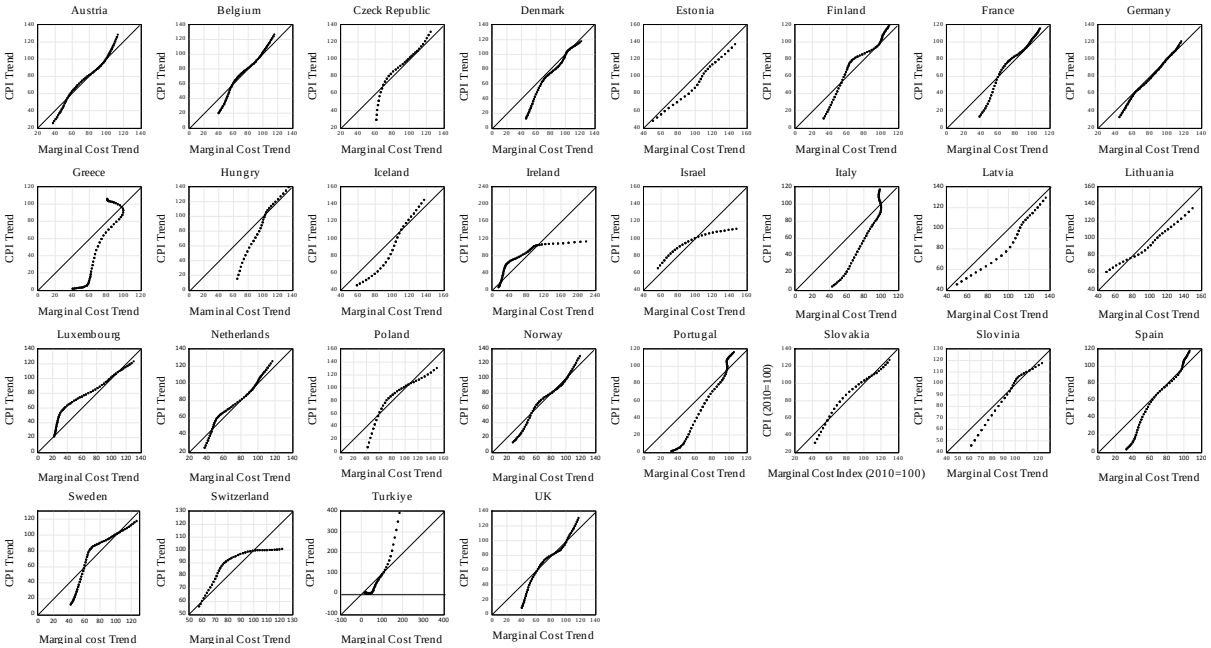


Figure (8) - 45°- Line Scatter Plots – US, EU-19 and EU-27

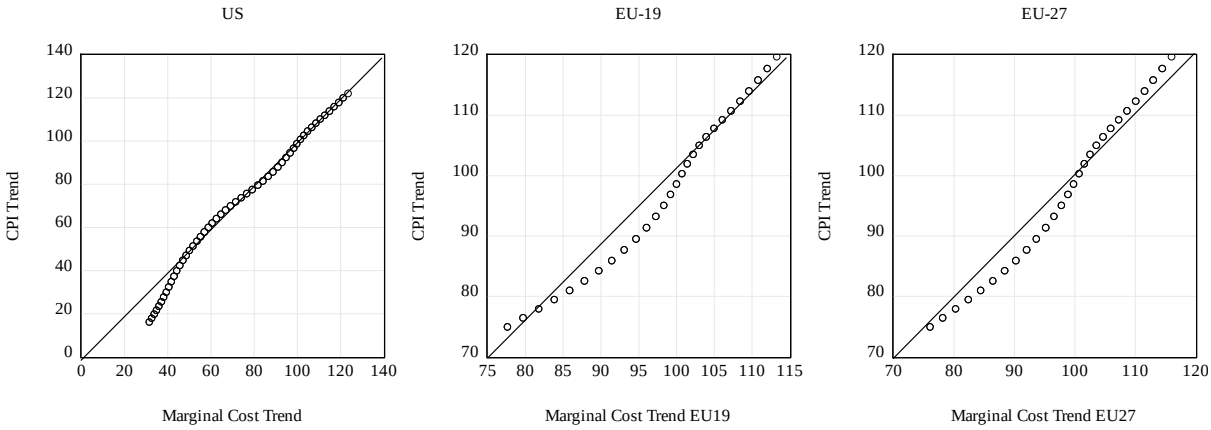


Figure (8) plots the United States, the EU-19, and EU-27. It shows that there is evidence for a stronger-form competition in the U.S., more so than the EU19 and the EU27 because the deviations of the price and the marginal cost trends from the 45° line are smaller.

[11] The vertical axis for Estonia was incorrect in the first version of the paper, which led to wrong interpretation.

Figure (9) - the 45° line scatter plots – Australasia

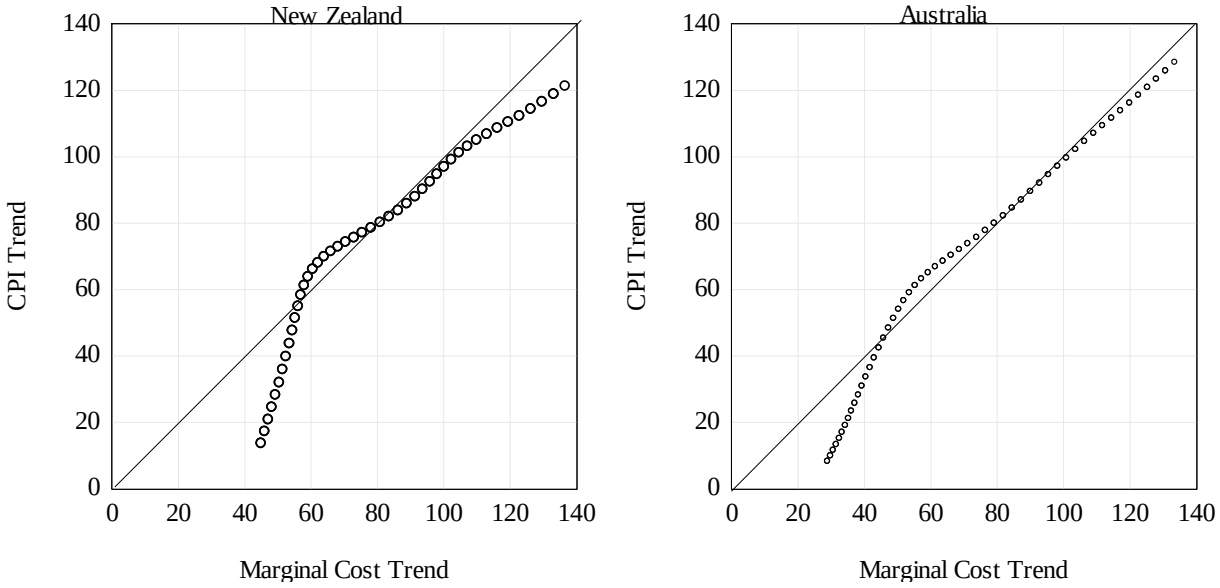


Figure (10) - the 45° line scatter plots – Asia

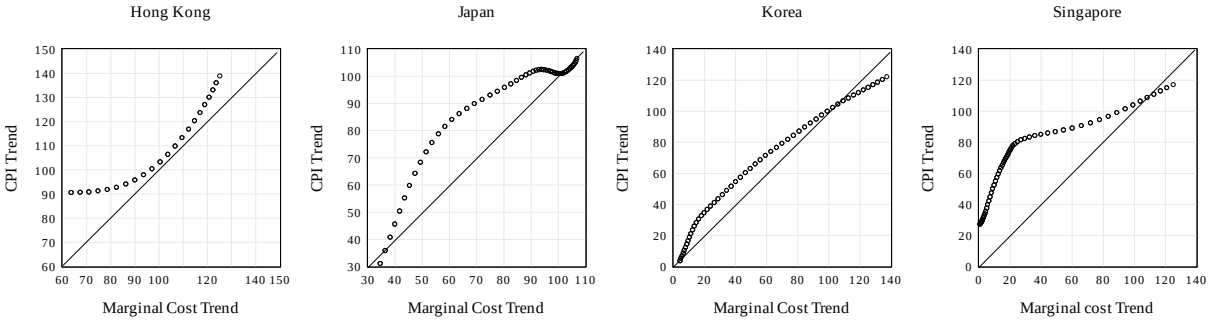


Figure (11) - the 45° line scatter plots – South America

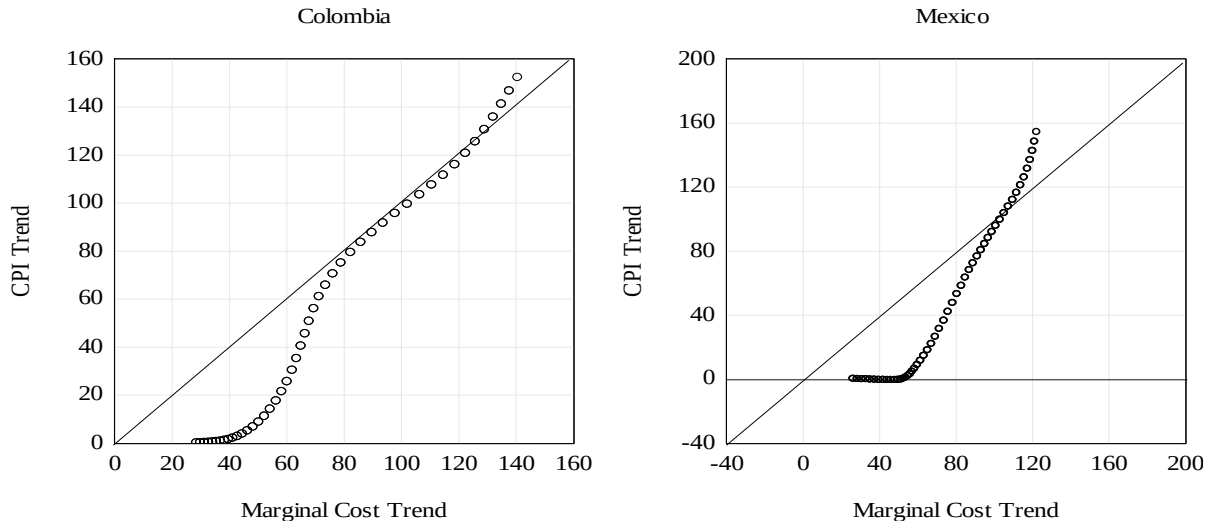
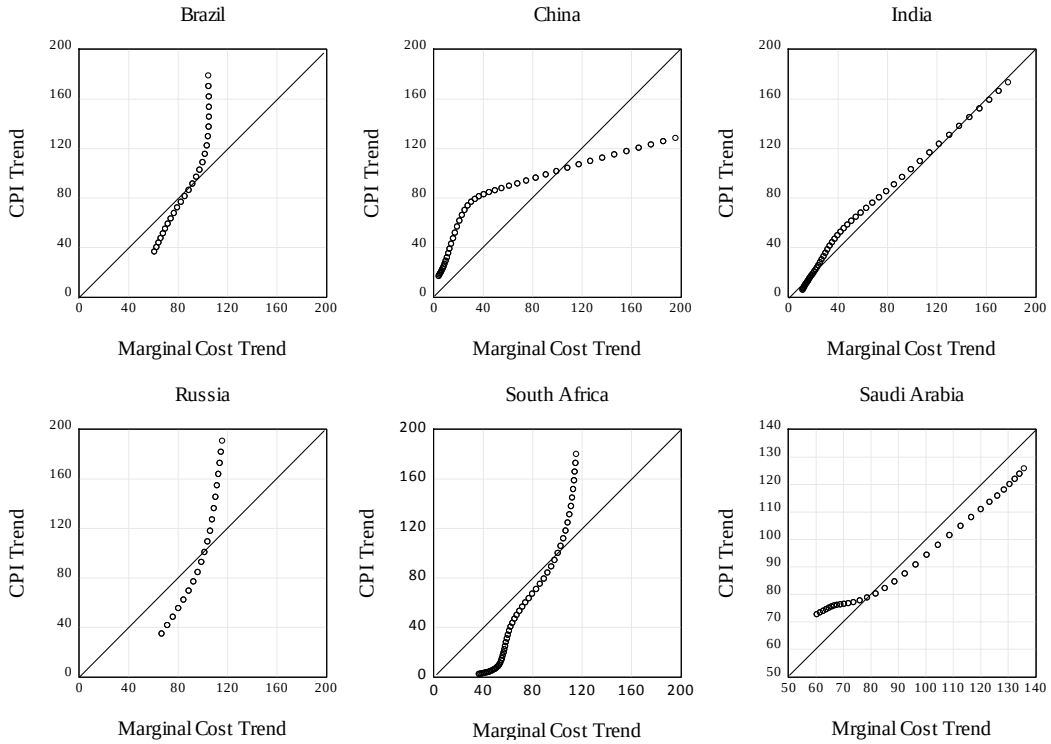


Figure (12) - the 45° line scatter plots – BRICS



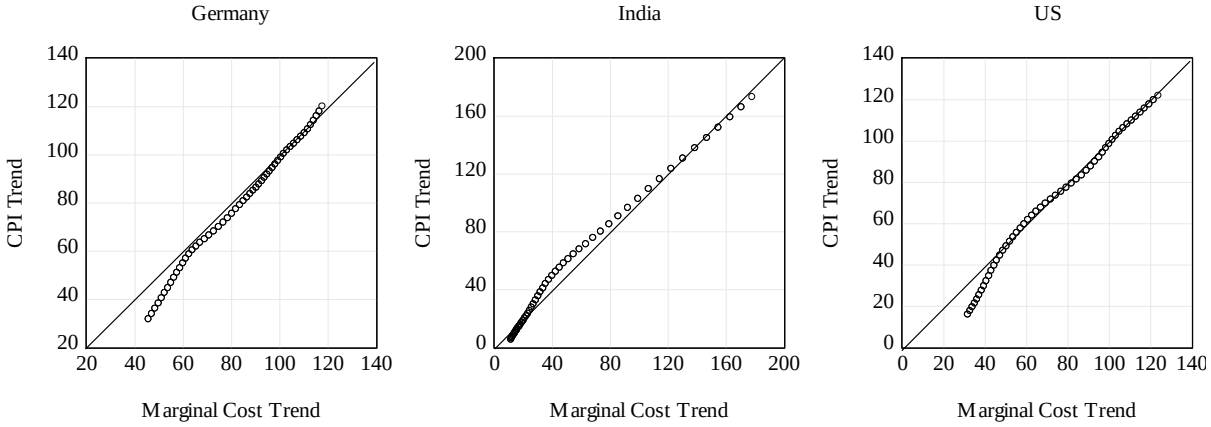
In figures (9), (10), and (11), Australia, New Zealand, the Asian countries, the two South American countries Colombia and Mexico, and the BRICS do not exhibit a stronger-form competition because of the large deviations of prices and marginal costs from the 45° line, except for India. India's price – marginal cost deviation from the 45° line is minimal. India and the US data seem to have the smallest deviations from perfect completion at the macro level. The South American two countries in our sample show very significant deviations from a stronger-form competition, where the price-marginal cost deviations from the 45° line are relatively large, and very significant differences from the US and Europe. Furthermore, Singapore, China, Russia, and South Africa plots seem atypical. The price – marginal cost deviations are very large and peculiar.

Policymakers in the rest of the world who are concerned about the state of competition in their economies should take this preliminary evidence when formulating policies. It would be a starting point for understanding the level of competition. Policies could be the main source of the wedge between prices and cost. For example, a tax on the prices of goods and services or a subsidy alters the equilibrium condition, i.e. increase and

decrease equilibrium market price. Monetary policy affects the real interest rate, i.e., the rental price of capital, which pushes the cost of production up and down, and creates a wedge between the price and the marginal cost. Trade barriers, oil price shocks, regulations etc. are all factors that could be tested.[12]

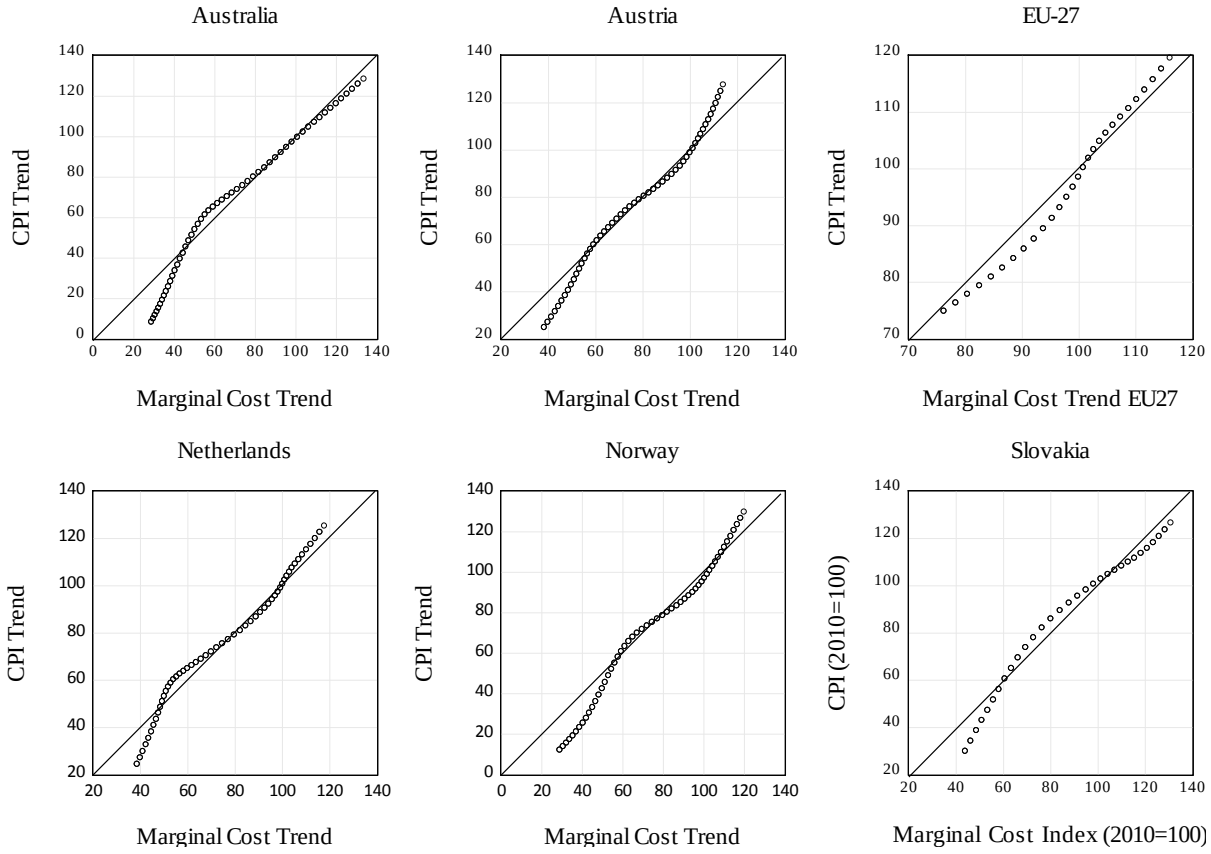
Based on these results, we identify two groups of countries. The first includes Germany, India, and the US, which seem to exhibit the least deviations of the price from the marginal cost in the sense that the CPI and, our measure of the marginal cost, the MCI are close to the 45° degree line. The second group includes Australia, Austria, the Netherlands, Norway, Slovakia, and the EU27, which have relatively lesser deviations than the first. Figure (13) depicts the first four countries together and figures (14) plot the second group of six countries, which have relatively larger deviations among all 43 countries.

Figure (13) – The Four Countries with the Stronger-Form Competition



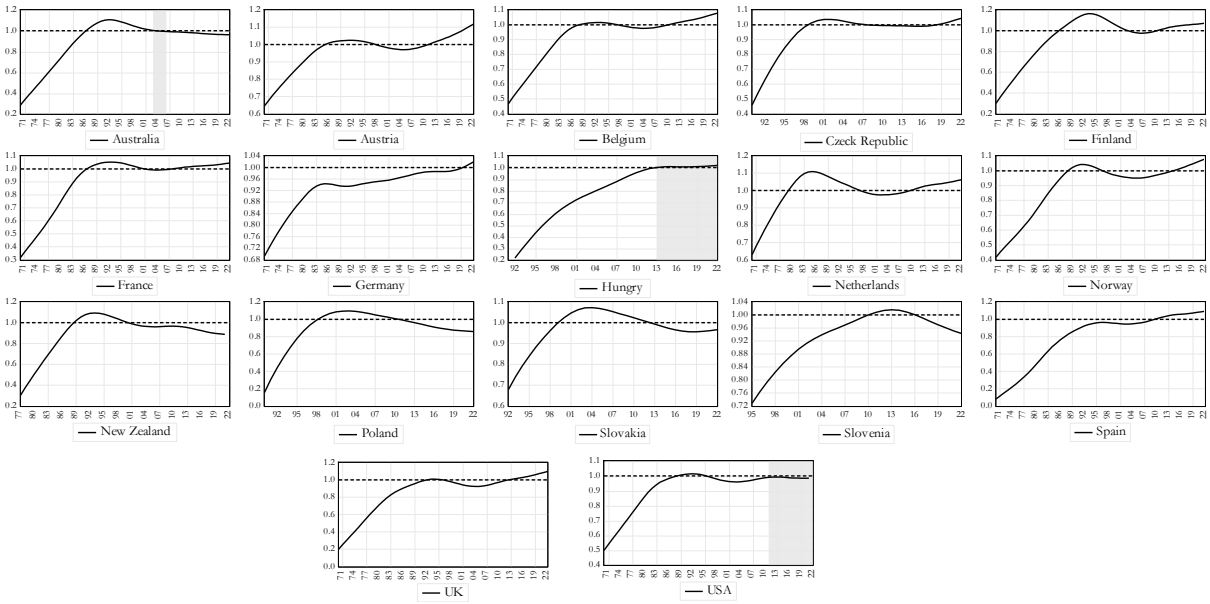
[12] There are two future research questions to be asked. First is to examine the industry level data, and the firm level data if available. The industry level data for the EU, the US and Japan are readily available. These micro data could show the location of the underlying lack of competitiveness and inefficiencies. Second is to explain the deviations from Perfect Competition.

Figure (14) – The Six Cases with Relatively Less Significant Strong-Form Competition



Loecker *et al.* (2020) using a different method and data suggested an increasing non-competitive pricing behavior and rising market powers in the U.S. The deviations from Perfect Competitions, or the price from the marginal cost, presented above are uninformative about non-competitive price setting and increasing market power because deviations of the price from the marginal cost are either > 1 or <1. Non-competitive price setting and monopoly power may exist only if the ratio $\frac{CPI}{MCI} > 1$. The ratio $\frac{CPI}{MCI} < 1$ implies a state of ineffciencies, i.e. the cost is higher than the price, does not imply market power. It might imply increasing inefficiencies, rising costs of production (i.e., labor cost, capital cost, raw material cost, etc), perhaps increasing regulations, government interventions, and increasing trade barriers etc. We plot the time series for the ratio $\left(\frac{CPI}{MCI}\right)_t$ by grouping the countries that have similar trends. We begin with the developed industrial countries, which have $\left(\frac{CPI}{MCI}\right)_t < 1$ from 1970, rising $\left(\frac{CPI}{MCI}\right)_t \to 1$ from below, and finally $\left(\frac{CPI}{MCI}\right)_t \geq 1$. Figure (15) plots the data.

Figure (15) – Group of Developed Industrial Countries with Similar $\left(\frac{CPI}{MCI}\right)_t$ Trends

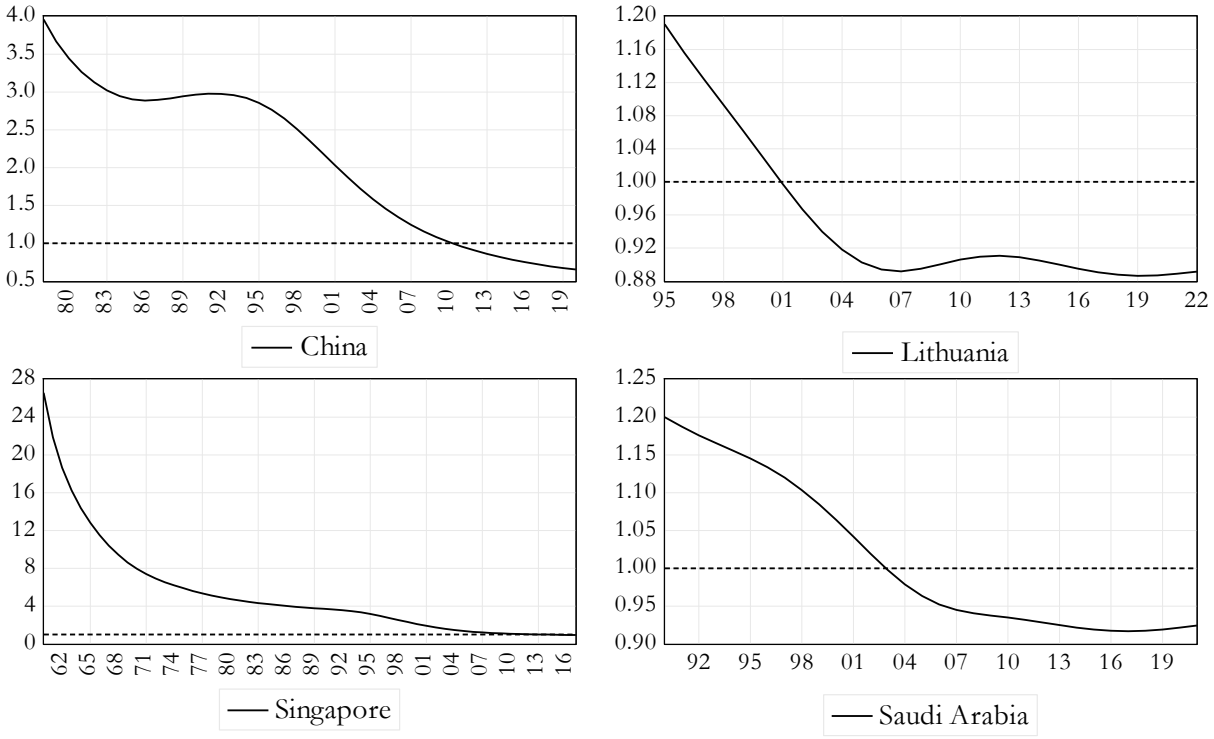


These 17 economies started from positions of $\left(\frac{CPI}{MCI}\right)_t < 1$ in the 1970s, which may reflect inefficiencies. Then ratios sloped upward $\rightarrow 1$, albeit exceeded 1 by the end of the sample in most cases. The speed at which the transitions from one state to another took place varied across countries; i.e. it took Germany a relatively longer time. Some countries' $\left(\frac{CPI}{MCI}\right)_t$ ratios fluctuated above and below 1 more than others, e.g., Austria, Belgium, Finland, France, the Netherlands, Norway, Spain and the U.K. By the end of the sample, the U.S. (2011-2022) and Hungary (2013-2022) stand out as relatively the closest to Perfect Completion. Australia has a very short period (2003-2006), where $\left(\frac{CPI}{MCI}\right)_t = 1$. These are the shaded areas in the graphs. Most countries in this group appear to have ended in a state of an increasing non-competitiveness (i.e., increasing monopolistic behavior), except two countries, which have drifted slowly and slightly into a state of inefficiencies, where $\left(\frac{CPI}{MCI}\right)_t < 1$ such as New Zealand.

There are four countries in the sample (China, Lithuania, Singapore, and Saudi Arabia) whereby the $\left(\frac{CPI}{MCI}\right)_t$ ratios have the opposite trends of the countries plotted above.

These countries started from a strong non-competitiveness position early in the sample, whereby $\left(\frac{CPI}{MCI}\right)_t > 1$, and then the ratio declined slowly and smoothly towards 1, but $\left(\frac{CPI}{MCI}\right)_t$ crossed the line to below 1, much earlier in time in Lithuania and Saudi Arabia than China. The transition from a state of strong non-competitiveness towards a state of competitiveness, even though overshooting is impressive. Singapore, however, stopped at $\left(\frac{CPI}{MCI}\right)_t$ =0 in 2007 and never descended below 1. Its relatively highly regulated economy notwithstanding, the fast transition towards a more competitive economy is very impressive. The data are plotted in figure (16).[13]

Figure (16) - $\left(\frac{CPI}{MCI}\right)_t$ for China, Lithuania, Singapore, and Saudi Arabia

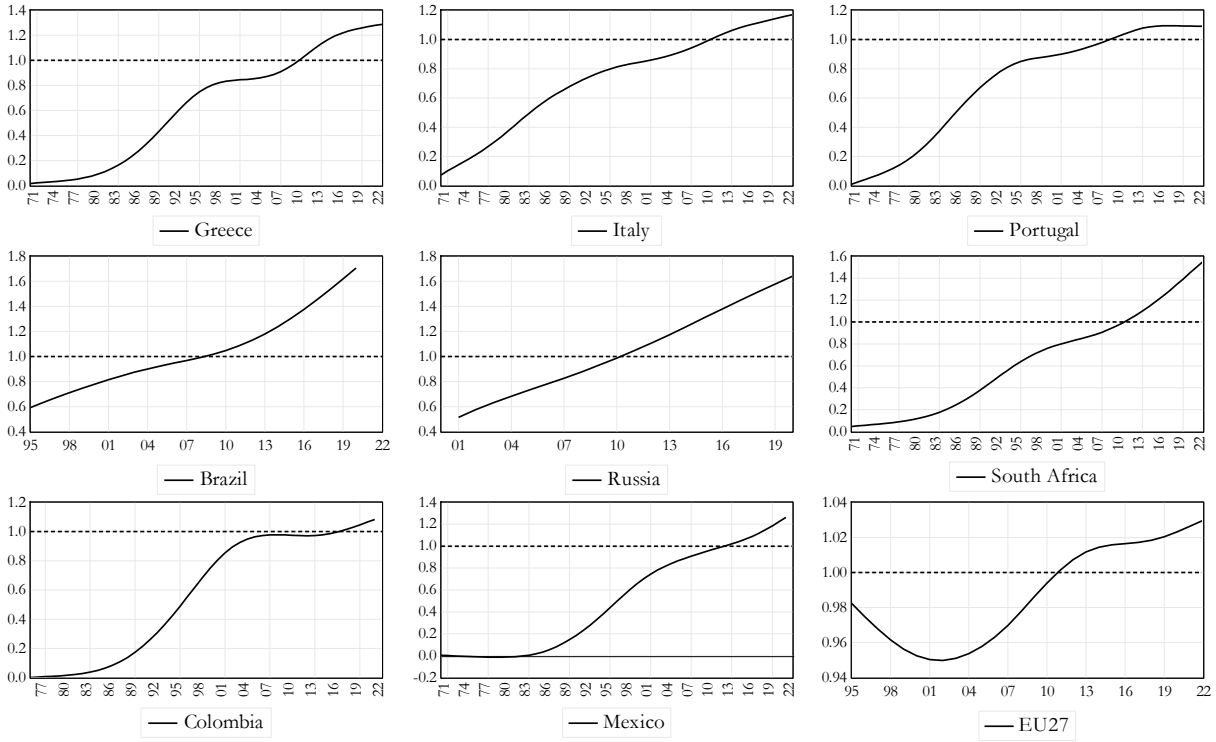


The third group of countries includes three EU members (Greece, Italy, and Portugal), three BRICS (Russia, Brazil, and South Africa), and two South American countries (Colombia, and Mexico). The EU shares the same trend. They experienced fast and steady, but variable transition from a state of inefficiencies, high costs of production,

[13] China and Singapore $\left(\frac{CPI}{MCI}\right)_t$ ratios stand out as relatively significantly large in magnitudes because the marginal costs are below prices over a long period as we noted earlier.

more regulations, and trade barriers where $\left(\frac{CPI}{MCI}\right)_t < 1$ to a state of strong non-competitiveness, whereby $\left(\frac{CPI}{MCI}\right)_t > 1$; Greece, Italy, Russia, South Africa, and the EU transitioned in 2010, Portugal in 2007, Brazil in 2008, Mexico in 2012, and Colombia in 2017. Colombia has the closest $\left(\frac{CPI}{MCI}\right)_t$ to 1 at the end of the sample. Figure (17) plots the $\frac{P}{MC}$ ratio of these countries, and the EU27 (EU19 has the same trend).

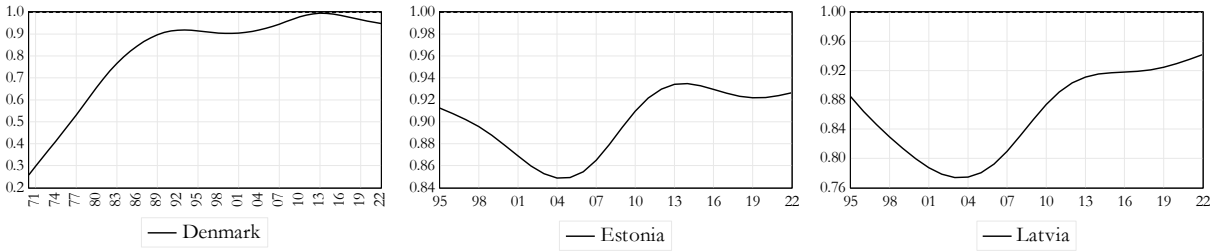
Figure (17) - $\left(\frac{CPI}{MCI}\right)_t$ Group of Countries with Fast Transition to Non-Competitiveness



There are three EU countries, Denmark, Estonia and Latvia, which have $\left(\frac{CPI}{MCI}\right)_t < 1$ over the entire sample. Denmark, Estonia and Latvia remained in a state of inefficiencies.[14] Figure (18) plots the ratios. Unlike Estonia and Latvia, the Denmark ratio moves faster towards one, albeit stays below one over the sample.

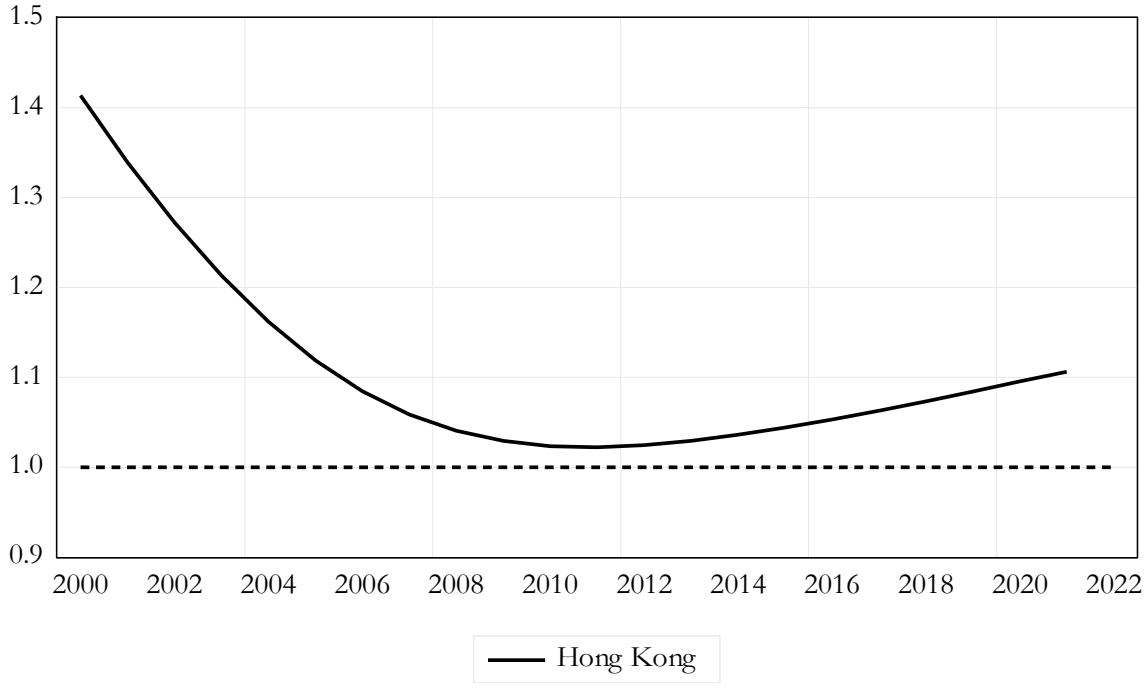
[14] There was a mistake in the vertical axis of the scattered plot of Estonia in the first version of this paper.

Figure (18) – Three European Countries with $\left(\frac{CPI}{MCI}\right)_t < 1$ Throughout



Opposite trend to the three European countries is Hong Kong with $\left(\frac{CPI}{MCI}\right)_t > 1$ over the entire sample, figure (19) plots the ratio. The ratio declined towards 1, never equaled one, and reversed direction again. This >1 convex shape suggests that Hong Kong has a strong non-competitiveness.

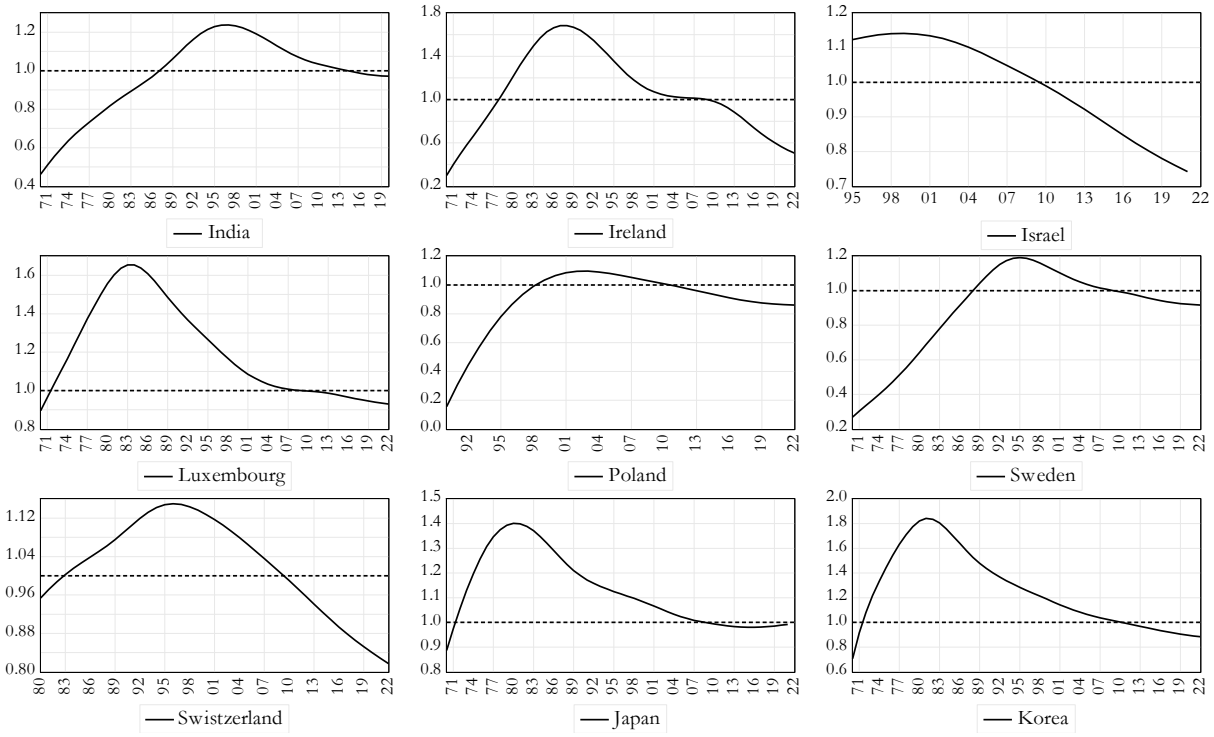
Figure (19) – Hong Kong in a State of Non-Competitiveness Throughout



Finally, there is a group of countries whose $\left(\frac{CPI}{MCI}\right)_t$ ratios have hump-shapes, from states of inefficiencies, to non-competitiveness, to states of inefficiencies again. Across the countries, the humps vary and so are the steepness of, and the deepness of the plunges. This group includes India, Ireland, and Israel. India and Ireland ratios began rising toward one in the 1970s. India reached the peak of the hump in 1997; Ireland reached a much higher peak in 1987. Then the ratios began falling with India not descending as fast

as Ireland. India is in a state closer to competitiveness than Ireland. Israel's sample is smaller; the ratio was > 1 from 1995 to 2009, and falling very fast. Luxembourg's peak is as high as Ireland while Poland and Sweden peaks are as high as India and relatively smaller peaks than Luxembourg. All of these countries' ratios are lower than 1 by 2022. Switzerland's ratio was slightly below 1 in 1980, climbed fast and reached a peak close to that of Sweden at the same time in 1995, but it dropped much faster and deeper into a state of inefficiencies. It remained above 1 from 1983 to 2009. The Luxembourg ratio remained above 1 much longer, from 1971 to 2006. Finally in the group are Japan and Korea, which have a similar picture. In both countries, the $\left(\frac{CPI}{MCI}\right)_t$ ratio was slightly under 1 in 1970, rose to a higher peak in Korea in 1981, then plunged to below 1, but Japan remained closer to a state of competitiveness than Korea.

Figure (20) – Group of Countries with Distinct Humped Shaped $\left(\frac{CPI}{MCI}\right)_t$



6. Conclusion

One of the pillars of free market philosophy is perfect competition. The idea is that the market is populated by a large number of firms producing homogeneous goods, and services. The size of each firm is relatively small such that it cannot set the price, hence a

price taker. These firms compete in order to make profits. When the price exceeds the marginal cost, they make profits and that would motivate more production and more firms to enter the market. The opposite is true. Firms would exit from the market if they cannot cover the marginal cost, i.e. when the price is below the marginal cost. There are clearly adjustments to be made to production over the short run, which all firms do. In the long run, the price is supposedly equal to the marginal cost, and there would be no entry and no exit in the steady state.

In this paper we confronted this microeconomics theory with macroeconomics data from 43 countries. We used annual data for the CPI as a measure of the price level. We assumed a quadratic total cost function and computed the derivative as a simple measure of the marginal cost. We postulated and tested two forms of Perfect Competition, a weak-form and a strong-form. Since Perfect Competition is a long-run steady-state condition, the weak-form exists if the price and the marginal cost are cointegrated. In a simple term, they share a common trend in the long run. We found more evidence for it in the data. Our bi-variate Engle-Granger (1987) one of three tests suggested by Engle and Granger rejected the null hypothesis that the price level and the marginal cost are not cointegrated in almost all countries. The ADF test of the residuals of the level regressions of the price level on the marginal cost strongly rejected the null hypothesis of no cointegration in 34 cases. However, the most powerful test, which is an ECM, rejected the null of no cointegration in 16 cases. Therefore there exists a significant amount of support in the macroeconomics data for a weak-form of Perfect Competition.

A stronger-form of competition exists only if the price level is *equal* to the marginal cost in the long run. In equilibrium, the marginal revenue is equal to the marginal cost. We plot a simple nonparametric 45° line scatter plot of the price level and the marginal cost trends. The trends are obtained from the HP filter. We could only find four countries, where such Perfect Competition holds in macro data. Germany, India, and the U.S. are the most competitive economies in the sense that the deviations from the 45° line are the smallest. There is some evidence that Hungry also has very small deviations at certain segments along the 45° line. There are relatively less competitive economies, where the

deviations from the 45 line are slightly larger. These are Australia, Austria, the Netherlands, Norway, Slovakia, and the EU-27.

The deviations of prices from marginal costs from the 45° line, however, could be either $CPI > MCI$ or $CPI < MCI$ over the sample. Each deviation bears a different macroeconomic interpretation. We plotted the time series $\left(\frac{CPI}{MCI}\right)_t$. We found only three cases, where $\left(\frac{CPI}{MCI}\right)_t \approx 1$; these are the U.S. (2011-2022), Hungry (2013-2022), and Australia (2003-2006). We interpreted ratios of $\left(\frac{CPI}{MCI}\right)_t > 1$ to imply non-competitiveness and monopoly power (market power). And, we interpret $\left(\frac{CPI}{MCI}\right)_t < 1$ to describe the state of more inefficiency. Inefficiency could arise from more regulations, and more government interventions in the market. Fiscal, monetary, and trade policies, among others, nudge goods and factor input prices away from equilibrium. For example, in the long-run, taxes on goods and services, on factor input such as land, raw materials, or wages etc. could affect the price level and the marginal cost of producing an extra unit of output. Monetary policy affects the real interest rate (the rental price of capital), thus affecting the cost of producing one additional unit of output. Equally, a minimum wage policy could affect production cost. Tariffs affect prices and push them away from marginal cost.

We found that most of the developed countries $\left(\frac{CPI}{MCI}\right)_t$ ratios to exhibit prolonged periods of inefficiencies in the 1970s, 1980s, and the 1990s, however, all ratios were steadily and slowly rising, albeit at different speeds, towards a state of more efficiency, but finally most of them overshot unity and ended up in a state of non-competitiveness.

Countries with very fast transitions from states of inefficiencies to states of non-competitiveness include three EU countries, Greece, Italy, and Portugal; three BRICS countries Brazil, Russia, and South Africa; and Colombia and Mexico. The ratio $\left(\frac{CPI}{MCI}\right)_t$ is a straight line rising from less than 1 to higher than 1.

In contrast, China, Lithuania, and Saudi Arabia data started off from a state of extreme non competitiveness, i.e. $\left(\frac{CPI}{MCI}\right)_t > 1$, and moved towards competitiveness is remarkable even though Lithuania and Saudi Arabia ended up in states of inefficiencies. The fact that the Chinese, but more so the Singaporean economy, transitioned to more competitive economies, albeit slowly, is very impressive. Furthermore, we identified three European countries in states of inefficiencies throughout the sample: Denmark, Estonia, and Latvia. Unlike Estonia and Latvia, the Denmark $\left(\frac{CPI}{MCI}\right)_t$ ratio moves faster towards one, albeit stays below one over the sample.

There is a group of countries whose $\left(\frac{CPI}{MCI}\right)_t$ ratios have hump-shapes, from states of inefficiencies, to non-competitiveness, to states of inefficiencies again. Across the countries, the humps vary and so are the steepness of, and the deepness of the plunges. This group includes India, Ireland, and Israel. India and Ireland ratios began rising toward one in the 1970s. India reached the peak of the hump in 1997; Ireland reached a much higher peak in 1987. Then the ratios began falling with India not descending as fast as Ireland. India is in a state closer to competitiveness than Ireland. Israel's sample is smaller; the ratio was > 1 from 1995 to 2009, and falling very fast. Luxembourg's peak is as high as Ireland while Poland and Sweden peaks are as high as India and relatively smaller peaks than Luxembourg. All of these countries' ratios are lower than 1 by 2022. Switzerland's ratio was slightly below 1 in 1980, climbed fast and reached a peak close to that of Sweden at the same time in 1995, but it dropped much faster and deeper into a state of inefficiencies. It remained above 1 from 1983 to 2009. The Luxembourg ratio remained above 1 much longer, from 1971 to 2006. Finally in the group are Japan and Korea, which have a similar picture. In both countries, the $\left(\frac{CPI}{MCI}\right)_t$ ratio was slightly under 1 in 1970, rose to a higher peak in Korea in 1981, then plunged to below 1, but Japan remained closer to a state of competitiveness than Korea.

The results are informative. The microeconomic equilibrium condition that the price level is equal to the marginal cost in the long run holds in fewer countries during specific

short periods. More economies exhibit a weaker form of Perfect Competition, where the price level and the marginal cost only share a common trend in the long run. The results could inform the policymaker on the state of competition in their economies. There is very weak and short-lived evidence for stronger-form of competitions and for Perfect Competition. Future research should be testing the industry data, which would give the policymaker more information about the source of inefficiency in the economy.

References

Acemoglu, Daron. (2009). Introduction to Modern Economic Growth. Princeton, New Jersey Oxford: Princeton University Press. ISBN 978-0-691-13292-1.

Christiano, Lawrence J. and Terry J. Fitzgerald. (2003). The Band Pass Filter, International Economic Review, 44(2), 435-465

Cochrane, J. (1991). Comments, NBER Macroeconomics Annual. MA. USA

Dickey, D.A. and W.A. Fuller. (1979). Distribution of the Estimators for Autoregressive Time Series with a Unit Root, Journal of the American Statistical Association, 74, 427–431

Elliott, Graham, Thomas J. Rothenberg and James H. Stock. (1996). Efficient Tests for an Autoregressive Unit Root, Econometrica 64, 813-836

Engle, Robert F. and C. W. J. Granger. (1987). Co-integration and Error Correction: Representation, Estimation, and Testing, Econometrica, 55, 251–276

Gonzalo, J., (1994). Five Alternative Methods of Estimating Long-Run Equilibrium Relationships, Journal of Econometrics, Vol.60 issue 1-2, 203-233.

Hall, Robert. (1988). The Relation between Price and Marginal Cost in U.S. Industry, Journal of Political Economy, Vol. 96, Issue 5, 921-47

Hodrick, R. J. and E. C. Prescott. (1997). Postwar U.S. Business Cycles: An Empirical Investigation," Journal of Money, Credit, and Banking, 29, 1–16

Kapetanios, George, Yongcheol Shin, and Andy Snell. (2003).Testing for a unit root in the nonlinear STAR framework, Journal of Econometrics, Volume 112, Issue 2, 359-379, ISSN 0304-4076, https://doi.org/10.1016/S0304-4076(02)00202-6

Kremers, J.J.M., N. R. Ericsson, and J.J. Dolado. (1992). The Power of Cointegration Tests, Oxford Bulletin of Economics and Statistics, Vol. 54, Issue 3, 325-348

Kwiatkowski, Denis, Peter C. B. Phillips, Peter Schmidt & Yongcheol Shin. (1992). Testing the Null Hypothesis of Stationary against the Alternative of a Unit Root, Journal of Econometrics, 54, 159-178

Loecker, J DE, J. Eeckhort, and G. Unger. (2020). The Rise of Market Power and the Macroeconomic Implications, Quarterly Journal of Economics, Vol. 135, issue 2, 561-644

MacKinnon, James G. (1996). Numerical Distribution Functions for Unit Root and Cointegration Tests, Journal of Applied Econometrics, 11, 601-618.

Mas-Colell, Andreu, Whinston, Michael D. and Green, Jerry R. (1995). Equilibrium and its Basic Welfare Properties, Microeconomic Theory, Chapter 16, Oxford University Press, ISBN 978-0-19-510268-0

Ng, Serena and Pierre Perron. (2001). Lag Length Selection and the Construction of Unit Root Tests with Good Size and Power, Econometrica, 69, 1519-1554

Phillips, P.C.B. (2003). Laws and Limits of Econometrics, Economic Journal, 113 (486), C26 - C52

Phillips, P. C. and Ouliaris, S. (1990). Asymptotic properties of residual based tests for cointegration, Econometrica: Journal of the Econometric Society, 165–193

Phillips, P.C.B. and P. Perron. (1988). Testing for a Unit Root in Time Series Regression, Biometrika, 75, 335–346

Rudebusch, G. (1993). The Uncertain Unit Root in Real GNP, American Economic Review, Vol. 83 (March), 264-72

Said, Said E. and David A. Dickey. (1984). Testing for Unit Roots in Autoregressive Moving Average Models of Unknown Order, Biometrika, 71, 599–607

Smith, Vernon, L. (1962). An Experimental Study of Competitive Market Behavior, Journal of Political Economy, Vol.70, Issue 2, 111-137

Stiglitz, Joseph E. (1994). Whither Socialism*?*, MIT Press, ISBN 978-0-262-69182-6