Empirical Investigations on a Classical Demand Pull - Supply Resistance Inflation Model

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Abstract

This paper tests empirically an alternate approach toward inflation based on a Classical/Marxian Political Economy approach. Conventional theories, either Monetarists or Keynesians, relate inflation to full-employment driven supply hindrances. If the economy is at, or around, such full-employment level, any increase in the aggregate demand would barely be attended by a sticky supply. And that would lead to pressures on the general prices. This understanding has been challenged by historical events; such as the main economies' stagflation trends, and the developing countries low-growth, high-inflation processes. If, however, one drops the full-employment assumption and considers capitalist economy as a self-expanding system, the rate of profit becomes the limit to growth. This, in an endogenous money supply framework, gives rise to a supply-resistance/demand-pull inflation. We test it for ten different countries showing the relevance of such approach.

Resumo

Este artigo testa empiricamente uma abordagem alternativa de inflação baseada numa abordagem da Economia Política Clássica/Marxiana. Teorias convencionais, Monetaristas ou Keynesianas, relacionam inflação às barreirasde oferta dadas pelo pleno-emprego (PE). Se a ecoomia está no ou ao redor do PE, qualquer crescimento de demanda agregada não seria respondida por uma oferta rígida, levando a alta de preços. Este entendimentoi tem sido posto em questão pelos evntos históricos – como as ondas de estagflação e o padrão de baixo-crescimento, alta-inflação de países em desenvolvimento. Se a hipótese do PE é abandonada, e se considera a economia capiltalista como sendo um sistema auto-expansivo, a taxa de lucro torna-se o limite ao crescimento. Com oferta de moeda endógena, isso gera um modelo de inflação de tipo demand-pull, supply-resistance. Nós testamos tal modelo para dez diferentes países, mostrando a relevância de tal abordagem alternativa.

1. Introduction

This article intends to empirically test an alternate inflation theory beased upon the classical political economy tradition. Such theory put together central elements of the classical political economy tradition: Injections of excess demand into the commodity market only exert (persistent) pressures over prices in the presence of supply resistance, or growth (capital accumulation) stiffness (Shaikh, 2001, 2012). This gives rise to a demand-pull/supply-resistance model of inflation. But differently from mainstream theories, such resistance is not given by full employment of factors, either labor or capital.

Elaborating on Marx's schemes of expanding reproduction, it is possible to derive that a capitalist economy maximum growth rate is reached when all surplus value is reinvested (Marx, 1978). At this point, such growth rate equals the rate of profit. To show Shaikh drawn on a Harrodian warranted path with a Kaldorian-classical savings function. Its investment-savings identity, $I = S = s_c * P$, would imply the following warranted rate of capital accumulation: $g_k = I/K = s_c * P/K = s_c * r$, where I, S, P and K stand respectively for the aggregate (normal capacity) amounts of investments, savings, overall profits and capital stock; r and s_c are thus the normal-capacity rate of profit and the capitalists propensity to save (and thus to invest; i.e. it is the capitalization rate). When the latter is one, $s_c = 1$, all profit is saved (recommitted to production) and therefore the warranted growth rate reaches its maximum level (Shaikh, 1999). Notice then s_c – ranging from zero to one – can be interpreted as a measure of how close the economic activity is from its limit. In this sense s_c can also be seen as a stiffness measure of the movement of inputs and outputs through the production process. Thus, Shaikh calls it thus the ***throughput coefficient***, henceforth, "τ". Its theoretical meaning, structural dynamics and consequences on inflation will be elaborated further over the sections of this chapter.

As it follows, the classical perspective we intend to test here leads to a breaking out of the straightjacket assumptions usually found in most traditional inflation theories. Those conventional assumptions can be summarized in three main orthodox-mainstream hypotheses (i) the neutrality-exogeneity of money; (ii) the full utilization of productive factors and (iii) the steady-state, balanced, growth (which also includes here most traverse analysis theories).

We disregard the first of those traditional assumptions on the grounds that money is understood here as being endogenously created, according to the needs of circulation. If for any reason its supply exceeds such needs, it will take the form of idle money and be deviated from circulation toward hoarding activities, with no direct effect on inflation. Then, as far as prices are concerned, net injections of purchasing power may only be inflationary when it goes to the commodity markets and only when there are mismatches between supply and demand in those markets. Such injections will only put pressures over prices whenever capital expansion (and thus potential supply) is reaching its limit. Here, according to the second traditional assumption such limit would be due to supply rigidities that are either automatic (Neoclassical) or sporadic (Keynesian) due to scarcity of factors -- labor and raw-material/equipments. But such factors scarcity story cannot be traced back from the classical political economy of the XIX century.

Instead, the classical approach to the problem of growth limit in potential supply could well be traced back through Marx's explanation – which was later re-discovered by von Neumann: "the maximum growth rate in any self-reproducing system is equal to the profit rate" (Kurz, 1995, pp. 383-384; quoted from Shaikh, 2012, p. 67).

Marx ruled out the physical/technical (scarce factors) rigidity argument by pointing out that firms can be quite flexible to expand capacity and employment through a couple of measures such as extending the working day, using the reserve army of labor, drawing on stocks of inventories, importing, etc. While capital is self-expanding its accumulation is profit-driven. One can say hence that under a classical standpoint, rather than full employment of factors, the limit to grow is given by the rate of profit; and as we have just seen, that can be measured by the ***throughput coefficient***.

A classical model like this would require thus two main variables: (i) the growth of bank credit to commodity market plus the net exports (or current account) as a proxy to the growth of excess demand; and (ii) the throughput coefficient as the classical growth-capacity gauge -- instead of the Neoclassical/Keynesian full employment-capacity. The interplay between the two can be expressed by a multiplicative interactive variable.

The theory also elaborates on a Sraffian multi-sector commodity production scheme to explain the nonlinear (quadratic) behavior of the throughput over inflation – which is explained by bottlenecks pervasive effects (Handfas, 2012). In the presence of injections of excess demand, the higher the throughput the stiffer would be growth, then the harder would be for supply to catch up with demand and the faster prices would tend to rise.

In order to help evaluating the validity of such theoretical framework, we seek to test here three of its main aspects. First, we want to know how well inflation can be explained by such combination of demand-pull and supply-resistance forces – i.e. how well the interactive variable works. Second, we need to check if the supply-resistance nonlinearity (quadratic form) fits well to the real data in different countries and periods. Third, we still intend to check whether the throughput is the best supply-resistance gauge – we will then compare it to other two, typically mainstream, growth limit measures: employment and capacity utilization. In order to undertake those tests, we have gathered datasets from ten different countries – seven OECD and three developing economies – most of them with time series ranging from the 1950's or 1970's up to date.

In the following sections of this article, we will set up first the model specification and discuss the econometric methodology to be adopted. Next we will present the dataset and the way the variables were constructed for each country. Finally we show the test results for each country with both its long-run, simplified version and its final, unrestricted, chosen regression which is calibrated to external shocks and inflationary memory. A discussion on historical elements may be briefly introduced for better interpret the results. We will also address a few special topics: the nonlinearity of the throughput function, the deflation/liquidity trap issue -- comparing the USA and Japan – and possible policy implications.

Lastly we intend to shed light on the comparison of the results we get here with other, more mainstream, theories. The traditional limit gauges will then be tested and compared with the throughput for the OECD countries.

There is no reason though to take for granted a linear and straightforward relationship between these two variables and inflation, as the third orthodox assumption would lead us. Because real growth is always unbalanced, capital accumulation brings about a turbulent and very frequently uneven system in which different industry branches might grow at different rates. Moreover, industries have different rates of profit, throughput coefficients and thus growth limits. Let us say in one industry firms are reinvesting almost all of their extracted surplus value (very high throughput). They cannot grow anymore, even if facing with a relentlessly increasing demand for its output -- due to other industry(ies) higher growth limits (higher rate of profit and thus lower throughput). A bottleneck in that more "tightened" sector will be formed, putting pressures over its price. More importantly, the bottleneck might have a domino effect leading in the last instance the whole system to a halt. That means the most tightened sector imposes the ultimate limit for the economic activity and therefore the ultimate pressures over general prices. Note that the bottleneck formation had no necessary relation with any particular production factor shortage but, instead, it reflects profitability trends.

2. Model Specifications

We intend to test in this chapter a classical inflation model. (Shaikh, 2011; Handfas, 2012). A straightforward representation of such model would look like

$$\pi_t = \alpha + e_t F[\text{limit}] \qquad (1)$$

where, π, α, e and F[limit] stand for inflation, a constant term, excess demand and a function of the growth limit. That model represents the long run relationship between inflation, and the nonlinear combination of demand-pull / supply-resistance forces which are respectively proxy through net injections of excess demand, e, and the throughput coefficient, τ.

The throughput coefficient is a classical/marxian gauge of supply resistance. It is he economy average throughput bears a non-linear, quadratic, behavior. So such overall relationship can be expressed as

$$\pi_t = \alpha + e_t[-\beta\, \tau_t + \gamma\, \tau_t^2\,] \qquad (1.1)$$

The coefficients β and γ are both greater than zero granting the inflation-growth limit (throughput) function a U-shape curve – as suggested by the inter-industry bottlenecks dynamics elaborated in the previous chapter.

The main goal of this chapter is therefore to test how adequate such theoretical framework – roughly summarized by equation (1.1) -- explains actual inflation in different economies and periods. To do so we need to test the significance of equation (1) parameters as well as its overall fit for the long run. We also intend to calibrate it to the shorter run fluctuations and external shocks.

In order to pursue those goals, we need first to set up an appropriate econometric methodology to be fostered and unfolded.

2.1. ADL Model and Long Run Relationship

Equation (1.1) shows the long run dynamics of the variables' relationship predicted at a general theoretical level of abstraction by our classical postulates. A more concrete analysis would require though two complementary devices. On the one hand, depending on the economy structural features, those throughput/excess demand forces can be more or less persistent. Production takes time and sector bottlenecks (or gluts) may be more or less resilient to be overcome. That means in the long run not only one, but perhaps a few periods "e" and "τ" values can impact current inflation, so that

$$\pi_t = \alpha + \Sigma[e_{t-j}(-\beta_j \tau_{t-j} + \gamma_j \tau_{t-j}^2)] \qquad (1.2)$$

On the other hand, one needs to aknowledge that in the short run other factors, even if theoretically less important, would also impact such relation. Exogenous shocks might transiently disrupt that long-run path. They are to be captured by the error term of the equation, ε_t . The resilience of those external shocks depends upon the economy inflationary memory, or momentum – and that varies not only with countries but also with historical periods. The constant term β_0 is supposed to partly account for such inertial inflation, π_{t-i} . Let then $\alpha = a + \alpha_i \pi_{t-i}$.

In this model, as in any stationary system, an external shock would have a higher impact on the current or next period inflation and then start to lose momentum over the following periods until it fades completely away. The speed of such adjustment equals thus to $(1 - \alpha_i)$; where $0 < \alpha_i < 1$. Therefore, in a more short-run form our relationship could be expressed by an autoregressive distributed lag (ADL) model of the type:

$$\pi_t = a + \alpha_i \pi_{t-i} + \Sigma[e_{t-j}(-\beta_j \tau_{t-j} + \gamma_j \tau_{t-j}^2)] + \varepsilon_t \qquad (2)$$

This can be more properly rewritten as:

$$\pi_t = a + \alpha_1 \pi_{t-1} - \sum_{i=0}^{n} \beta_i x_{t-i} + \sum_{i=0}^{p} \gamma_i z_{t-i} + \varepsilon_t \qquad (3)$$

where x and z are the multiplicative variables: $x = e^*\tau$ and $z = e^*\tau^2$. Note that the momentum term in equation (3) accounts only for the previous year inflation – again, this is only for simplifying our presentation; one can easily generalize the model for higher autoregressive orders[1].

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[1]
$$\pi_t = a + \sum_{i=1}^{m} \alpha_i \pi_{t-i} + \sum_{i=0}^{n} \beta_i x_{t-i} + \sum_{i=0}^{p} \gamma_i z_{t-i} + \varepsilon_t$$

where m, n and p would be the lag lengths of π, x and z. We also can say that, for economic coherence's sake, n=p so that the U-shaped curve of the throughput function is present in any time-lag order.

2.2. Stationarity, the ECM and the long run relationship

In order to set up a model that can test the classical theory expressed by equations (1) through (3), one needs to take into account a few econometric problems. As π, x and z are economic variables that change in time, it would not be surprising if it is found out non-stationarity in their behavior, which would compromise the estimators and the whole regression. One then needs to make sure that the roots of each of the three variables' auto-regressive vectors lie outside the unit circle. This could be tested with an Augmented Dickey-Fuller procedure for unit root test. However the power of an ADF test is weak (Hamilton, 1994, p.321).

That just makes it more appealing for us to set up an Error Correction Model (ECM) parametrization of the (equation [3]) ADL model. The ECM method allows us to make sure that the model is co-integrated in case of unit root -- in the case that all variables have unit root, say I(1) but share a common trend. By co-integrating them the model itself becomes stationary I(0). Accordingly we can then rewrite equation (3) through a Bewley transformation (Patterson, p 351-4) such as:

$$\pi_t - \pi_{t-1} = a + (\alpha_1 - 1)\pi_{t-1} + \sum_{t=0}^{n}\beta_i x_{t-i} + \sum_{t=0}^{n}\gamma_i z_{t-i} + \sum_{t=0}^{n}\beta_i x_{t-i-1} - \sum_{t=0}^{n}\beta_i x_{t-i-1} + \sum_{t=0}^{n}\gamma_i z_{t-i-1} - \sum_{t=0}^{n}\gamma_i z_{t-i-1} + \varepsilon_t$$

Rearranging that further will give us

$$\Delta\pi_t = a + (\alpha_1 - 1)\pi_{t-1} + \sum_{t=0}^{n}\beta_i x_{t-i-1} + \sum_{t=0}^{p}\gamma_i z_{t-i-1} + \sum_{t=0}^{n}\Delta\beta_i x_{t-i-1} + \sum_{t=0}^{p}\Delta\gamma_i z_{t-i-1} + \varepsilon_t$$

and then,

$$\Delta\pi_t = \sum_{t=0}^{n}\Delta\beta_i x_{t-i-1} + \sum_{t=0}^{p}\Delta\gamma_i z_{t-i-1} + \varepsilon_t + (1-\alpha_1)\left[-\pi_{t-1} + \frac{a}{1-\alpha_1} + \sum_{t=0}^{n}\frac{\beta_i}{1-\alpha_1}x_{t-i-1} + \sum_{t=0}^{p}\frac{\gamma_i}{1-\alpha_1}z_{t-i-1}\right] \quad (4)$$

If either the three variables, π, x and z, are stationary, I(0), or if they share a common trend, being each I(1), then the (equation [4]) ADL is stationary -- which means in the long run

$$\Delta\pi_t = \sum_{t=0}^{n}\Delta\beta_i x_{t-i-1} + \sum_{t=0}^{p}\Delta\gamma_i z_{t-i-1} + \varepsilon_t \qquad (5)$$

And for that, ε_t needs only be a stochastic error, with $E(\varepsilon_t)=0$. It needs not even be i.i.d.. Equation (5) implies that the expression inside the squared brackets in equation (4) to also be equal zero. If so, then

$$\pi_{t-1} = \frac{a}{1-\alpha_1} + \sum_{t=0}^{n}\frac{\beta_i}{1-\alpha_1}x_{t-i-1} + \sum_{t=0}^{p}\frac{\gamma_i}{1-\alpha_1}z_{t-i-1}$$

or simply put, $\pi_t = \frac{a}{1-\alpha_1} + \sum_{t=0}^{n}\frac{\beta_i}{1-\alpha_1}x_{t-i} + \sum_{t=0}^{p}\frac{\gamma_i}{1-\alpha_1}z_{t-i}$

If $a^* = \frac{a}{1-\alpha_1}$; $\beta^* = \frac{\beta}{1-\alpha_1}$ and $\gamma^* = \frac{\gamma}{1-\alpha_1}$, then by substituting those parameters we get

$$\pi_t = a^* + \sum_{t=0}^{n}\beta_i^* x_{t-i} + \sum_{t=0}^{p}\gamma_i^* z_{t-i} \qquad (6)$$

Equation (6) represents the long-run behavior proposed by the classical theory: setting aside external (short-run) shocks, inflation is explained only by the nonlinear interaction between excess demand and the throughput coefficient.

If equation (6) parameters are proven to be statistically significant, it means the ADL model is stationary and consistent. What is more, this equation reveals the long run relationship between inflation and the other two variables, their current value as well as – if this is the case -- lagged ones.

2.3. The Strategy for Testing the Models

Our strategy for testing the classical inflation theory will then start by running this long run ECM relationship and then test the significance of its parameters one by one (their t-statistics) as well as compare the initial unrestricted model against the restricted ones through a Wald test that checks the F statistics. If the unrestricted model bears, for instance, three lags in each variable, it will then be compared with other restricted models with lower lag length. By eliminating the coefficients with lower t-statistics, one can approach the best model, finding out the lag length that would maximize the overall fit of the long run model as well as the individual significance of each long run parameter. Once this is done, it will reveal firstly and more importantly whether the (classical) theory postulates hold for the dataset or not. If it does then it will show not only how inflation is driven by the non-linear interconnection of credit expansion and throughput but also how long it takes for the latter two to affect the former.

Once those long run parameters are known, we will follow to the fine tune calibration. The next step then will be adding the (historically relevant) known external shocks (e.g. oil shock) by means of dummy variables and checking their significance. Lastly it is still needed to check the existence or, lack thereof, of longer or shorter inflationary resilience. Likewise we add π_{t-1} , π_{t-2} … and test their coefficient significance. After dropping/adding those short run parameters to the ECM, we end up with the chosen ADL model.

2.4. The lag length of the unrestricted ADL (m, n, p) model

In order to help finding the best lag length for an initial trial, two basic techniques are to be used. It will firstly be checked visually the auto-correlation of the variables, as shown in the correlogram of the USA inflation in section 4.1.3.1. One can thus have a better idea of how many inflation lagged (autoregressive) variables could be included in the model. Then a set of selection-order criteria is run using a maximum of three lags – it would be unlikely to find a highly significant impact of one variable on others longer than three years. Even if otherwise, it would be unwise to exaggerate on the number of lagged variables at the expenses of degrees of freedom, considering the limitations imposed by the sample size. Besides, the lagged (long-run, theoretical) variables, x_t, x_{t-1}… and z_t, z_{t-1} … , whose order is ultimately determined by the long-run ECM relationship, do take care of a great deal of the inflationary memory (momentum) – so that a part of the autoregressive variables, π_{t-1}, π_{t-2} …, can be left out.[2]

3. Variables, Their Underlying Composition and the Datasets

The theoretical framework we are about to test has two independent variables, e and τ -- that represent the demand-pull and the supply resistance respectively -- and a dependent one, inflation, π. At an empirical level however it is needed to define more precisely how those variables are to be measured and composed. Indeed, this is an uneasy decision; not only it has to be conceptually adequate but it also needs to be feasible in terms of data availability – particularly if one intends to generalize the test for as many countries as possibles. Keeping that in mind, we have chosen the underlying data following a certain rationale whose summary is exposed below.

3.1. Injections of Excess Demand:

Demand growth requires growth in purchasing power. The former is actually a positive function of the latter (Shaikh, 2011). Credit expansion is a key element that allows accumulation to be fulfilled. Accordingly, such expansion happens "when capitalists draw on previously accumulated funds or borrow newly created credit money in order to finance production" (Filho, 2001). By doing so, they inject new purchasing power into the economy.

Those injections "may also be created by central bank support to financial institutions, by non-sterilized balance of payments surpluses, or by corporate or household dissaving or borrowing for speculative purposes." The former two are instruments of monetary policy which may lever those injections, granted though that the state cannot be faulted for

[2] In section 4 we will implement the strategy we have outlined here, step by step, for each of the ten different countries we have chosen -- using annual data (and also quarterly data for two of them). However, for avoiding tedious repetition, we will show all those steps (in detail) only for the USA annual dataset; for all the others we will present only a summary of their main results.

them, for they are “routinely and necessarily created by private decisions that are not subject to state control” (Filho, 2001). The latter two are “purely” endogenous fuel for credit expansion.

In other words the new purchasing power can arise out of (i) new high powered money which enters as expenditures (gold output in an earlier period, currency except for the banking sectors borrowed reserves); of (ii) credit advanced by banking institutions (commercial banks, thrifts, consumer unions, etc.); or of (iii) trade credit (among businesses, and between businesses and consumers). However, only those new purchasing power that come from (i) high powered money or (ii) banking institutions can result in increases in the quantity of money -- currency holdings plus bank deposits. While high powered money changes currency holding, loans create deposits. Trade credit (iii), on the contrary, does not change directly change the quantity of money. Besides, part of the overall injections shows up in the financial assets’ market rather than in the commodities’ market, resulting thus in no pressures over prices.

Among all possible injections of purchasing power it is needed then to identify which of them would really and directly affect the commodity markets. In this respect, there are three main domestic sources of such injections that can be found in the national accounts: banks, which create new money when they extend loans; direct consumer credit; and the portion of government deficits financed by direct printing money or Central Bank credit (indirect printing money). International trade surpluses are also a source of inflows. All in all, excess demand, Et, ends up being a composite of two different items as follows.

E_t = New Credit to Commodity Market + Net Foreign Demand = Net Injections of Excess Demand

For defining what to count in the Net Credit to Commodity market, a few important remarks (Shaikh, 1999) should be raised. Banks actively create new money by extending loans. Those who borrow from them do so for spending, not holding -- since they have to pay interest for such loan. Only part of such bank funded expenditures goes to the market of commodity goods -- its complement goes to financial assets markets. Government bills and bonds bought by private banks are generally monetization of bank reserves and go to financial asset markets, injecting no purchasing power in good markets. In terms of International Financial Statistics survey, “thrift institutions” (S&L, Mutual Saving Banks and Credit Unions) and money market funds are financial intermediaries and do not create new purchasing power. Then:

e_t = net injections of excess demand/GDP = {yearly changes in the stock of [Central Bank Claims on Central Govt +Net Debt of Central Govt to Depository Corporations (i.e. Commercial Banks) + Depository Corporations Claims on State & Local Govts + Depository Corporations Claims on Private Sector] + Current Account}/GDP

3.2. Throughput coefficient

$\boldsymbol{\tau}$ = Private enterprise Gross Capital Formation/ Private enterprise Gross Operating Surplus

Note that in some cases the private enterprise data can be proxy through corporations data or some constructed similar series.

3.3. Inflation

$\boldsymbol{\pi}$ = % change in the GDP Deflator

3.4. The Countries to Be Tested and the Datasets

The ten countries we have chosen for testing the classical theory of inflation, although not exhaustive, are a good and interesting sample -- at least to start a wider and more complete investigation[3]. They are among the main economies in the world, are

[3] Eastern European countries, Russia, China and India, to mention just a few of them, could not be added to our list due to unavailability of data. The absence of other important economies is quite unfortunate; yet it does not dwarf the relevance of the results gotten here.

geographically relatively well distributed and, to certain extent, are good representatives of the main country groups according to regional trade and to levels/types of development. This qualitative approach was obviously not the only touchstone used to select the countries and datasets. The other important rule was the availability of data – which turns out to be adamantly selective, given the quantity, diversity and complexity of the underlying variables needed to construct the three theoretical variables.

In a first selection approach it was tried a batch of more than fifty countries whose data were sparsely found in the main multilateral institutions databases -- IMF (for the bank credit data), UNDATA, World Bank, OECD, AMECO – and also a few countries' official data sources (central banks, statistics institutes, finance ministries etc.). From that initial trial, it was selected 25 possible candidates. Further data collection research was undertaken for those countries – so that gaps were attempted to be filled, using local statistics, estimates etc. A second selection was undertaken based upon sample size and data quality criteria. Most of those countries did not pass either criterion – it was not possible to find not only (complete) data for each and every (underlying) variable but also feasible and appropriate proxies. Besides, most series available were not long enough for running a minimally reliable and meaningful regression (about 30 observations, or more). Other countries have incomplete or gravely broken series and/or other similar problems. In the end seven countries were chosen – Canada, France, Germany, Japan, South Korea, UK and USA. The lack of any developing -- and particularly Latin American, inflation prone -- country made us to relax the criteria and allow other three representative countries: Brazil, Mexico and South Africa. Neither of them has good and long series. However their particular economic importance would justify their presence. The first two experienced high inflationary processes (actually hyperinflation in Brazil) and are very good representatives of the Latin American type of economic development. The last one is the most important economy of the Sub-Saharian Africa. While the test results of those three countries are not quite reliable due to data limitations, they can shed light on interesting general reflections -- if they are not taken for their face value.

Annual time series were used for all ten countries. In addition to that, for the USA and France, the model was also tested with quarterly data, increasing the reliance of the regression results. Altogether 785 observations for each time series were used for running the tests; that means, annual data: 62 for the USA, 61 for France, 58 for the UK, 41 for Canada, 31 for Germany, 31 for Japan, 34 for South Korea, 20 for Brazil, 17 for Mexico and 15 for South Africa; quarterly data: 234 for the USA and 215 for France.

The source for the underlying data used to construct "π" and "e" is basically the IMF-IFS database (with a few exceptions). The source for computing τ is the OECD, AMECO and in a few cases the country official statistics and economic data sources. For many countries it was needed to combine those sources with those of multilateral institutions as well as with other sources in order to construct a larger sample (e.g. French Current Account starts only in 1970 in the IMF database. Such series was merged with a series pre-1970 available on the French central bank web page. Something similar was done with the USA). For other countries it was needed to merge similar banking series that had different names in the IMF database. Euro area countries also required a special treatment (different currencies for different periods etc). Although sometimes this would look like a patchwork, it was always made sure there is coherence in the whole series. In the next section further detail on data sources and variable construction will be presented beforehand for each county so that they can be taken into account in each results analysis.

4. General Test Results for Ten Countries

For each of the ten countries we will test the classical theory of inflation we will proceed as follows. Firstly a few remarks on the country inflation recent history will be briefly introduced taking into account general and idiosyncratic features of each economy – special attention will be given to the USA and Brazil since they are respectively the most important economies of the two groups of countries, OECD and developing ones – this is because, in part, some basic points to be raised in those two cases can be generalized for other economies of each group and thus will not be redundantly repeated. By contrasting those stylized facts with the dataset and with the theoretical postulates we will try to make sense of the variables behavior over the last decades. next we present the dataset and variables construction details. Finally we will present possible long run relationship (ECM) models and check if the theory holds disregarding short run shocks and memory.

Finally we will introduce – according to the historical records – possible shocks to that simple ECM, present the main results and graphs, choose the best model and set up a brief conclusion regarding the adequateness of the classical theory for each country data.

5. Overall Test Result Conclusions and Possible Implications

In the previous section we have tested for seven OECD countries – plus three developing ones -- two pivotal aspects of the classical inflation theory basic framework, as outlined by equations (1) through (3). Firstly, by checking the regression coefficients significance for each country dataset we wanted to know how well inflation can be explained by the combination of demand-pull and supply-resistance forces – i.e. how well the interactive variable works. Secondly, testing the overall fit and the significance of the long run regression terms we can check whether the supply-resistance nonlinearity (quadratic form) fits well to the real data. In the next section we will also check whether the throughput is the best supply-resistance gauge, comparing it with other theoretical measures.

All those tests will help us make inferences about each country population coefficients based upon the samples we have gathered. Those coefficients significance (or lack thereof) neither proves nor disproves the ultimate validity of the classical inflation theory. Their significance could however reveal evidences that would support pivotal aspects of such theory reasoning. They might also shed some light on hidden particularities of different economies and different periods.

In order to facilitate the countries' tests analyses and conclusions, **Table 5.1** summarizes the test results -- reported before in the many regression tables of sections 4.1 through 4.8-- for each of the ten different countries. It is presented here, country by country: The regressions' R^2, their degrees of freedom (DF), their coefficients values and significance (t-test) results for both the long run, simplified (ECM), models and their complete, short-run shocks calibrated versions. It also shows for each regression the module of the critical value at a 2% significance level, $\left|t^*_{2\%}\right|$ -- so that if the module of a coefficient "t" is lower than such critical value, it will appear shaddy, meaning it is not significant at 2%. For the short run calibrated (unrestricted) models, the results for the autoregressive lagged inflation term -- when they were used -- are also reported. In some cases an alternate regression was also presented. For keeping the table as summarized as possible the constant term was omitted and the dummies are only mentioned.

Table 5.1 **: Classical Inflation Model, 10 Countries Main Test Results**

QUARTERLY DATASET:

Country	Model		$e_t\tau_t$	$e_t\tau^2_t$	$e_{t-1}\tau_{t-1}$	$e_{t-1}\tau^2_{t-1}$	(...)	$e_{t-4}\tau_{t-4}$	$e_{t-4}\tau^2_{t-4}$	π_{t-1}	$\lvert t^*_{2\%}\rvert$	Dummies	DF	R^2
USA (quarterly)	ECM (Long Run)	coefficient	-3.9	12.59				-1.78	7.53					68%
234 obs	["model 0"]	t-statistics	-4.64	5.36				**-2.1**	3.23		2.3		225	
	ECM 1 (Long Run)	coefficient			-5.74	20.08								66%
from 1953,1Q	alternate:["model1"]	t-statistics			-11.42	14.41					2.3		230	
to 2011, 2Q	Complete Model	coefficient			-3.88	13.4				0.33		Korean War, Oil Shocks 1 and 2, Int'l Commodity Deflation, 1998 and 2009 Financial Crisis.		85%
	["model3"]	t-statistics			-8.36	9.44				6.45	2.3		223	
France (quarterly)	ECM (Long Run)	coefficient			-12.24	37.03		-6.22	19.1					48%
215 obs	["model 1"]	t-statistics			-5.87	6.1		-3.22	3.38		2.3		206	
	Complete Model	coefficient			-11.55	34.97		-4.73	14.92			1963,2q and 1968,4q strong Rise in Wages; Oil Shock 1 and 2; 2008/9 Int'l Financial Crisis		72%
from 1958,1Q	["model 2"]	t-statistics			-7.34	7.63		-3.26	3.51		2.3		201	
to 2011, 3Q	Complete Model	coefficient			-8.97	26.98		-1.22	4.21	0.39				79%
	[alternate:"model3"]	t-statistics			-6.32	6.51		**-0.9**	**1.06**	7.86	2.3		200	

ANNUAL DATASET:

Country	Model		$e_t\tau_t$	$e_t\tau^2_t$	$e_{t-1}\tau_{t-1}$	$e_{t-1}\tau^2_{t-1}$	$e_{t-2}\tau_{t-2}$	$e_{t-2}\tau^2_{t-2}$	π_{t-1}	π_{t-2}	$\lvert t^*_{2\%}\rvert$	Dummies	DF	R^2
USA (annual)	ECM (Long Run)	coefficient	-2.8	7.5										64%
62 obs.	["model 1"]	t-statistics	-5.83	5.52							2.4		57	
1949 - 2010	Complete Model	coefficient	-2.5	6.14					0.47	-1.19		Korean War, Oil Shocks 1 and 2 and Int'l Commodity Deflation.		92%
	["model 3"]	t-statistics	-7.81	8.58					6.13	-2.58	2.4		51	
France (annual)	ECM (Long Run)	coefficient			-2.59	3.91								43%
61 obs.	["model 1"]	t-statistics			-4.29	4.99					2.4		57	
1950 - 2010	Complete Model	coefficient			-1.39	2.13			0.34			1958 Exchange Rate Devaluation, Oil Shocks 1 and 2 and broken series (1999) w/ introd. of euro.		87%
	["model 3"]	t-statistics			-4.01	4.55			4.37		2.4		52	
UK	ECM (Long Run)	coefficient	-2.58	4.92			-1.92	4.02						63%
58 obs.	["model 1"]	t-statistics	-4.38	4.74			-3.3	3.84			2.4		51	
1953 - 2010	Complete Model	coefficient	-0.98	1.87			-1.09	2.32	0.36			Oil Shocks 1 and 2; 1992 Speculative Attack; 2001 and 2008 Int'l Financial Turmoil and Crisis.		92%
	["model 3"]	t-statistics	-2.44	2.6			-2.67	3.02	4.62		2.4		45	
Canada	ECM (Long Run)	coefficient	-2.18	4.98	-2.25	5.03	-1.3	3.13						76%
41 obs.	["model 1"]	t-statistics	-4.34	4.47	-4.38	4.52	-2.48	2.75			2.4		32	
1970 - 2010	Complete Model	coefficient	-1.75	3.99	-1.86	4.15	-1.06	2.54				Oil Shocks 1 and 2; 1998/9 Int'l Financial crisis; and (2009) broken series.		90%
	["model 2"]	t-statistics	-4.98	5.11	-5.15	5.28	-2.92	3.21			2.5		28	
South Korea	ECM (Long Run)	coefficient	-3.02	3.35										54%
34 obs.	["model 2"]	t-statistics	-5.87	5.54							2.5		27	
1976 - 2009	Complete Model	coefficient	-1.03	1.46					0.49			Oil Shock; Asian Financial Crisis.		91%
	["model 3"]	t-statistics	-3.23	4.2					6.81		2.5		25	
Japan	ECM (Long Run)	coefficient	-1.21	2.11										47%
31 obs.	["model 1"]	t-statistics	-4.03	4.22							2.5		25	
1977 - 2010	Complete Model	coefficient	-0.8	1.38				0.44				2nd Oil Shock; 1997 Asian Crisis		84%
	["model 2"]	t-statistics	-4.51	4.57				4.7			2.5		22	
Germany	ECM (Long Run)	coefficient					-1.62	2.8						74%
31 obs.	["model 1"]	t-statistics					-4.9	6.12			2.5		26	
1980 - 2010	Complete Model	coefficient					-1.1	2.07				Oil Shock;"dotcom" bubble burst Finacial Crisis.		83%
	["model 2"]	t-statistics					-3.24	4.3			2.5		24	
Brazil*	ECM (Long Run)	coefficient	-53.7	181.8										87%
20 obs.	["model 2"]	t-statistics	-2.35	3.13							2.6		17	
1990 - 2009	Complete Model	coefficient												
		t-statistics												
Mexico**	ECM (Long Run)	coefficient	-45.8	8.9										63%
17 obs.	["model 1"]	t-statistics	-0.56	**0.58**							2.6		14	
1993 - 2009	Complete Model	coefficient	-11	20.1								Two emerging market capital flight crises (1995 and 2002)		63%
	["model 2"]	t-statistics	**-1.89**	**1.92**							2.7		12	
						(...)	$e_{t-4}\tau_{t-4}$	$e_{t-4}\tau^2_{t-4}$						
South Africa	ECM (Long Run)	coefficient	-2.45	6.44			-1.47	4.99						80%
15 obs.	["model 1"]	t-statistics	-4.01	4.19			-2.5	3.79			3.0		7	
1995 - 2009	Complete Model	coefficient	-1.9	5			-1.63	5				Emerging markets capital flight crisis (2002)		92%
	["model 2"]	t-statistics	-3.73	3.97			-3.61	4.99			3.1		6	

[Countries were ordered in this table according to their regression sample size. The higher the # of obs. the more reliable tend to be the tests results]

[the results for the three developing countries, Brazil, Mexico and South Africa, are ilustrative only. They are based on a too small sample size and cannot be regarded as reliable.]

* Brazil's Model variables are multiplied by their variance (weight).

** Since Mexico's ECM (model1) coefficients are not significant, there is no way to ensure the existence of the long run relationship predicted by the theory, at least for this small sample.

5.1. The Significance of the Classical Theory Interactive Terms

All OECD countries' ECM, long run, relationships are significant and, except for France and South Korea, have a relatively good fit (R^2 above 60%). The fit is considerably improved when dummies and a final fine-tune adjustment in the lag length are added to the models.

Looking at equation (3) again, $\pi_t = a + \alpha \pi_{t-1} - \sum_{i=0}^{n} \beta_i x_{t-i} + \sum_{i=0}^{p} \gamma_i z_{t-i}$

it is possible to say that at 2% level of significance we can reject the null hypothesis of the long run coefficients insignificance (H_0: $\beta>0$ and $\gamma<0$) for all those seven countries. The interactive terms $e\tau$ and $e\tau^2$ are all significant showing robust evidences of central classical postulates. The larger the country sample size, the greater tend to be the confidence in such evidences.

On this respect, USA and France were tested twice, quarterly and annually. Their samples are considerably large granting quite reliable regression results. UK and, to a lesser extent, Canada were also tested for relatively large samples.

The same cannot be said of the non-OECD countries. Among them Mexico was the only that did not show satisfactory results. Since those developing countries' regressions are illustrative only we do not intend drawing any further conclusion at this point.

5.2. The Nonlinear Behavior

A remarkable result shown in table 5.1 is that the coefficient of $e\tau$ and $e\tau^2$ have the expected signs for all ten countries. For all regressions, $\beta_i<0$ and $\gamma_i > 0$, which ensures the polynomial, U-shape, functional form suggested by the classical theory – due to the throughput/bottleneck effect. Accordingly, one can indeed compute the level of throughput that minimizes $F(\tau)$: $\tau = \beta_i/(2\gamma_i)$; Or the one that makes inflation equal to zero, $\tau = \beta_1/\beta_2$, -- which is the deflation-inflation threshold so that τ above this value creates inflation when $e>0$ and vice-versa.

With this in mind one can unfold some insightful thoughts with implications on countries macro adjustments. This will be briefly discussed next.

7. Summary and General Conclusions.

We have empirically investigated here the validity of a non-orthodox approach to the understanding of inflation based upon the classical political economy tradition. Such approach takes into account the interaction of excess demand and capital expansion hindrances for explaining either upswing or downswings pressures over general prices needing not assume either neutrality of money, or full employment, or steady-state equilibrium. It can be expressed by a second-degree function that relates inflation with the interaction of injections of excess-demand and supply-resistance (the capital expansion hindrances). Such function – its long run ECM version as well as its expanded versions -- was tested for seven different OECD economies plus three developing countries.

Three main questions were posed before us in order to test such theoretical framework. Firstly, is the demand-pull/supply-resistance interaction actually well related to inflation (and deflation)? Secondly, is such relation really defined by a nonlinearity due to the supply-resistance behavior (the bottlenecks story)? Thirdly, is the classical gauge, the throughput ratio, the best one for representing the supply-resistance forces?

The tests we have run show good evidences for answering positively the three questions. In all seven OECD countries (whose dataset are much larger and more reliable) the statistical regressions of the abovementioned classical approach mathematical expression (equations (1.1) through (3)) yielded significant coefficient estimates. Just by themselves such nonlinear interaction can explain a good deal of the actual historical inflation. That shows a good long run relationship as suggested by the classical framework. When adjusted to the short-run shocks and to inflation memory effects, it gains precision and the regressions improve their fit to the data. Although developing countries data is not large enough, there are also clues showing the presence of the same type of relationship.

By testing this classical model, we could also shed light on a few other important macroeconomic topics such as the stagflation and the liquidity trap issues. We have seen that the throughput may either amplify or stifle the transformation of excess demand into inflation. In certain extreme cases it could still transform an inflow of credit into deflation -- as it has been the case for Japan – or an outflow of credit into inflation – as in the USA.

We hope this article has helped the elaboration of alternative possibilities to tackle not only inflation but also other macroeconomic dynamic topics such as the interplay of credit and growth. The many tests we have run here give reliable support to the classical claims delved in the previous chapter, despite one or another drawback on data availability and (exceptional) inconclusiveness in one or two cases -- particularly the developing ones. Moreover, this empirical investigation and its subsequent (classical theory-based) analyses have not only helped us to reach a better understanding of inflation as a process; But they have also allowed us to address a comprehensive and critical range of topics, suggesting a whole new perspective on alternative policies to be unfolded.

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