LONG-RUN UNEMPLOYMENT: NATURAL OR EPIPHENOMENAL?

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ABSTRACT

The “natural rate of unemployment” (NRU) hypothesis has been the dominant hypothesis on long-run unemployment for many decades, despite lots of evidence against it. In this report, the main criticisms of the NRU hypothesis will be surveyed, and an alternative hypothesis – hysteresis – will be presented and explored. This is followed by a survey of the different ways of empirically testing the NRU hypothesis against the hysteresis hypothesis, and the results of these tests. These results show that neither hypothesis has conclusive empirical support. Hence, hysteresis cannot be ignored in favor of the NRU. Finally, we carry out some preliminary tests using provincial unemployment rate data and show that “hysteresis” may be affecting unemployment in most of the provinces.

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Chapter 1. Introduction

Is a laissez-faire market economy inherently stable and welfare maximizing or not? This question was (and still is) at the core of macroeconomic debates. The Great Depression in 1929, The General Theory of Keynes in 1936, and more recently, the Great Recession in 2008-09 shed some light on the damage that can be caused by market malfunctioning and showed the need for government intervention in the economy to minimize damages and maximize welfare. This was the popular view in the past until the stagflation of the 1970s, after which the neoclassical paradigm which favors laissez-faire markets came into prominence.

One of the main hypotheses that challenged the effectiveness of government intervention, and influenced economic policies in the last few decades, is the "natural rate of unemployment" (NRU) hypothesis. NRU is the long-run equilibrium rate of unemployment, and is a point of attraction for the unemployment rate following any temporary shock, according to this hypothesis (Friedman, 1968). According to this logic, governments cannot alter this rate using aggregate demand policy interventions, and such policies will only change the inflation rate in the long-run.

However, as time passed and more shocks occurred, unemployment rates in more than one country increased, and remained at high levels without being attracted back to a "natural rate". This imposed a challenge on the validity of the NRU hypothesis. Proponents of NRU responded by introducing the "structuralist theory" which will be explored later in this report. On the other hand, skeptics of the NRU hypothesis introduced an alternative hypothesis, called "hysteresis in unemployment". "Hysteresis in unemployment" means that past events (like temporary shocks) can change the unemployment rate in the long-run (Cross, 2014).

Interestingly, Friedman (in a letter to Rod Cross) said that he doesn't believe that the NRU hypothesis and the idea of "hysteresis" effects need to be contradictory, in the sense that the current NRU need not be independent from the history that led to it (Cross, 2014). In addition, Friedman mentioned that the idea that the current equilibrium of an economic system is affected by past events was recognized since the time of Alfred Marshall (Cross, 2014).

One aim of this report is to shed some light on the main criticisms of the NRU hypothesis, which will be explored in Chapter 2. Another aim is to provide a survey for the main explanations and implications of "hysteresis in unemployment" in addition to contrasting it with alternative explanations provided for rising unemployment rates that didn't revert back to NRU. This will be done in Chapter 3. Then, Chapter 4 is dedicated to surveying how different researchers tested for the alternative hypotheses. Last but not least, in Chapter 5, the results of testing for "hysteresis in unemployment" in the Canadian provinces are presented, while Chapter 6 provides the conclusion of the report.

Chapter 2. The Natural Rate Hypothesis and its Criticisms

2.1 The Natural Rate of Unemployment in a Nutshell

The prevalent hypothesis on long-run unemployment in macroeconomic textbooks is the "natural rate of unemployment" (NRU). Some economists like to differentiate between NRU and the "non-accelerating inflation rate of unemployment" (NAIRU); however, the two concepts can be viewed as synonyms intrinsically, and will be used as such for the purpose of this report. The basic idea of NRU is an assertion that the unemployment rate has a unique equilibrium towards which it gravitates in the long-run. Friedman (1968) defines the NRU as "…the level that would be ground out by the Walrasian system of general equilibrium equations, provided there is imbedded in them the actual structural characteristics of the labor and commodity markets, including market imperfections, stochastic variability in demands and supplies, the cost of gathering information about job vacancies and labor availabilities, the costs of mobility, and so on" (p.8).

The main message of NRU is that if the unemployment rate is forced below (or above) its unique equilibrium rate, through an aggregate demand policy intervention for example, this will result in accelerating inflation (or deflation) (Stiglitz, 1997). This is because, according to this logic, any deviation from the unique market equilibrium unemployment rate is "temporary" and does not change the long-run "natural rate of unemployment", while it can permanently increase inflation by altering people's inflation expectations. This has formed the theoretical basis for the adoption of inflation targeting by many central banks, a policy that started about three decades ago and is still dominant throughout the world today.

2.2 Multiple Equilibria and NRU Criticisms

The NRU hypothesis does not seem to satisfy all economists. For example, the eminent economist, Robert Solow, says that: "A natural rate that hops around from one triennium to another under the influence of unspecified forces, including past unemployment rates, is not 'natural' at all. 'Epiphenomenal' would be a better adjective; look it up" (Solow, 1986; p. S33). Setterfield, Gordon, and Osberg (1992) say that "…we could find a NAIRU model with desirable econometric properties to recommend almost any feasible male unemployment rate as the NAIRU in Canada in the mid 1980s" (p.134). This quote not only questions the concept of a unique NAIRU, but the usefulness of this hypothesis, even if it is true, for policy formulation. Moreover, Friedman's quote above shows that the NRU hypothesis is based on assuming a unique Walrasian general equilibrium. If there exists multiple general equilibria rather than a unique general equilibrium, then a laissez-faire economy can reach any of the possible stable equilibrium points, each with a different unemployment rate. A brief discussion of potential reasons for the existence of multiple equilibria in a given economy, and a survey of NRU criticisms are presented below.

2.2.1 Uncertainty, Imperfect Insurance and Imperfect Information

Carlaw and Lipsey (2012) question the validity of the existence of a unique long-run path for the economy by presenting an alternative view of "…an economy that is growing and constantly changing under the driving force of endogenous, path-dependent technological change" (Carlaw & Lipsey, 2012, p.762). Technological change is path-dependent, according to this view, because research and development decisions (which are crucial for technological advance) are made by profit-seeking and/or utility-seeking agents who face “genuine uncertainty”. “Genuine uncertainty” means that there isn’t a particular behavior that a “representative” agent would follow to maximize their profit/utility, because the behavior of each agent would be determined by his/her expectation about the uncertain future. Hence, the path of technological advance and consequently of future economic growth and unemployment are determined by decisions made by individuals in the present, and “bygones are not bygones” as Cross (2014) says. The implication is that the past cannot be forgotten, since its effect lingers on.

Moreover, Costain (2000) argues that an economy with imperfect insurance may be subject to multiple equilibria due to the volatile behavior of investors and workers with uncertainty, namely “portfolio choice under risk” and “precautionary saving”. Since these decisions affect the level of investment, the economy’s productive capacity and therefore the economy’s general equilibrium in the next period, are affected. In addition, Van den Berg (2003) points out that imperfect information in the labor market and different production technologies of firms may lead to more than one possible equilibrium wage and therefore multiple unemployment equilibria.

2.2.2 Income Distribution

Patriarca and Vona (2013) mention that multiple equilibria can arise from different ways of income redistribution following the emergence of a new sector. If we allow for heterogeneity where labor primarily consumes and entrepreneurs primarily invest, then redistribution favoring labor would negatively affect investment while redistribution favoring entrepreneurs would negatively affect consumption (and therefore the incentive to innovate and invest) (Patriarca & Vona, 2013). Hence, only a balanced redistribution of income, one that does not change the distribution structure before the emergence of the new sector, can keep the economy on its original long-run path. Hence, different ways of redistribution can lead to different long-run equilibria.

Moreover, Oyama (2003) says that a balanced income distribution, where more people have enough income to afford education, results in a higher level of human capital and higher productivity which in turn leads to a long-run equilibrium with higher economic growth and lower unemployment and vice-versa.

2.2.3 Human Capital

Similarly, Ortigueira (2006) argues that the initial stock of human capital can affect an economy's equilibrium output and unemployment in the long-run. The logic is that with higher human capital stock, more time is allocated for production and education, since these activities need skills. This in turn leads to higher growth in output and lower unemployment in the long-run. In comparison, with lower human capital stock, and due to the lack of skills, more time is allocated to job search and leisure activities. This in turn leads to an equilibrium with lower growth in output and higher unemployment in the long-run (Ortigueira, 2006).

2.2.4 Credit Constraints

Miao, Wang, and Xu (2012) say that if firms are bound by credit constraints, then different credit market conditions lead to different equilibrium unemployment rates. This is because the availability of credit affects firms' investment and employment decisions. The authors suggest that fluctuations in credit availability could happen due to changes in beliefs which lead to fluctuations in output and employment without changes in fundamentals (Miao, Wang, & Xu, 2012).

2.2.5 Externalities and Increasing Returns to Scale

Beugnot and Tidball (2010) suggest that the presence of a positive externality like knowledge spillovers in monopolistic competition could lead to increasing returns to scale in the aggregate production function which in turn leads to multiple equilibria. Moreover, Julien and Sanz (2005) say that if we take transaction costs and strategic complementarities in monopolistic competition into consideration, then a sufficiently high increasing returns to scale in transaction technology can lead to multiple equilibria even if there are constant returns to scale in production. This is plausible since with price competition (which exists in monopolistic competition), firms can be strategic complements (i.e. if one firm expands its production, it would be profitable to the competitor to follow this behavior).

2.2.6 Assuming Dynamic Homogeneity

Furthermore, Lang and Setterfield (2015) argue that for a unique NAIRU to exist, the relationship between current inflation and expected and/or previous inflation (depending on the model used) in the long-run equilibrium must be homogenous of degree one, or what they call "dynamic homogeneity". The authors use the following Phillips Curve equation:

$$p = \alpha + \beta p^e + \sum_{i=1}^{n} \gamma_i \, p_{-i} - \delta U + \eta \qquad (2.1)$$

p is current inflation, p^e is expected inflation, p_{-i} is lagged inflation, U is the unemployment rate and η reflects shocks. They show that for a unique "natural rate of unemployment" to exist, $\beta + \sum_{i=1}^{n} \gamma_i = 1$ should necessarily hold in the long-run equilibrium (i.e. at the point when $p = p^e = p_{-i} = p^*$). Otherwise, there would be a tradeoff between inflation and unemployment in the long-run. The authors' main criticism for the recent empirical work on NAIRU is that $\beta + \sum_{i=1}^{n} \gamma_i = 1$ is assumed or imposed on the data rather than tested (Lang & Setterfield, 2015).

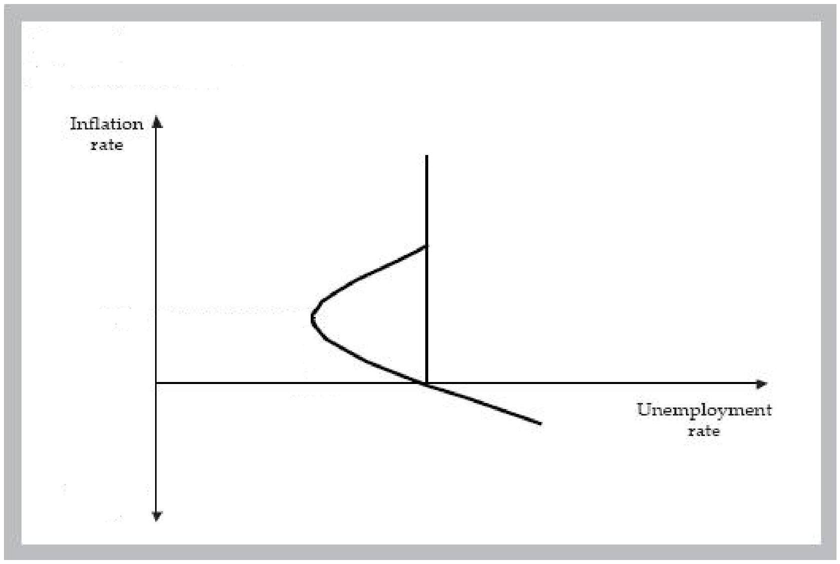
2.2.7 The Benefit of Low to Moderate Inflation

Fortin (2003) suggests that some degree of low to moderate inflation can decrease long-run unemployment. He focuses on the so-called Eckstein-Brinner effect and the Tobin Effect. The Eckstein-Brinner effect is the possibility that low inflation will not be incorporated into wage contracts since the cost of ignoring such inflation is negligible. In this case, such inflation can decrease real wages and stimulate employment. The Tobin effect is the idea that workers in declining industries may be resistant to reductions in their nominal wage but not resistant to erosion of their real wage via inflation. This is rational since reductions of their nominal wage affects relative wages (which is a real variable); whereas inflation preserves relative wages intact. As a result, workers are unwilling to accept real wage cuts through lower wages in the context of price stability, but are willing to accept real wage cuts through inflation eroding a constant money wage. Therefore, low to moderate inflation can do the job of decreasing real wages and slowing down the decline of sunset industries, slowing down the release of labour, and avoiding bottlenecks in search unemployment. This added "lubrication" could reduce the long-run unemployment rate.

The result of combining both effects would be a Phillips Curve with a bend at low to moderate inflation rates which becomes vertical at higher inflation rates as higher rates would be fully incorporated in wage contracts (Fortin, 2003). As Figure 2.1 below illustrates, this is different from the usual vertical long-run Phillips Curve with a unique

NAIRU. If this holds in reality, it opens the door for some degree of policy intervention where a favourable mix of low to moderate inflation and low unemployment can be chosen.

Figure 2.1. An Alternative Phillips Curve



2.2.8 The Natural "Range" and the Non-accelerating "Band"

Likewise, Bhaskar (1990) says that if workers are concerned about fairness (i.e. about relative wages, as mentioned before), then unions will match their nominal wage demands with what they <u>expect</u> other comparable unions to ask for. This gives rise to a "range" of possible equilibrium real wages, and therefore to a "natural range of unemployment" according to the author (Bhaskar, 1990). Furthermore, Carlaw and Lipsey (2012) say that in reality, instead of a unique NAIRU, there is a "band of non-accelerating inflation" where output and unemployment can fluctuate without triggering acceleration in inflation (or deflation). In the short-run, this is mainly due to two reasons; flat short-run cost curves for many firms and the fact that uncertainty about the future can decrease the aggressiveness of wage demands. In the long-run, the "band" can shift as the economy evolves with path-dependent technological change as mentioned earlier.

Ip (2004) supports the hypothesis of a "range" of output and unemployment where inflation remains stable, and proposes a mixed policy of inflation and growth targeting.

2.2.9 Labor Market Indeterminacy

Farmer (2013) focuses on the idea that moral hazard problems prevent an efficient market solution for filling vacancies. He says that for the labor market to have a unique equilibrium, there should be a unique equilibrium way to fill vacancies with unemployed workers. For this to be possible, ideally, there should be a perfectly competitive "match-making" market. Such a market, if it existed, would allocate unemployed people efficiently across the available vacancies. However, the nonexistence of such market "…leads to a fundamental indeterminacy in the labor market" (Farmer, 2013, p.10). While search theorists close a general equilibrium model with the "Nash bargaining equation" to solve the above mentioned problem, Farmer (2013) suggests to a "belief function" to close the model and determine a unique path for the unemployment rate. Farmer (2013) suggests a belief equation where "…households expect that the growth rate of nominal GDP next period will equal the growth rate this period" (p.11). He mentions that such a belief equation is "rational" in the sense that the beliefs would be "correct on average", and he claims that his model outperforms New Keynesian models which incorporate the NRU, in fitting recent U.S. data on unemployment, inflation and interest rates (Farmer, 2013).

2.2.10 Critical Observations Inconsistent with NRU and the rise of "Hysteresis" Hypothesis

Perez-Alonzo & Di Sanzo (2011) say that: "In several European countries, one of the stylized facts of unemployment since mid 1970's is that it has steadily increased without any significant decrease or evident tendency to revert to a stable underlying unemployment" (p.1). This increase in unemployment rates which did not seem to be returning to a "natural rate" gave rise to the "hysteresis in unemployment" hypothesis as an alternative explanation for the behavior of long-run unemployment (see, e.g., Blanchard & Summers, 1986). Simply put, "hysteresis in unemployment" says that past events/shocks (even if temporary) can permanently change the unemployment equilibrium rate in the long-run. If true, "hysteresis in unemployment" means, among other things, that a policy that focuses on inflation targeting and ignores changes in unemployment could be harmful for the economy in the long-run.

Chapter 3. "Hysteresis in Unemployment" and Alternative Explanations

Cross (1993) says that the meaning of the word "hysteresis" is 'that which comes later' (p.53). *Hysteresis effects are the effects that persist after removing the initial cause which produced them* (Cross, 1993). When economists talk about "hysteresis in unemployment", they usually mean that a temporary shock or stimulus can have permanent effects on the long-run unemployment rate. The effects are permanent in the sense that after a negative shock for example, the unemployment rate will have no tendency to decrease again to its pre-shock rate on its own (i.e. in the absence of a subsequent positive shock or a policy intervention). In comparison, the "natural rate of unemployment" hypothesis suggests that after a temporary shock or stimulus, the unemployment rate has an automatic tendency to return back to its "natural rate".

3.1 Hysteresis and Alternative Hypotheses

Rising levels of unemployment that did not seem to return to a "natural rate", as mentioned in Chapter 2, gave rise to three explanations for that phenomenon: "hysteresis", "persistence" and the "structuralist theory". The latter two are extensions of the "natural rate" hypothesis, while "hysteresis" is based on postulating non-stationarity in unemployment rate dynamics (Ayala, Cunado & Gil-Alana, 2012). The following discussion aims to define the three hypotheses and to provide a contrast between them. After that, the main explanations of the causes and implications of "hysteresis in unemployment" will be explored further.

3.1.1 Hysteresis vs. Persistence

Some economists use "hysteresis in unemployment" and "persistence in unemployment" interchangeably (Stanley, 2004). These two concepts may sometimes lead to similar policy recommendations (depending on the degree of persistence), but are different concepts theoretically (Leon-Ledesma, 2002). In the case of "hysteresis", the unemployment rate does not adjust toward a "natural rate" following a shock, as mentioned before. This is because the effects of the shock can linger in the long-run to a point that changes the long-run equilibrium unemployment rate. In contrast, "persistence" means that the unemployment rate can get stuck away from the "natural rate of unemployment" for a relatively long period of time, yet the "natural rate" is still the point of attraction. In other words, it is still the long-run equilibrium unemployment rate (Leslie, Pu, & Wharton, 1995). The difference between "hysteresis" and "persistence" can be illustrated using a linear difference equation, based on the discussion in Leslie, Pu, and Wharton (1995), as follows:

$$Y_t = \alpha + \rho Y_{t-1} + \varepsilon_t \qquad (3.1)$$

Y is the unemployment rate, ε is the usual error variable, and $\alpha = 0$ is a special "driftless" case. If $\rho = 1$, the equation above is said to have a unit root, which means that the effects of random shocks will not fade away with time (and this implies "hysteresis"). This idea will be illustrated further in the coming two chapters. On the other hand, if $|\rho| < 1$, then the effects of shocks will fade away with time and the unemployment rate will be converging to a "natural rate" equal to $Y^* = \alpha/(1-\rho)$ in the long-run equilibrium, when $Y_t = Y_{t-1} = Y^*$, and $E(\varepsilon_t) = 0$). The closer ρ is to 1, the greater the number of periods it will take the unemployment rate to converge to its "natural rate", which implies "persistence".

Hence, in the context of a linear difference equation like (3.1), “hysteresis” is implied by $\rho = 1$, while “persistence” is when ρ is less than but close to one. Leslie et al. (1995) say that in the case of “persistence”, the effects of a shock can sometimes “…have a half-life of only three periods” (p.511). This means that the persistent effects will disappear in a relatively short period of time, with no need for policy intervention in such a case. Therefore, the authors conclude that the difference between the two concepts “cannot be trivialised as irrelevant to the policy maker” (Leslie et al, 1995, p.511). However, a high degree of persistence may require a policy intervention similar to the case of “hysteresis”.

3.1.2 “Genuine Hysteresis”

Another group of economists (see, e.g., Göcke, 2002; Mota & Vasconcelos, 2012; Cross, 2014) say that a linear difference equation with a unit root, although useful to indicate the existence of “hysteresis”, may not fully capture the characteristics of “genuine hysteresis” as they understand it. Two main differences can be identified from this view. The first point is that the dynamics of a system with “genuine hysteresis” are best described using non-linear models rather than linear models. A linear difference equation with unit root means that a temporary shock leaves permanent effects (which implies “hysteresis”), yet it also means that applying an equal but opposite shock brings the unemployment rate back to its initial level. However, according to the “genuine hysteresis” view, two equal but opposite shocks will not bring back the unemployment rate to its initial level (Mota & Vasconcelos, 2012).

The following example by Mota and Vasconcelos (2012) illustrates this idea. Consider an inactive price-taking firm with a simple production function where one worker produces one unit of output. The output price necessary to induce this firm to become active and hire a worker must cover both wage costs and hiring costs (like the cost of advertising a vacancy and cost of training for example). If the current price is enough to cover wage costs only, but not hiring costs, then the firm will not hire any worker and will remain inactive. If an exogenous shock increases output price to a point sufficient to make market entry feasible for the firm (i.e. if the new price covers wage costs and hiring costs), then it will enter the market and hire a worker. If another shock decreases the price back to its initial level (or if the previous shock was temporary and dissipated), this will not push that firm to exit the market. This is because the initial (lower) price is enough to cover wage costs and keep the firm active in this case (and keep the worker employed), while hiring costs are now considered sunk costs. Hence, the same firm facing the same price took two different states (inactive vs. active) depending on the path from which it approached the price. Taking firing costs (like severance pay for example) into consideration adds another factor to the decision to exit the market. Output price has to fall to a point that makes a firm's loss from remaining active and paying a worker's wage exceed the firm's loss from having to pay firing costs in case it decides to exit (Mota & Vasconcelos, 2012). Further, if the economy is composed of heterogeneous firms (i.e. firms with different hiring and firing costs), then different firms would have different triggering points for entry and exit. Therefore, temporary shocks can change the number of active and inactive firms in the economy and consequently change the long-run equilibrium levels of output and employment (i.e. cause "hysteresis"). Moreover, applying an equal but opposite shock, or allowing a temporary shock to dissipate, will not push the economy (output and unemployment) back to its initial level as shown in the previous example (Mota & Vasconcelos, 2012).

The second distinctive feature of the “genuine hysteresis” view is that an economic system under this view has a “selective memory”. This means that not every shock will remain in the system’s “memory” as a linear difference equation with a unit root suggests. Only shocks that are big enough to be “non-dominated” will cause the system to shift to a new path and therefore have permanent effects (Göcke, 2002). To illustrate, consider that previous shocks have resulted in a certain composition of active and inactive firms in the economy. For a new shock to shift the economy into a new path, and therefore have permanent effects, it has to be big enough to push the price level to a point that causes significant changes to the current composition of active and inactive firms in the economy. Otherwise, the new shock would be “dominated” by previous shocks, and will not remain in the system’s “memory”. That is, the effects of “dominant” shocks will still determine the long-run state of the economic system and therefore will remain in the system’s “memory” until another bigger shock comes and dominates. In contrast, using a linear difference equation with unit root implies that any shock shifts the system to a new path and therefore every shock changes the equilibrium rate of unemployment permanently. In summary, although in both cases, temporary shocks can have permanent effects on unemployment, the two cases (linear difference equation with a unit root and “genuine hysteresis”) can differ in the details of the underlying dynamics.

3.1.3 The Structuralist Theory

On the other hand, another hypothesis that arose to explain shifting long-run equilibrium rates of unemployment is the “structuralist theory”. This hypothesis says that the observed long-run shifts in unemployment are actually changes in the “natural rate” itself resulting from persistent or permanent changes occurring in the structural factors determining it (Ayala et al., 2012).

Phelps (1995), who put forward this hypothesis, suggests three such structural factors. First, he mentions that a permanent increase in world interest rates would shift the labor demand curve and hence change the equilibrium (i.e. the "natural") rate of unemployment. Second, he says that increased interference in labor markets and increased wage-related taxes also result in an increase in the "natural rate of unemployment". Finally, he refers to increased private wealth and increased generosity of the welfare state (unemployment and other benefits) as reasons that result in a higher level of wages and therefore a higher "natural rate of unemployment" (Phelps, 1995).

However, one point of criticism for this hypothesis is that during the period when long-run unemployment was increasing in many European countries, real wages were generally decreasing and the generosity of both the welfare state and unemployment benefits were either constant or falling in most of these countries (Pressman, Seccareccia & Lavoie, 1995).

3.2 Underlying Causes of "Hysteresis in Unemployment"

3.2.1 The Insider-Outsider Hypothesis

One of the most well-known explanations suggested for "hysteresis in unemployment" is the "insider-outsider" hypothesis. Lindbeck and Snower (1986) presented this hypothesis as a possible explanation for the persistence of involuntary unemployment. The idea is that employed workers ("insiders") have more market power than unemployed workers ("outsiders") due to the cost incurred by a firm to replace an “insider’ with an “outsider”. Insiders control “…the process of wage negotiation. Thus wages may be set so that involuntary unemployment results, but the outsiders are nevertheless unable to improve their position through underbidding…” (Lindbeck & Snower, 1986, p.235). Blanchard and Summers (1986) used the “insider-outsider” hypothesis to suggest that since a recession increases the number of unemployed workers who would therefore lose their power to influence wages, this could lead to a permanent increase in unemployment (i.e. cause “hysteresis”). This would happen as “insiders” block real wages from decreasing to the level necessary to restore the original unemployment rate, and as a result, a new higher unemployment rate becomes the new long-run equilibrium unemployment rate. However, one could argue that the “insider-outsider” hypothesis, if true, causes “persistence” rather than “hysteresis”, and that the long-run “natural rate of unemployment” remains unchanged. For example, Dobbie (2004) says that if we assume that “insiders” care about job security and not only about wages, then they will eventually soften their wage demands, and the wage level will slowly adjust until the “natural rate” is restored. The speed of adjustment would depend on the preferences of “insiders” (i.e. job security versus higher wages). In addition, if members of a union do not lose their membership automatically once they become unemployed, then a union that cares about all its members would be willing to compromise some wage demands in order to restore the employment of its members. Furthermore, the complete loss of power by “outsiders” to influence wages is an assumption that may not always hold. Allowing “outsiders” to have some power to influence wages means that even if “insiders” push to keep wages at higher levels, the “outsiders” will try to pull wages down. Therefore, the speed of adjustment of wages (or the "degree of persistence") will depend on the balance of power between the two opposing forces affecting the wage level (Dobbie, 2004).

3.2.2 Human Capital Depreciation, Unemployment "Stigma" and Job Search Inefficiency

Another explanation for "hysteresis in unemployment" is human capital depreciation (Pissarides, 1992). Long periods of unemployment could make the unemployed workers lose their skills, they would need re-training, and this would affect their ability to get back to employment. This keeps them unemployed for even a longer period of time. A long period of unemployment can cause "scarring" or "stigma", which basically means that a long history of unemployment sends a bad signal about unemployed workers to employers and induces firms not to employ them, even if their skills did not actually deteriorate (Graafland, 1991). In addition, discouragement from failing to find a job could lead to lower efficiency in job searching, or even to dropping out of the labor force (Graafland, 1991). A long period of recession increases the number of unemployed workers exposed to such effects which in turn leads to an increase in the unemployment rate that persists after the recession is over, and can become permanent. It can become permanent because even after the economy recovers, the combined effects of human capital depreciation, unemployment "stigma", and lower search efficiency can decrease the job finding rate and therefore permanently increase the long-run equilibrium unemployment rate. Moreover, the "insider-outsider" effect can combine with these effects and amplify the negative consequences of recessions on the unemployment rate in the long-run (Graafland, 1991).

3.2.3 Growth Disruption and "Hysteresis in Unemployment"

An alternative explanation for "hysteresis in unemployment" is linked to economic growth. It starts from "…the natural rate of growth [which] is the actual rate of growth that keeps unemployment constant" (León-Ledesma & Thirlwall, 2002, p.442). The "natural rate of growth" (g_n) is determined by the growth in labor force (n) and in labor efficiency (λ) (Lavoie, 2009). This implies that the growth in actual employment (e) is proportional to the actual growth in real output (g). The following two equations are presented by Lavoie (2009) to illustrate this idea:

$$g_n = n + \lambda \Rightarrow n = g_n - \lambda \qquad (3.2)$$

$$e = g - \lambda \qquad (3.3)$$

Hence, when $g < g_n$, this means that $e < n$ and therefore unemployment increases. This is because the growth in labor force exceeds the growth in employment. The change in unemployment

(ΔU) can therefore be presented as follows:

$$\Delta U = n - e = g_n - g \qquad (3.4)$$

Unemployment will keep increasing until actual growth gets back to the "natural rate of growth". But this means that the increase in unemployment will <u>not</u> be reversed once the actual rate of growth catches up with the "natural rate of growth", because once the two rates are equal, the change in unemployment stops but at a higher level of unemployment (Lavoie, 2009). The actual growth rate has to exceed the "natural rate of growth" for some period(s) in order to bring the unemployment rate back to its original level. Otherwise, the unemployment rate will be permanently higher that before, and this implies "hysteresis in unemployment". Moreover, if inflation changes depend on the change in unemployment and not on the level of unemployment, then a policy of disinflation (like the episode that occurred in the 1980s) will permanently increase the unemployment rate. The assumption about inflation's dependence on the change in unemployment is viable if we note that a threat to job security (which is expected to decrease wage demands) occurs when unemployment is rising, rather than when unemployment is high but constant. This idea is formally presented by Lavoie (2009) as follows (where π stands for inflation):

$$\Delta\pi = -\gamma(\Delta U) + \varepsilon \Rightarrow \Delta\pi = \gamma(g - g_n) + \varepsilon \qquad (3.5)$$

Therefore, according to this approach, after inflation falls to the rate targeted by the disinflation policy, the change in unemployment will stop, but unemployment will be permanently stuck at a higher level. For example, say current inflation is 5% and the current unemployment rate is 5%. If $\gamma = 1$, then to decrease the inflation rate to 3%, we need to increase the unemployment rate to 7%, and for this to happen, the actual growth rate needs to be 2% lower than the "natural rate of growth" for that period of time. Subsequently, to keep inflation at 3% permanently, we need to keep unemployment at 7% permanently (because $\Delta\pi = 0$ when $\Delta U = 0$ and $g = g_n$). The only way to return unemployment to 5% is if actual growth subsequently exceeds the "natural rate of growth" as mentioned before, but for this to happen, inflation has to increase above its new target. This will be blocked from happening if the official policy is strict inflation targeting. This argument can be advanced further if we allow for the possibility that deviations from "the natural rate of growth" can permanently change "the natural rate of growth" itself (Lavoie, 2009). This provides an alternative view on macroeconomic dynamics which warrants further research.

3.2.4 "Genuine Hysteresis" Revisited

Last but not least, as mentioned before when talking about "genuine hysteresis", another explanation for the underlying causes of "hysteresis in unemployment" is the different entry/exit triggering points for firms with different hiring and firing costs which means that temporary shocks can permanently change long-run unemployment by permanently changing the composition of active and inactive firms in an economy.

3.3 A Brief Discussion on Policy Considerations

3.3.1 Monetary and Fiscal Policy

In contrast to the NRU hypothesis, "hysteresis" hypothesis implies that monetary and fiscal policy can change the long-run rate of unemployment. If there is "hysteresis in unemployment", this means that inflation targeting policy can be harmful in the long-run, since the increases in unemployment associated with targeting lower inflation rates can become permanent as mentioned earlier. In addition, "hysteresis in unemployment" means that policy intervention (monetary and/or fiscal) is needed to alleviate the adverse effects of recessions, not only to stabilize the economy in the short-run, but also to stop the effects on unemployment from becoming permanent.

3.3.2 The Classical Approach to Labor Markets & Labor Market Policy

Nevertheless, some of the explanations discussed in the previous section for the underlying causes of "hysteresis" are similar in their approach to the classical approach to labor markets. The focus is on labor market "imperfections", and the blame of causing "hysteresis" is on the institutions and laws designed to protect workers according to some of these explanations. For example, it is understood that the "insider-outsider" hypothesis is more likely to hold in the presence of strong labor unions. In addition, generous unemployment benefits are assumed to cause longer unemployment spells which opens the door for human capital depreciation, unemployment "stigma" and increased search inefficiency. One can even say that unemployment benefits can reinforce the "insider-outsider" effect because the "insiders" would be less bothered about the "outsiders" knowing that they can receive generous benefits while unemployed.

Therefore, a labor market policy recommendation based on such explanations for the causes of "hysteresis" would be to "liberate" the labor market from its "imperfections". This means limiting the power of unions and reducing unemployment benefits or even eliminating both.

3.3.3 Reality Check

However, before jumping to such conclusions, a few points are worth mentioning. Even if unions and unemployment benefits (arguably) affect the unemployment rate in a negative way, the socio-economic costs of weakening or canceling these institutions/benefits could be even bigger. As Mota and Vasconcelos (2012) put it: "Admittedly, the flexibilization of labor markets would reduce hysteresis effects favoring the long-run neutrality of money. However, this policy may carry costs" (p.94). Moreover, some studies provide evidence that labor protection laws and government intervention in labor markets could in fact be beneficial. For example, a study by Amable and Mayhew (2011) about the change in unemployment rates after the Great Recession across different OECD countries found that countries with more protective laws and more collective bargaining coverage, other things equal, witnessed a lower increase in unemployment. The authors conclude by saying: "Given the potential importance of long-lingering effects of cyclical rises in unemployment—that is, of potential hysteresis effects—these institutional features may have long-term advantages" (Amable & Mayhew, 2011, p.219). In addition, Hijzen and Martin (2013) mentions that 25 OECD countries used "short-time work" schemes designed to protect employees from lay-offs during economic downturns, and that empirical evidence show strong support for the success of this policy in curbing unemployment increases during the Great Recession. A study by Arico and Stein (2012) supports this finding as well. "Short-time work" (STW) schemes are arrangements in which employers refrain from laying- off employees, while employees agree to work less hours per week, and the government covers the loss of income occurring during that period (Hijzen & Martin, 2013). The findings of these studies are at odds with the claim that "liberating" labor markets from government intervention and labor protective laws are necessary measures to reduce unemployment. With the possibility of "hysteresis" effects, the previous findings indicate that government intervention and labor protective laws may have actually stopped the unemployment rates from permanently increasing to higher levels following the Great Recession. These findings also impose further questions on the validity of some of the explanations provided by Phelps (1995) in his "structuralist theory", since increased government intervention (through STW) have stopped unemployment rates from increasing as far as they would have in the absence of such schemes. Even though these findings, like most empirical findings, are subject to further investigation, yet a small element of truth in these findings means that economists need to rethink some of the generally accepted beliefs about the causes of higher unemployment and the ways of curbing unemployment.

3.4 Summary

In summary, one could say that there is a “consensus” on the definition of “hysteresis” as being permanent effects of temporary shocks. However, this definition seems to be the only part of agreement between economists on this topic. Some reject the hypothesis to start with. Some confuse “hysteresis” with “persistence” although the two concepts are intrinsically different. Then, there is a group of economists presenting their own distinct view about “genuine hysteresis”. There is also Phelp’s “structuralist theory” which attributes long-run changes in unemployment to changes in the “natural” rate itself. Furthermore, the underlying causes of “hysteresis” are still open for debate and research. Understanding alternative views and explanations of “hysteresis” is vital since this will affect the conclusions reached and the policy recommendations provided.

Chapter 4. Different Tests For Hysteresis

Dolado, Jenkinson, and Sosvilla-Rivero (1990) say that "…stationary series should at least have constant unconditional mean and variance over time, a condition which appears rarely to be satisfied in economics" (p. 249). If that's the case, it can be said that differencing is a "pre-requisite for econometric modelling" since it can convert a non-stationary series into a stationary one (Dolado, Jenkinson, & Sosvilla-Rivero, 1990). Based on that, they present the following definition: "A variable y_t is said to be integrated of order d…if it has stationary, invertible, non-deterministic ARMA [auto regressive moving average] representation after differencing d times. Thus, a time series integrated of order zero is stationary in levels, while for a time series integrated of order one, the first difference is stationary" (Dolado et al., p. 251). Consequently, the traditional way of testing for the "natural rate" versus "hysteresis in unemployment" is to check whether the time series being tested is integrated of order zero (i.e. stationary series, "natural rate" holds) or integrated of order one (i.e. non-stationary series, which indicates "hysteresis" effects).

4.1 A Survey of Tests

4.1.1 Dickey-Fuller and Related Tests

Two main tests have been proposed by Dickey and Fuller (1979) and by Phillips and Perron (1988). Dickey and Fuller (1979) propose three "classes of models" to be examined: one with no intercept, one with an intercept and one with an intercept and a linear time trend as follows:

$$Y_t = \rho Y_{t-1} + \varepsilon_t \qquad (4.1)$$

$$Y_t = \mu + \rho Y_{t-1} + \varepsilon_t \qquad (4.2)$$

$$Y_t = \mu + \beta t + \rho Y_{t-1} + \varepsilon_t \qquad (4.3)$$

The null hypothesis to be tested in each model is ρ=1 (i.e. whether the time series is integrated of order one, which is also called the unit root hypothesis, and this indicates "hysteresis" effects). Fukuda (2008) comments on that by saying: "Different model classes provide different statistics; this can often lead to different conclusions" (p. 2786). However, a researcher can revert to an underlying theory when selecting whether to include a constant and/or a time trend or not when testing a particular time series. In addition, the test can be performed using the three model specifications and results can be compared. For example, if the unit root hypothesis is supported in all the three model specifications, then this indicates that there is strong support for it. The testing proposed by Phillips and Perron (1988) is similar to Dickey and Fuller (1979), and the unit root hypothesis is the null hypothesis in this test as well. However, these two tests have been criticized as being biased toward accepting the unit root hypothesis when the root is close to but less than one. For example, Kwiatkowski, Phillips, Schmidt and Shin (1992) say that "…the way in which classical hypothesis testing is carried out ensures that the null hypothesis is accepted unless there is strong evidence against it" (p. 160).

4.1.2 Making Stationarity the Null Hypothesis (The Kwiatkowski et al. Test)

To balance the perceived bias of the previous tests, Kwiatkowski et al. (1992) propose tests that make the nonexistence of a unit root (i.e. integration of order zero) as the null hypothesis to be tested. This way, in order to accept the unit root hypothesis, there should be strong evidence to reject stationarity (Leslie et al., 1995). However, Leslie et al. (1995) say that the Kwiatkowski et al. (1992) test can also yield varying results depending on the model specification and the number of time lags added. Moreover, conducting a test with a bias toward accepting stationarity and comparing it to a test with a bias toward accepting non-stationarity does not solve the problem if the objective is to get conclusive results.

4.1.3 Tests Using Fractional Integration

Subsequently, fractional integration has been used as an attempt to solve this problem (see, e.g., Ayala et al., 2012). Dolado et al. (1990) define fractional integration as "…using non-integer differencing orders to achieve stationarity in the data" (p.262). Ayala, Cunado & Gil-Alana (2012) use the following equation to present fractional integration ($d \geq 0$, L is the lag operator, x_t is the variable of interest, and u_t is a stationary error term):

$$(1 - L)^d x_t = u_t \qquad (4.4)$$

Dolado et al. (1990) state that "…all that is needed to have 'long-memory'…is a degree of differencing $|d| > 0.5$. Thus, it is clear that a wide range of dynamic behavior is ruled out a priori if d is restricted to integer values" (p. 263).

4.1.4 The Problem of Structural Breaks

The tests mentioned above do not include structural breaks. Many researchers have pointed out that ignoring the possibility of structural breaks may lead to inaccurate conclusions in the presence of such breaks (see, e.g., Lee & Strazicich, 2003). To address this problem, some tests use models with one or two dummy variables to capture structural breaks. An example of such a model is cited by Lee and Strazicich (2003), where B_{1t} and B_{2t} below denote structural breaks:

$$y_t = \mu_0 + d_1 B_{1t} + d_2 B_{2t} + y_{t-1} + v_{1t} \qquad (4.5)$$

In the model above, if $d_1 = d_2 = 0$ cannot be rejected, then the unit root hypothesis is supported and vice-versa. Nonetheless, Chang and Su (2014) point out three main problems with this kind of test. First, there is a "pre-selection bias" resulting from the estimation of the number and position of structural breaks when they are unknown, which is common according to the authors. Second, by using dummy variables, it is assumed that the structural breaks happen "instantaneously and abruptly" rather than "gradually" and this may cause a bias toward falsely accepting the "structuralist theory". Third, since most of these tests use only one or two dummy variables to demonstrate only one or two breaks, they lose power if there are more than two breaks.

4.1.5 Coping with Non-Linearities: Fourier Approximations

Another criticism for traditional unit root tests is the use of linear models while the unemployment rate dynamics may be non-linear. For example, Lee (2010) mentions that "…literature has documented that nonlinearities in unemployment rates are present due to cyclical asymmetries or idiosyncratic factors specific to the labor market…[hence] the commonly used linear unit root tests… may have a low power when the unemployment rate displays nonlinear behavior" (p. 1097). Enders and Lee (2012) propose a unit root test that aims to accommodate for nonlinear trends as well as structural breaks whose position and number are unknown and that can occur smoothly and gradually rather than abruptly by using a Fourier approximation. Fourier approximation can improve the size and power properties of the test by decreasing the number of parameters that need to be estimated and it can save the researcher from the need to estimate or assume the number, location and form of structural breaks according to the authors. Enders and Lee (2012) propose the following model:

$$y_t = d(t) + \rho y_{t-1} + \gamma . t + \varepsilon_t \qquad (4.6)$$

They use a Fourier expansion to approximate $d(t)$ as follows:

$$d(t) = \alpha_0 + \sum_{k=1}^{n} \alpha_k \sin(2\pi kt/T) + \sum_{k=1}^{n} \beta_k \cos(2\pi kt/T)\,; \;\; n \leq T/2, \qquad (4.7)$$

"…where n represents the number of cumulative frequencies contained in the approximation, k represents a particular frequency, and T is the number of observations" (Enders & Lee, 2012, p.575). If the trend is linear, then α_k and β_k will both equal zero and $d(t) = \alpha_0$, and the model becomes identical to the one suggested by Dickey and Fuller (1979) with an intercept and a linear trend.

4.1.6 Panel Data

Chang and Su (2014) point out that "much of the difference in disaggregated unemployment rates will be masked in the aggregate data" (p. 302). This means that, for example, using an unemployment time series at the national level may lead to accepting the "natural rate" hypothesis, but if we test unemployment time series at a provincial level, or for different educational and demographic categories, we may get support for the "natural rate" hypothesis in some of the series and support for "hysteresis" in the other. This leads to different conclusions and different policy recommendations for each category. Therefore, Chang and Su (2014) suggest that panel approaches could give unit root tests higher power through the use of cross sectional data. However, two main problems with panel approaches are noted. First, in many cases, cross-sectional independence is assumed rather than tested; and ignoring cross-sectional dependence can make the tests biased (Chang & Su, 2014). Second, many existing panel approaches are ineffective in separating which of the tested series are stationary and which are not (Chang & Su, 2014).

4.1.7 Multi-Variate Models and The Unobserved Components Approach

Furthermore, some economists, like Moller (2013) call for the use of multivariate models. Moller (2013) says that univariate models focus on testing for the presence (or absence) of "hysteresis in unemployment" and ignore the underlying causes of the changes in unemployment rates and this may lead to drawing false conclusions according to the author.

An important task when using multivariate models is to correctly identify relevant variables and to properly distinguish between "endogenous" and "exogenous" variables (Moller, 2013). Moller (2013) says that by correctly identifying and testing for the source(s) of movement in the unemployment rate, one can accurately conclude whether the unemployment rate is stuck away from its "natural rate" due to slow adjustment in "endogenous" variables, like wages for example, or whether the "natural rate" itself is changing due to changes in "exogenous" variables, like oil prices for example, or whether both things are happening at the same time.

Another approach that stresses the importance of testing the sources of movement in the unemployment rate is the "unobserved components approach". This approach has been suggested by Jaeger and Parkinson (1990) using a linear framework, and by Perez-Alonso and Di Sanzo (2011) using a non-linear framework. Both papers point out the importance of differentiating between "cyclical and natural shocks" and that the traditional univariate approaches don't do so. Perez-Alonso and Di Sanzo (2011) say that "… the presence of a unit root in the unemployment rate is a necessary condition for the existence of hysteresis but not a sufficient one …" (p. 2). The "unobserved components approach" tries to use information available on observable variables, like capacity utilization for example, to separate between what is "cyclical" and what is "natural" in the unemployment rate dynamics (Jaeger & Parkinson, 1990; Perez-Alonso & Di Sanzo, 2011). Again, the authors point out that under this approach, it is important to properly identify relevant variables and whether they relate to "cyclical" or "natural" unemployment. Preferably, to make the test simpler, it is suggested to use a variable that doesn't need to be broken down into "cyclical" or "natural" itself (Jaeger & Parkinson, 1990). Jaeger and Parkinson (1990) present three main equations:

$$U_t = U_t^N + U_t^C \qquad (4.8)$$

U_t is total unemployment rate, U_t^N is the "natural" component and U_t^C is the "cyclical" component. U_t^C is presented with a second order difference equation, an assumption that can be relaxed according to the authors:

$$U_t^C = \emptyset_1 U_{t-1}^C + \emptyset_2 U_{t-2}^C + \varepsilon_t^C \qquad (4.9)$$[1]

ε_t^C represents "cyclical" shocks while ε_t^N in the next equation represents "natural" shocks. U_t^N is presented as per equation (4.10) below. Θ measures the effects of a lagged cyclical shock (ε_{t-1}^C) on the "natural" component of unemployment (i.e. the effects that don't decay with time, which means "hysteresis" effects). If $\Theta = 0$, then the "natural rate" is <u>not</u> affected by such effects.

$$U_t^N = U_{t-1}^N + \varepsilon_t^N + \Theta\varepsilon_{t-1}^C \qquad (4.10)$$

[1] In the original paper Jaeger and Parkinson, U_{t-2}^C was mistakenly typed as U_{t-1}^C

Jaeger and Parkinson (1990) link U_t^C to capacity utilization, as an example of an observable variable correlated to "cyclical" unemployment, and perform their testing. On the other hand, Perez-Alonso and Di Sanzo (2011) believe that the potential presence of structural breaks and non-linearity in unemployment dynamics limits the accuracy of the linear approach shown above. Therefore, they modify equation (4.10) as follows:

$$U_t^N = \begin{cases} U_{t-1}^N + \alpha_1 U_{t-1}^C + \varepsilon_t^N, \ U_{t-1} \geq \gamma \\ U_{t-1}^N + \alpha_2 U_{t-1}^C + \varepsilon_t^N, \ U_{t-1} < \gamma \end{cases} \qquad (4.11)$$

γ is a particular threshold unemployment rate that needs to be identified by the reseacher. The authors say that the above specification (4.11) allows for the possibility that the effect of shocks can be different depending on the condition of the economy (Perez-Alonso & Di Sanzo, 2011). Hence, the test becomes as follows:

1) If $\alpha_1 = \alpha_2 = 0$, then there is no support for hysteresis.
2) If $\alpha_1 = \alpha_2 \neq 0$, then there is support for linear hysteresis.
3) If $\alpha_1 \neq \alpha_2 \neq 0$, then there is support for non-linear hysteresis.

Like every test, this test has its weaknesses. For example, identifying γ could be subjective (Perez-Alonso & Di Sanzo, 2011). Nonetheless, the "unobserved components approach" in its non-linear version, in addition to the test of Enders and Lee (2012) mentioned earlier, can both be considered a step forward in testing for unemployment rate dynamics as non-linear specifications are taken into consideration in both these approaches.

4.1.8 Test Proliferation and Out of Sample Forecasting

Gustavsson and Österholm (2010) note that "…depending on which test the researcher prefers the conclusions reached often differ." (p. 780). This is evident in the fact that different results have been reached in papers testing for unemployment rate time series in the same countries or regions for the same periods of time. Examples of such results will be presented in the next section. This shows the importance of taking the results obtained from various tests with caution.

Gustavsson and Österholm (2010) suggest using "out-of-sample forecasting" to complement existing tests for "hysteresis in unemployment". The idea is to have two competing models, impose unit root on one and make the other stationary. Then, use these models to forecast unemployment rates and compare the forecasted rates to actual data. The actual behavior of unemployment rates is expected to affect the "forecasting performance" of each model, and the model that reflects the reality of unemployment rate dynamics must produce more accurate forecasts (Gustavsson & Österholm, 2010). The authors mention that "out-of-sample forecasting" is not meant to replace other unit root tests, yet it can be a useful tool to complement other tests when the results reached from those tests are inconclusive (Gustavsson & Österholm, 2010).

4.1.9 Testing "Genuine Hysteresis"

On the other hand, proponents of "genuine hysteresis" have proposed tests designed specifically to detect "hysteretic" behavior based on this hypothesis (see, e.g., Piscitelli, Cross, Grinfeld, & Lamba, 2000). Piscitelli, Cross, Grinfeld, and Lamba (2000) propose an algorithm to calculate the "hysteresis operator" in a model where the "hysteretic" behavior of agents at the micro level aggregates to the macro level and produces an input-output relation that can be described with a "Preisach hysteresis model" as follows:

$$y(t) = \Gamma\big(x(t)\big) = \iint_{a \geq b} g(a,b) F_{ab}\big(x(t)\big)\, da\, db \qquad (4.12)$$

Γ is the "hysteresis operator" based on (a,b) pairs of switching points which are different for each agent and $g(a, b)$ is the weight of each agent.

Nevertheless, it is admitted that there are difficulties in applying this kind of testing. For example, some authors point out the difficulty of getting accurate estimates of the switching points and/or the "non-dominated" extremums (see, e.g., Göcke, 2002; Cross, 2014). Others mention the difficulty of separating "hysteretic" behavior from other non-linear or cyclical behavior (Hughes Hallett & Piscitelli, 2002). Hughes Hallett and Piscitelli (2002) say that: "It is not that research has established that hysteresis does not apply. The problem has been that we have lacked the means to detect it clearly, and separately from other elements of market or institutional behavior" (p. 304). However, while "genuine hysteresis" may be complex and difficult to model and test, this is not a reason to discredit it.

4.1.10 Summary

The survey above is not meant to be comprehensive. The purpose of the above section was to shed some light on the main approaches that have been used to test for "hysteresis in unemployment" in addition to some criticisms to these approaches and to point out that different tests can lead to different results. The next section will go through the results presented in a variety of papers used as references to prepare this report.

4.2 A Survey of Results

In this section, examples of results from empirical papers are presented. As mentioned in the previous section, results can vary according to the tests being used.

Chang and Su (2014) tested for "hysteresis" using panel data on unemployment rates of various educational attainment categories in Taiwan. Using linear panel unit root tests that assume (rather than test for) cross-sectional independence, "hysteresis" was rejected. When structural breaks were introduced, mixed results were found. Finally, using a non-linear model, "hysteresis" was supported.

Ayala et al. (2012) used time series data on unemployment rates in 18 Latin American countries, and obtained four different results depending on the test being used. When using a linear unit root test, the conclusion was that "hysteresis" cannot be rejected for the majority of countries. Results were mixed when one structural break was included. The "structuralist theory" was supported for most of the countries when two structural breaks were included. Finally, using fractional integration, "hysteresis" was supported for the majority of countries and "persistence" was supported for the remaining countries.

Mota and Vasconcelos (2012) used Portuguese firm-level monthly data from January 1995 to December 2005, and found that the "…behavior of aggregate employment is better explained by the model that considers hysteresis in the relationship between product demand (represented by real sales) and the level of employment. Also, we find signs of hysteresis in the relationship between interest rates and employment. This has important implications for the role of monetary policy" (p.110).

Perez-Alonso and Di Sanzo (2011) found support for "hysteresis" using quarterly time series data on unemployment and real GDP in Italy (from 1970 to 2002) and the United States (from 1965 to 2002). The authors used the unobserved components approach for testing.

Lee (2010) applied panel unit root testing using data from 29 OECD countries, and found support for the "natural rate of unemployment" in 23 countries and for "hysteresis in unemployment" in the remaining 6 countries.

Kula and Aslan (2010) used panel data on unemployment by educational attainment in 17 OECD countries for periods between 12 to 27 years (depending on the country). The authors found support for "hysteresis" for workers with lower educational attainment (primary and secondary school), while "hysteresis" was rejected for workers with higher educational attainment (post-secondary).

Lee, Lee and Chang (2009) used panel data on unemployment from 19 OECD countries in the period between 1960 and 2004. They used models with structural breaks and found that the data is best described by the "structuralist theory".

Gomes and da Silva (2009) found mixed results when testing for unemployment in Brazilian regions. Lin, Kuo, and Yuan (2008) also found mixed results using panel data on unemployment in 16 OECD countries.

Chang, Lee, Nieh, and Wei (2005) used panel data on unemployment from 10 European countries in the period between 1961 and 1999 and found support for "hysteresis" in 8 out 10 countries.

Leon-Ledesma (2002) used panel data from 51 American states and 12 European countries in the period from 1985 to 1999 and found that "hysteresis" was rejected for the United States but supported for European countries. Roed (2002) used unemployment data from 10 OECD countries for the period between 1960 and 1995 and found that "hysteresis" is supported in 9 countries.

Smyth and Easaw (2001) found support for "hysteresis" using time series data from the United States between 1948 and 1998. In addition, Koustas and Veloce (1996) found high "degree of persistence" in the unemployment rate in Canada using quarterly post-war time series data. Last but not least, Graafland (1991) found support for "hysteresis" in Netherlands using time series data for the period between 1966 and 1987.

4.3 Meta-Regression Analysis (MRA)[2]

Rather than testing an unemployment time series directly, it has been suggested that meta-regression analysis (MRA) can be used to validate (or invalidate) the "natural rate" or "hysteresis" hypotheses through *testing the empirical literature* that has tested these two hypotheses. Stanley (2013) defines this method as follows: "Meta-analysis is the statistical analysis of an entire research literature. It seeks to summarize, evaluate, and analyse what we know about a given empirical question, phenomenon, or effect… Like meta-analysis, MRA includes and summarizes all empirical estimates of a given effect. However, unlike other meta-analyses in other disciplines, MRA always involves a multiple regression that accounts for routine misspecification biases and genuine systematic differences found among reported econometric estimates" (p. 207).

4.3.1 Initial Steps in MRA

The first step in performing an MRA is to gather all the empirical literature that test the hypothesis of interest (the "natural rate" or "hysteresis" for example). To be correctly pooled in an MRA, empirical papers must be testing for the same hypothesis, estimating the same parameter(s), and reporting the necessary test statistics. Therefore, it is understood

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[2] This section is based on three papers by T.D. Stanley: Stanley (2004), Stanley (2005) and Stanley (2013).

that it would be appropriate to combine papers that test for "hysteresis" using the tests of Dickey and Fuller (1979) and Phillips and Perron (1988), for example. However, combining these papers with tests that make the "natural rate" as the null hypothesis, like the Kwiatkowski et al. (1992) for example, in one MRA might be problematic. The second step in an MRA is to convert different restriction tests from different papers into a "common metric" to facilitate comparison. The third step is to select "moderator variables" that reflect the differences between the tests from different papers which may in turn explain the different results that has been reached in these papers. For example, two papers using the same test may have different sample sizes, so a "moderator variable" will be included in an MRA to reflect such differences.

4.3.2 Meta-Significance Testing (MST) and Precision-Effect Testing (PET)

Stanley (2005) says that an MRA test can be performed after these three steps, and he mentions two sub-tests in such an analysis: meta-significance testing (MST) and precision-effect testing (PET). The logic behind the first test, MST, can be presented as follows: "Suppose that the question under investigation is whether some parameter…is in fact equal to zero...When H_0 is true, estimates of this parameter will vary randomly around zero, and the associated standardized test statistic (often a t-statistic) will not show any systematic relation to the study's degrees of freedom, or to its sample size… On the other hand, when the alternative hypothesis is true, statistical power causes the observed magnitude of the standardized test statistic to vary with degrees of freedom" (Stanley, 2005, p. 614). Therefore, an MST will test the relationship between the reported test statistics and degrees of freedom across the studies gathered in the first step mentioned earlier. Stanley (2005) cites the following model for MST and says that it can be applied to “any statistical test”,

$$E(ln\ |t|) = \beta_0 + \beta_1 lndf \qquad (4.13)$$

df stands for “degrees of freedom”. If the null hypothesis is true, then $\beta_1 = 0$, and the expected value of the t-statistic will not have a systematic relation with the degrees of freedom as mentioned. According to Stanley (2005), this testing is not adversely affected by problems like publication bias, which is the tendency to publish studies with ‘statistically significant’ results and neglect those with ‘statistically insignificant’ results. However, if big and random misspecification errors are common in the empirical literature from which the information is extracted, then this will skew the reported t-statistics from these studies and could lead to inaccurate conclusions from the MST.

To complement the previous test and to account for publication bias, PET is performed. PET is based on the notion that the relationship between an estimated parameter and the standard error reported in a study can be modelled as follows:

$$t_i = \gamma_0 + \gamma_1 \left(\frac{1}{Se_i}\right) + e_i \qquad (4.14)$$

t_i is the reported t-statistic in the *i*th study, γ_1 is the true value of the parameter in question, and Se_i is the standard error from the *i*th study. Stanley (2005) says that the estimated values of the parameter in different studies must vary randomly around the true value, if there is no publication bias.

Proponents of MRA, like Stanley, argue that combining the results of MST and PET on a full set of empirical literature on a certain hypothesis can help make more accurate conclusions about the validity of that hypothesis after filtering the effects of misspecification, small-sample, and publication biases. Stanley (2004) and Stanley (2005) perform two separate MRAs, the first includes 24 studies with estimates of unemployment persistence for 99 countries, while the second includes 9 studies with 34 tests for the "natural rate" hypothesis. The first MRA supports "hysteresis" with a t-value more than 9, while the second MRA rejects the "natural rate" hypothesis with a t-value more than 10. Referring to the "natural rate" hypothesis, Stanley (2005) concludes that such "…results are what classical statistical theory predicts for an empirically false hypothesis" (p. 626).

4.3.3 Conclusion

Like every approach, MRA has some drawbacks. For example, the task of gathering "all" the empirical studies that test a particular hypothesis, though it is easier with today's technology than it has ever been, is still a difficult task especially if the aim is to include studies that have not been published in addition to the published ones. Moreover, it has been noted that an MRA is as good as the studies it includes. Nonetheless, despite the fact that results of MRA have to be taken with caution like any other econometric test, the results mentioned above send a message that the possible invalidity of the "natural rate" hypothesis has to be taken more seriously.

4.4 Summary

Empirical literature on unemployment is full of studies that support one hypothesis or the other. An objective researcher surveying the different tests that have been applied can reach two conclusions. First, each testing approach has some weaknesses. Second, and partly due to the first, neither the "natural rate" hypothesis nor "hysteresis" have gained unquestionable support from empirical studies. However, since many studies using different testing approaches have shown support for the existence of “hysteresis” effects in unemployment, such effects must no longer be ignored when formulating economic policy. In addition, the “natural rate” hypothesis must stop being presented as the prevalent hypothesis on long-run unemployment.

Chapter 5. Testing for "Hysteresis in Unemployment" in Canadian Provinces

This chapter is dedicated to report the results from testing unemployment rates in the Canadian provinces to check whether the rate in each province reverts to a "natural rate", or is subject to "hysteresis" effects.

5.1 Data Description, White-Noise Testing, and Correlograms

5.1.1 Data Description

The data used is time series data on the annual average unemployment rates during the last 40 years (from 1976 to 2015) in each Canadian province. The source of data is the Labor Force Survey from Statistics Canada[3]. Table 5.1 below shows descriptive statistics for each province.

Table 5.1 Descriptive statistics of 40 years unemployment rates per province, %

Province	Mean	Standard Deviation	Min	Max	Range
Alberta (AB)	6.3	2.3	3.5	11.3	7.8
British Columbia (BC)	8.6	2.5	4.3	15.0	10.7
Manitoba (MN)	6.4	1.6	4.2	9.5	5.3
New Brunswick (NB)	11.4	1.9	7.5	15.2	7.7
Newfoundland and Labrador (NL)	16.1	2.5	11.6	20.2	8.6
Nova Scotia (NS)	10.5	1.8	7.6	14.3	6.7
Ontario (ON)	7.5	1.5	5.0	10.9	5.9
Prince Edward Island (PEI)	12.4	2.1	9.3	17.6	8.3
Quebec (QC)	10.0	2.0	7.2	14.2	7.0
Saskatchewan (SA)	5.8	1.4	3.8	8.3	4.5

[3] http://www.stats.gov.nl.ca/statistics/Labour/PDF/UnempRate.pdf

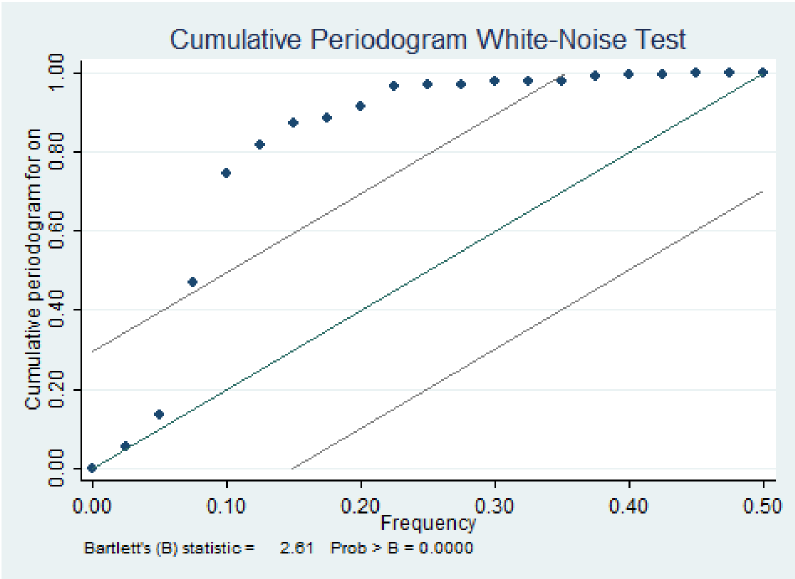
We can observe big differences between provinces from the Table 5.1. For example, the difference between the lowest average (5.8% in SA) and the highest average (16.1% in NL) is more than 10%. There are also notable differences in the ranges of unemployment rates in each province. Therefore, this might be an indication that unemployment in different provinces reacts differently to shocks, and that some provinces might be more subject to "hysteresis" effects than others due to structural and/or other reasons.

5.1.2 White-Noise Testing

Gujarati (1995) says that if the process generating the time series data is purely random, or in other words, it displays a white noise process, then the time series is stationary. To illustrate, consider the first-difference of a difference equation with a unit root. When an equation with a unit root like $Y_t = Y_{t-1} + \varepsilon_t$ is transformed into its first-difference ($\Delta Y_t = Y_t - Y_{t-1} = \varepsilon_t$), the first-difference, which is stationary, is displaying a purely random white noise process (Gujarati, 1995). Therefore, the logic behind the white-noise testing is to test whether the process generating the time series data (the unemployment rate time series data for each province in our case) is purely random (i.e. the time series is stationary) or not. The white-noise testing used in this report is known as Bartlett's Cumulative Periodogram White-Noise Test, in reference to Bartlett (1955). The null hypothesis in this test is that the time series data is generated from a purely random, white-noise process (i.e. that the time series is stationary). If the null hypothesis cannot be rejected, then the time series is deemed as stationary. However, if the null is rejected, this does not necessarily mean that "hysteresis" holds, it just gives us a good starting point by ruling out the possibility that the data generating process is purely random.

White-noise process hypothesis is rejected for all provinces except Ontario, as shown in the figure below, which gives an indication that "hysteresis in unemployment" may not hold in the case of Ontario.

Figure 5. 1. Cumulative Periodogram for the Unemployment Rate Time Series in ON

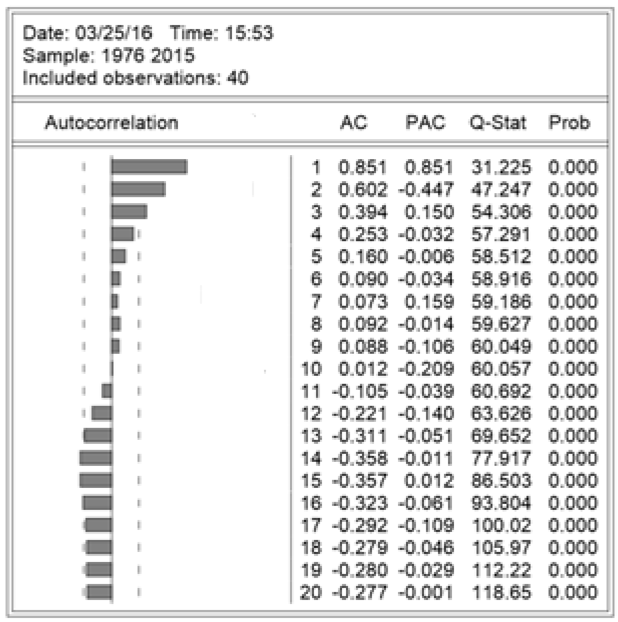


5.1.3 Correlograms

According to Gujarati (1995), a correlogram plots the values of the autocorrelation function of a time series at different time lags. An autocorrelation function is the covariance at each lag divided by the variance. Gujarati (1995) mentions that if a time series is stationary, then the autocorrelation coefficient will converge to zero. In contrast, if the time series is non-stationary (which is an indication of "hysteresis"), then the autocorrelation coefficient will not converge to zero even after many lags (Gujarati, 1995). Hence, the correlogram of the unemployment rate time series of a province can give an indication as to whether the unemployment rate in that province is subject to "hysteresis" or not. It must be noted that this is <u>not</u> a formal test of stationarity. However, if the correlograms lead to conclusions similar to the results of the unit root tests presented in the next section, then this gives support for these results. Figures 5.2 to 5.11 below show the correlogram for each province.

Figure 5. 2. Correlogram for the Unemployment Rate Time Series in AB

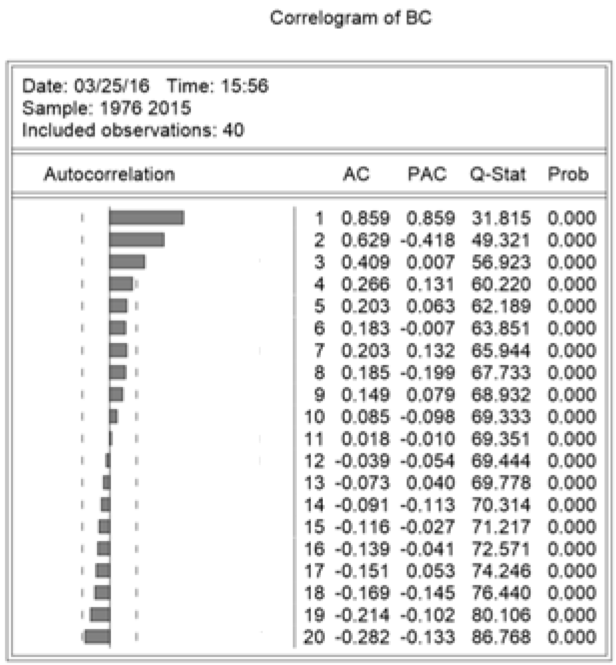
Correlogram of AB



Date: 03/25/16 Time: 15:53
Sample: 1976 2015
Included observations: 40

Autocorrelation		AC	PAC	Q-Stat	Prob
	1	0.851	0.851	31.225	0.000
	2	0.602	-0.447	47.247	0.000
	3	0.394	0.150	54.306	0.000
	4	0.253	-0.032	57.291	0.000
	5	0.160	-0.006	58.512	0.000
	6	0.090	-0.034	58.916	0.000
	7	0.073	0.159	59.186	0.000
	8	0.092	-0.014	59.627	0.000
	9	0.088	-0.106	60.049	0.000
	10	0.012	-0.209	60.057	0.000
	11	-0.105	-0.039	60.692	0.000
	12	-0.221	-0.140	63.626	0.000
	13	-0.311	-0.051	69.652	0.000
	14	-0.358	-0.011	77.917	0.000
	15	-0.357	0.012	86.503	0.000
	16	-0.323	-0.061	93.804	0.000
	17	-0.292	-0.109	100.02	0.000
	18	-0.279	-0.046	105.97	0.000
	19	-0.280	-0.029	112.22	0.000
	20	-0.277	-0.001	118.65	0.000

Figure 5. 3. Correlogram for the Unemployment Rate Time Series in BC

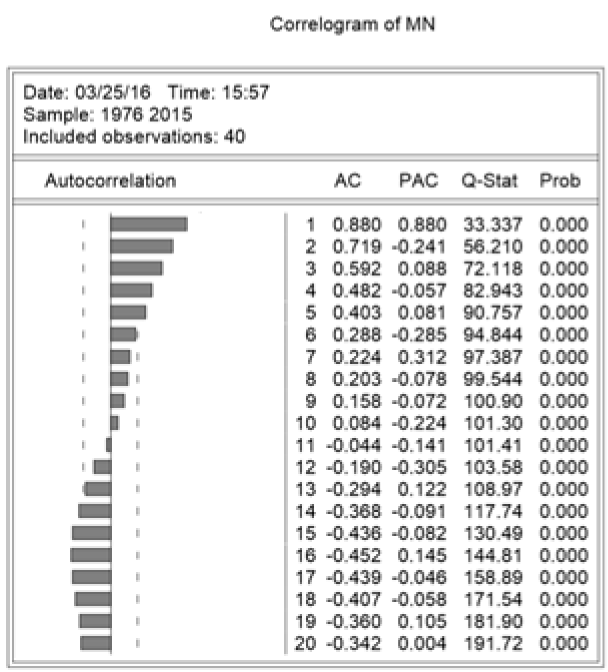


Correlogram of BC

Date: 03/25/16 Time: 15:56
Sample: 1976 2015
Included observations: 40

Autocorrelation		AC	PAC	Q-Stat	Prob
	1	0.859	0.859	31.815	0.000
	2	0.629	-0.418	49.321	0.000
	3	0.409	0.007	56.923	0.000
	4	0.266	0.131	60.220	0.000
	5	0.203	0.063	62.189	0.000
	6	0.183	-0.007	63.851	0.000
	7	0.203	0.132	65.944	0.000
	8	0.185	-0.199	67.733	0.000
	9	0.149	0.079	68.932	0.000
	10	0.085	-0.098	69.333	0.000
	11	0.018	-0.010	69.351	0.000
	12	-0.039	-0.054	69.444	0.000
	13	-0.073	0.040	69.778	0.000
	14	-0.091	-0.113	70.314	0.000
	15	-0.116	-0.027	71.217	0.000
	16	-0.139	-0.041	72.571	0.000
	17	-0.151	0.053	74.246	0.000
	18	-0.169	-0.145	76.440	0.000
	19	-0.214	-0.102	80.106	0.000
	20	-0.282	-0.133	86.768	0.000

Figure 5. 4. Correlogram for the Unemployment Rate Time Series in MN



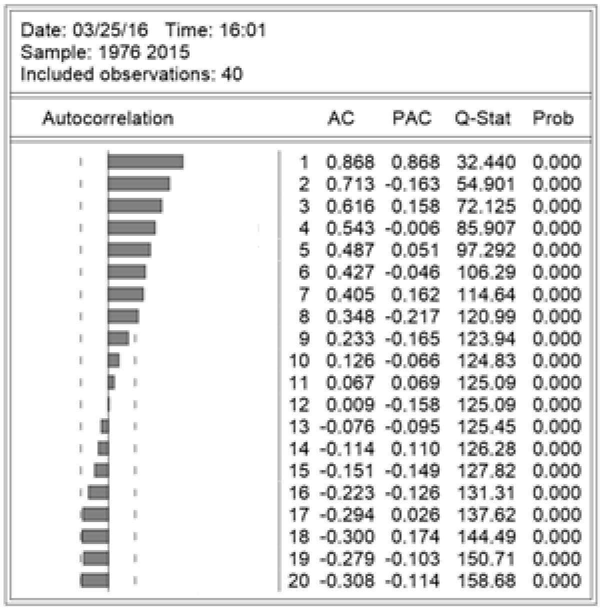
Correlogram of MN

Date: 03/25/16 Time: 15:57
Sample: 1976 2015
Included observations: 40

Autocorrelation		AC	PAC	Q-Stat	Prob
	1	0.880	0.880	33.337	0.000
	2	0.719	-0.241	56.210	0.000
	3	0.592	0.088	72.118	0.000
	4	0.482	-0.057	82.943	0.000
	5	0.403	0.081	90.757	0.000
	6	0.288	-0.285	94.844	0.000
	7	0.224	0.312	97.387	0.000
	8	0.203	-0.078	99.544	0.000
	9	0.158	-0.072	100.90	0.000
	10	0.084	-0.224	101.30	0.000
	11	-0.044	-0.141	101.41	0.000
	12	-0.190	-0.305	103.58	0.000
	13	-0.294	0.122	108.97	0.000
	14	-0.368	-0.091	117.74	0.000
	15	-0.436	-0.082	130.49	0.000
	16	-0.452	0.145	144.81	0.000
	17	-0.439	-0.046	158.89	0.000
	18	-0.407	-0.058	171.54	0.000
	19	-0.360	0.105	181.90	0.000
	20	-0.342	0.004	191.72	0.000

Figure 5. 5. Correlogram for the Unemployment Rate Time Series in NB

Correlogram of NB

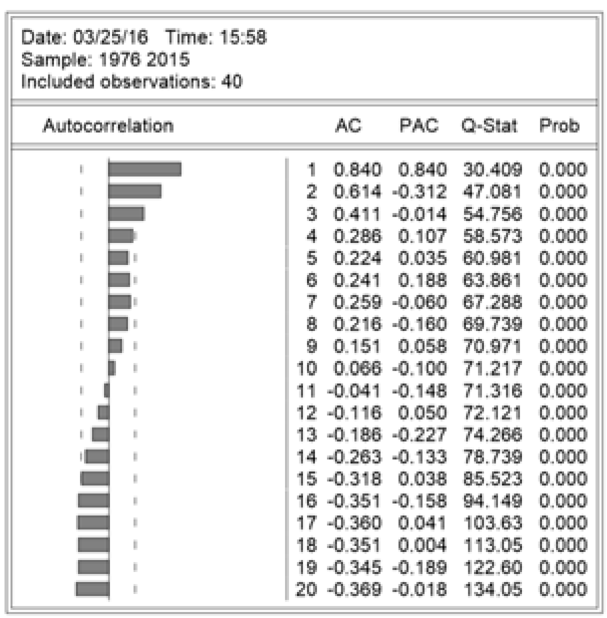


Date: 03/25/16 Time: 16:01
Sample: 1976 2015
Included observations: 40

	AC	PAC	Q-Stat	Prob
1	0.868	0.868	32.440	0.000
2	0.713	-0.163	54.901	0.000
3	0.616	0.158	72.125	0.000
4	0.543	-0.006	85.907	0.000
5	0.487	0.051	97.292	0.000
6	0.427	-0.046	106.29	0.000
7	0.405	0.162	114.64	0.000
8	0.348	-0.217	120.99	0.000
9	0.233	-0.165	123.94	0.000
10	0.126	-0.066	124.83	0.000
11	0.067	0.069	125.09	0.000
12	0.009	-0.158	125.09	0.000
13	-0.076	-0.095	125.45	0.000
14	-0.114	0.110	126.28	0.000
15	-0.151	-0.149	127.82	0.000
16	-0.223	-0.126	131.31	0.000
17	-0.294	0.026	137.62	0.000
18	-0.300	0.174	144.49	0.000
19	-0.279	-0.103	150.71	0.000
20	-0.308	-0.114	158.68	0.000

Figure 5. 6. Correlogram for the Unemployment Rate Time Series in NL

Correlogram of NL



Date: 03/25/16 Time: 15:58
Sample: 1976 2015
Included observations: 40

	AC	PAC	Q-Stat	Prob
1	0.840	0.840	30.409	0.000
2	0.614	-0.312	47.081	0.000
3	0.411	-0.014	54.756	0.000
4	0.286	0.107	58.573	0.000
5	0.224	0.035	60.981	0.000
6	0.241	0.188	63.861	0.000
7	0.259	-0.060	67.288	0.000
8	0.216	-0.160	69.739	0.000
9	0.151	0.058	70.971	0.000
10	0.066	-0.100	71.217	0.000
11	-0.041	-0.148	71.316	0.000
12	-0.116	0.050	72.121	0.000
13	-0.186	-0.227	74.266	0.000
14	-0.263	-0.133	78.739	0.000
15	-0.318	0.038	85.523	0.000
16	-0.351	-0.158	94.149	0.000
17	-0.360	0.041	103.63	0.000
18	-0.351	0.004	113.05	0.000
19	-0.345	-0.189	122.60	0.000
20	-0.369	-0.018	134.05	0.000

Figure 5. 7. Correlogram for the Unemployment Rate Time Series in NS

Correlogram of NS

Date: 03/25/16 Time: 16:04
Sample: 1976 2015
Included observations: 40

	AC	PAC	Q-Stat	Prob
1	0.864	0.864	32.155	0.000
2	0.664	-0.325	51.650	0.000
3	0.499	0.085	62.944	0.000
4	0.363	-0.065	69.093	0.000
5	0.255	0.003	72.209	0.000
6	0.198	0.104	74.149	0.000
7	0.224	0.231	76.710	0.000
8	0.244	-0.144	79.830	0.000
9	0.214	-0.082	82.320	0.000
10	0.148	-0.104	83.541	0.000
11	0.053	-0.121	83.703	0.000
12	-0.072	-0.146	84.010	0.000
13	-0.181	0.046	86.046	0.000
14	-0.251	-0.087	90.127	0.000
15	-0.299	-0.118	96.139	0.000
16	-0.331	-0.069	103.80	0.000
17	-0.351	-0.082	112.79	0.000
18	-0.340	0.043	121.62	0.000
19	-0.320	0.034	129.83	0.000
20	-0.345	-0.196	139.84	0.000

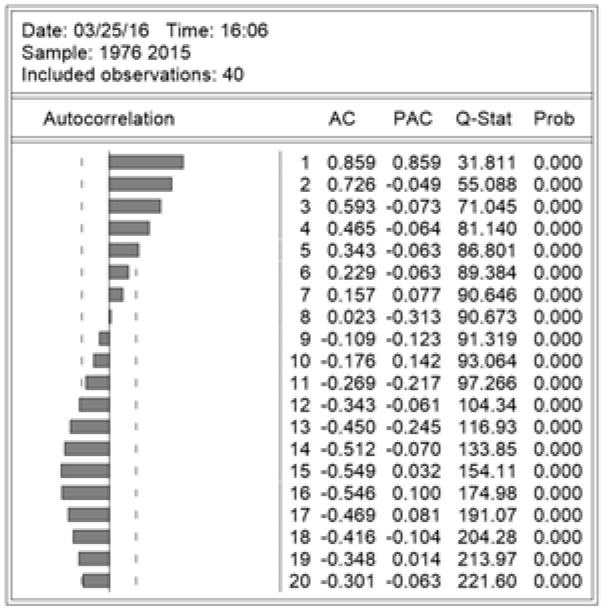
Figure 5. 8. Correlogram for the Unemployment Rate Time Series in ON

Correlogram of ON

Date: 03/25/16 Time: 16:05
Sample: 1976 2015
Included observations: 40

	AC	PAC	Q-Stat	Prob
1	0.725	0.725	22.636	0.000
2	0.290	-0.496	26.354	0.000
3	-0.091	-0.127	26.727	0.000
4	-0.332	-0.124	31.879	0.000
5	-0.442	-0.156	41.250	0.000
6	-0.489	-0.263	53.052	0.000
7	-0.350	0.206	59.301	0.000
8	-0.123	-0.078	60.098	0.000
9	0.077	-0.063	60.415	0.000
10	0.156	-0.136	61.786	0.000
11	0.147	0.018	63.039	0.000
12	0.087	-0.179	63.497	0.000
13	0.048	0.140	63.639	0.000
14	-0.014	-0.181	63.652	0.000
15	-0.087	-0.018	64.156	0.000
16	-0.071	0.066	64.508	0.000
17	-0.013	-0.004	64.521	0.000
18	0.054	-0.095	64.745	0.000
19	0.041	-0.046	64.878	0.000
20	-0.038	-0.153	65.000	0.000

Figure 5. 9. Correlogram for the Unemployment Rate Time Series in PEI

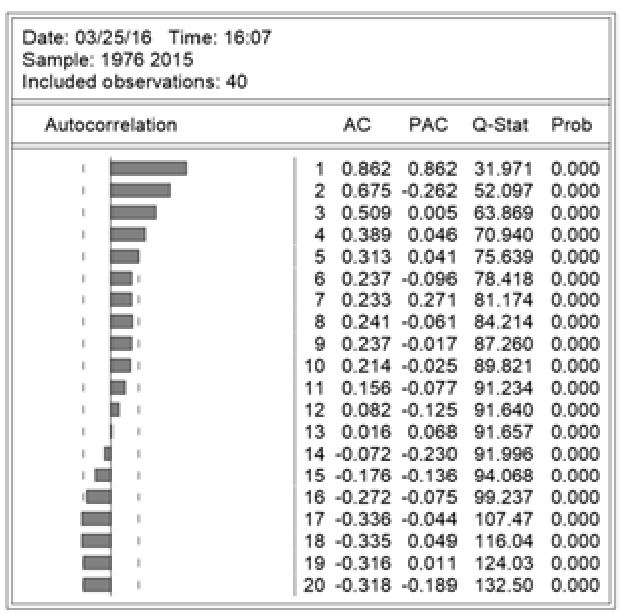


Correlogram of PEI

Date: 03/25/16 Time: 16:06
Sample: 1976 2015
Included observations: 40

Autocorrelation		AC	PAC	Q-Stat	Prob
	1	0.859	0.859	31.811	0.000
	2	0.726	-0.049	55.088	0.000
	3	0.593	-0.073	71.045	0.000
	4	0.465	-0.064	81.140	0.000
	5	0.343	-0.063	86.801	0.000
	6	0.229	-0.063	89.384	0.000
	7	0.157	0.077	90.646	0.000
	8	0.023	-0.313	90.673	0.000
	9	-0.109	-0.123	91.319	0.000
	10	-0.176	0.142	93.064	0.000
	11	-0.269	-0.217	97.266	0.000
	12	-0.343	-0.061	104.34	0.000
	13	-0.450	-0.245	116.93	0.000
	14	-0.512	-0.070	133.85	0.000
	15	-0.549	0.032	154.11	0.000
	16	-0.546	0.100	174.98	0.000
	17	-0.469	0.081	191.07	0.000
	18	-0.416	-0.104	204.28	0.000
	19	-0.348	0.014	213.97	0.000
	20	-0.301	-0.063	221.60	0.000

Figure 5. 10. Correlogram for the Unemployment Rate Time Series in QC

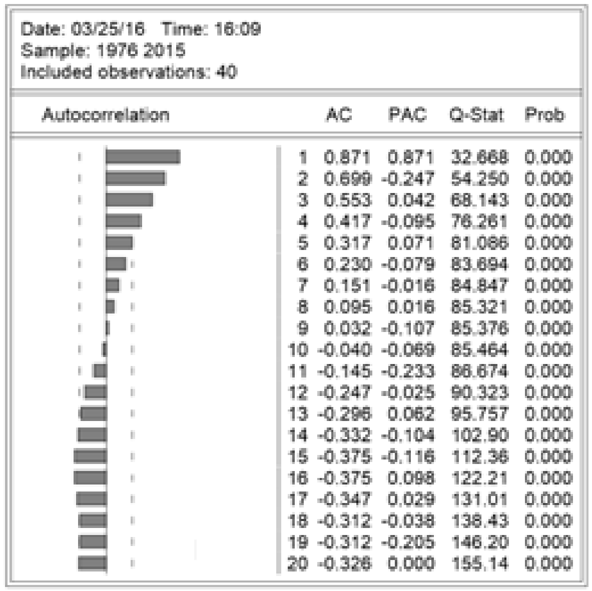


Correlogram of QC

Date: 03/25/16 Time: 16:07
Sample: 1976 2015
Included observations: 40

Autocorrelation		AC	PAC	Q-Stat	Prob
	1	0.862	0.862	31.971	0.000
	2	0.675	-0.262	52.097	0.000
	3	0.509	0.005	63.869	0.000
	4	0.389	0.046	70.940	0.000
	5	0.313	0.041	75.639	0.000
	6	0.237	-0.096	78.418	0.000
	7	0.233	0.271	81.174	0.000
	8	0.241	-0.061	84.214	0.000
	9	0.237	-0.017	87.260	0.000
	10	0.214	-0.025	89.821	0.000
	11	0.156	-0.077	91.234	0.000
	12	0.082	-0.125	91.640	0.000
	13	0.016	0.068	91.657	0.000
	14	-0.072	-0.230	91.996	0.000
	15	-0.176	-0.136	94.068	0.000
	16	-0.272	-0.075	99.237	0.000
	17	-0.336	-0.044	107.47	0.000
	18	-0.335	0.049	116.04	0.000
	19	-0.316	0.011	124.03	0.000
	20	-0.318	-0.189	132.50	0.000

Figure 5. 11. Correlogram for the Unemployment Rate Time Series in SA



Correlogram of SA

Date: 03/25/16 Time: 16:09
Sample: 1976 2015
Included observations: 40

Autocorrelation		AC	PAC	Q-Stat	Prob
	1	0.871	0.871	32.668	0.000
	2	0.699	-0.247	54.250	0.000
	3	0.553	0.042	68.143	0.000
	4	0.417	-0.095	76.261	0.000
	5	0.317	0.071	81.086	0.000
	6	0.230	-0.079	83.694	0.000
	7	0.151	-0.016	84.847	0.000
	8	0.095	0.016	85.321	0.000
	9	0.032	-0.107	85.376	0.000
	10	-0.040	-0.069	85.464	0.000
	11	-0.145	-0.233	86.674	0.000
	12	-0.247	-0.025	90.323	0.000
	13	-0.296	0.062	95.757	0.000
	14	-0.332	-0.104	102.90	0.000
	15	-0.375	-0.116	112.36	0.000
	16	-0.375	0.098	122.21	0.000
	17	-0.347	0.029	131.01	0.000
	18	-0.312	-0.038	138.43	0.000
	19	-0.312	-0.205	146.20	0.000
	20	-0.326	0.000	155.14	0.000

For 7 provinces, the correlograms (Figures 5.4 to 5.7 and 5.9 to 5.11) show that the autocorrelation coefficient does not converge to zero even after 20 lags. This means that the effect of a shock does not fade away with time (Gujarati, 1995), and therefore stays in the "memory" of the process that is generating the time series data, which implies "hysteresis". For Alberta and British Columbia, the correlograms (figures 5.2 and 5.3) show possible convergence to zero, but the outcome is vague and needs further investigation through formal testing. Finally, Figure 5.8 for Ontario supports the conclusion from the white-noise testing, since the autocorrelation coefficient clearly converges to zero. Hence, the results of the white-noise testing and the shapes of the correlograms give reasons to suspect "hysteresis" in 7 provinces, and to suspect that "hysteresis" may not apply in Ontario, while the outcome is vague in the cases of Alberta and British Columbia.

5.2 Unit-Root Testing

As mentioned before, the presence of a unit root in a time series is an indication of "hysteresis", since a series with a unit root is non-stationary, and further, it has long memory with strong dependence on initial conditions[4]. Although the Dickey-Fuller (1979) test may not be enough to conclude for certain whether unemployment is subject to "hysteresis", it is still a good starting point for the analysis. If this test rejects the unit root hypothesis despite its perceived bias toward accepting it, then this gives reasons to believe that "hysteresis" may not be applicable to the time series being tested. On the other hand, if the unit root hypothesis cannot be rejected with this test, then this gives a starting point to suspect the presence of "hysteresis" and to perform further investigation. Therefore, I perform the augmented Dickey-Fuller (ADF) test (see, e.g., Gujarati, 1995). The ADF test is similar to the original Dickey-Fuller (1979) test, yet in the ADF test, a number of lagged difference terms is added to the model until the error term in the model becomes serially independent (Gujarati, 1995). Noting that if a series is integrated of degree one, then its first-difference is stationary (Gujarati, 1995), this means that equations (4.1) to (4.3) from the previous chapter can be re-written as follows:

$$\Delta Y_t = \delta Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_t \qquad (5.1) \quad \text{[Model 1]}$$

$$\Delta Y_t = \mu + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_t \qquad (5.2) \quad \text{[Model 2]}$$

$$\Delta Y_t = \mu + \beta t + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_t \qquad (5.3) \quad \text{[Model 3]}$$

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[4] We can also look at the Hurst exponent and the Lyapunov exponent for the detection of non-stationarity and long memory.

In equations (5.1) to (5.3) above, $\Delta Y_t = Y_t - Y_{t-1}$ is the first difference of the unemployment rate in each time series being tested (i.e. in the time series of each province in the case of this report). The number of lags included when testing for each province was automatically determined by the statistical software using the data. The unit root hypothesis is the null hypothesis to be tested as mentioned before, and this translates into (H_0: $\delta = 0$) in the equations above (which is equivalent to ρ=1 in equations (4.1) to (4.3) from the previous chapter). For each time series, unit root testing was performed with no constant or trend (as in equation 5.1, or "Model 1"), with a constant (as in equation 5.2, or "Model 2") and with a constant and a trend (as in equation 5.3, or "Model 3"). Table 5.2 below summarizes the unit root testing results found for each province.

Table 5.2 Unit Root Hypothesis Testing Results Per Province

Province	**Model 1**	**Model 2**	**Model 3**
AB	Cannot be rejected	**Rejected at 10% level**	Cannot be rejected
BC	Cannot be rejected	Cannot be rejected	**Rejected at 10% level**
MN	Cannot be rejected	Cannot be rejected	Cannot be rejected
NB	Cannot be rejected	Cannot be rejected	Cannot be rejected
NL	Cannot be rejected	Cannot be rejected	Cannot be rejected
NS	Cannot be rejected	Cannot be rejected	Cannot be rejected
ON	Cannot be rejected	**Rejected at 1% level**	**Rejected at 5% level**
PEI	Cannot be rejected	Cannot be rejected	Cannot be rejected
QC	Cannot be rejected	Cannot be rejected	Cannot be rejected
SA	Cannot be rejected	Cannot be rejected	Cannot be rejected

Based on the results in Table 5.2, the unemployment rate in 7 provinces may be subject to "hysteresis" since the unit root hypothesis cannot be rejected with any model for these provinces. For Alberta and British Columbia, the results are less clear, since the unit root hypothesis is rejected at 10% in at least one of the models. Finally, for Ontario, the results provide strong basis to reject the unit root hypothesis. This is in line with what is expected given the results of the white-noise testing and from looking at the correlograms.

5.3 Summary

In summary, looking at the unemployment rate time series data for the Canadian provinces from three perspectives (white-noise testing, correlograms, and unit-root testing), it can be said that there is evidence of possible "hysteresis in unemployment" in most of the provinces. These results are subject to further investigation of course. For example, the presence of structural breaks and non-linearities must be accounted for using more advanced tests. However, the results reported in this chapter give a starting point for further analysis, and since the official policy of the Bank of Canada since 1991 has been inflation targeting, any indication of possible "hysteresis in unemployment" has to be taken seriously.

Chapter 6. Conclusion

The "natural rate of unemployment" hypothesis has influenced macroeconomic policies worldwide for many years. Despite mounting criticism, the NRU hypothesis has survived and remains the prevailing hypothesis on long-run unemployment. However, this report provided various theoretical reasons from the literature, and empirical results, which lead us to consider seriously the possibility that unemployment may be subject to "hysteresis". If that's the case, then we need to be wary of letting unemployment rates increase due to a belief that it will sort itself out later and return to a "natural rate".

Furthermore, proper distinctions need to be made between the different hypotheses on changes in long-run unemployment rates (i.e. between "persistence", "hysteresis" and the "structuralist theory"). Different cases may apply in different places which in turn leads to different policy recommendations. Empirical results from papers testing for the alternative hypotheses are at best mixed. Proponents of each hypothesis may highlight different studies to support their hypothesis. However, taken objectively the research can be interpreted as saying there isn't conclusive support for any of the hypotheses.

Nonetheless, the problem is that while both the theoretical and empirical literature are full of evidence that show changes in long-run unemployment rates in many countries, it seems that the possibility of "hysteresis in unemployment" is not being taken seriously by the paradigm that currently dominates economic thinking and policy-making. Ignoring "hysteresis" effects on unemployment can make economic analysis and policy-making simpler, but this simplification can be harmful and seriously damage economies (and reduce welfare) in the long-run.

In the Canadian context, the results of the tests presented in this report point out that unemployment in most of the provinces may be subject to “hysteresis”. The official inflation targeting policy of the Bank of Canada can therefore be doing serious damage for unemployment despite being successful in keeping inflation in check.

In conclusion, I believe, as suggested by many economists, that we are still far from truly understanding the complex dynamics of macroeconomic variables, including unemployment. Better understanding of these dynamics will lead to better policy recommendations that can improve societies’ welfare. Understanding “hysteresis in unemployment” and taking it more seriously can be an important contribution to this process.

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