DISSECTING US RECOVERIES

2017

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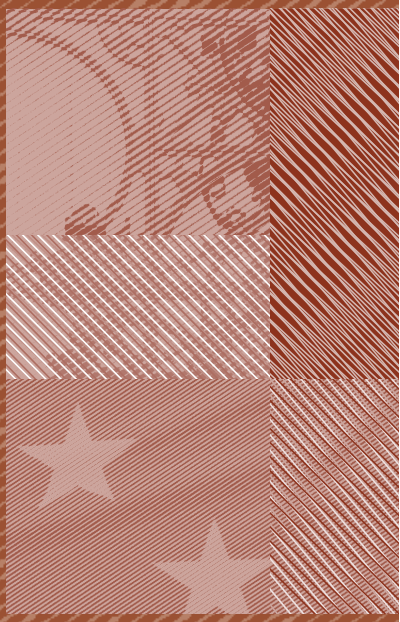

Documentos de Trabajo
N.º 1708

BANCO DE **ESPAÑA**
Eurosistema

DISSECTING US RECOVERIES [*]

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(*) M. Dolores Gadea acknowledges financial support from the Ministerio de Ciencia y Tecnología under grants ECO2014-58991-C3-1-R and ECO2014-58991-C3-2-R. The views expressed in this paper are the responsibility of the authors and do not necessarily represent those of the Banco de España or the Eurosystem.
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Documentos de Trabajo. N.º 1708

2017

ISSN: 1579-8666 (on line)

Abstract

We propose a set of new quantitative measures to characterise more fully the features of economic recoveries. We apply these measures to post-war US expansions and use cluster analysis to determine that there are two different types of recoveries in recent US economic history, with most expansions before 1984 (Great Moderation) looking quite different from those after.

Keywords: business cycles, recoveries.

JEL classification: C22, E32.

Resumen

En este trabajo, se propone un conjunto de medidas cuantitativas para capturar de forma más precisa las características de las recuperaciones económicas. Estas medidas se aplican a la economía de Estados Unidos, con datos posteriores a la Segunda Guerra Mundial. Un análisis clúster permite determinar la existencia de dos tipos diferentes de expansiones en Estados Unidos. Las recuperaciones anteriores a la Gran Moderación son claramente diferentes de las posteriores.

Palabras clave: ciclos económicos, recuperaciones.

Códigos JEL: C22, E32.

1 Introduction

The slow pace of the recovery in the US after the Great Recession is a concern for economists and policymakers [see e.g. Fernald (2014), Summers (2014) and Fischer (2014)]. GDP growth has been lower than expected and downward revisions of projections have become usual. To have a deep knowledge of the path and nature of recoveries is of great interest, as this has consequences on long-run economic activity and job creation capacity. However, since the seminal paper of Harding and Pagan (2002), in which they dissect the business cycle phases, little effort has been made to develop new measures of the features of the recoveries.[1] In this paper, we propose some new quantitative measures that enrich the analysis of the nature of recoveries. While the measures of Harding and Pagan (2002) are global and do not take into account the dynamics of recoveries, our measures allow to capture these dynamics, thus obtaining information on the different stages of recoveries. In particular, the early quarters of a recovery are key for an economy to recover the output lost during the recession. By means of a cluster analysis, we provide a comparison of different US recovery patterns, distinguishing a different behavior since the beginning of the Great Moderation (1984).[2] The results are of fundamental interest for policymakers and for macroeconomists since they allow to capture the business cycle accurately. The new measures are easily reproducible for different countries and so are expected to be useful to compare stylized facts of different expansions and relate them with other economic variables.

[1] Bec et al. (2015) are an exception, but they work in a parametric framework.
[2] See Kim and Nelson (1999) and McConnell and Perez-Quiros (2000).

2 Measures

Harding and Pagan (2002) propose four measures to examine the business cycle phases once turning points have been established by dating methods. These are (i) *duration* (in quarters), (ii) *amplitude* (which compares the log level of GDP at the turning points), (iii) *cumulation* (the cumulated gain or loss and consists of the sum of the amplitudes of each cyclical phase or total area described by the GDP in logs) and (iv) *excess* (the difference between the real area drawn by the path of the GDP growth in logs and the hypothetical triangle which would have formed with a linear growth rate throughout the whole phase).[3] A positive *Excess* (concave path) means that the recovery starts with a high growth rate that subsequently slows down, whereas a negative *Excess* (convex path) is produced when the opposite happens. If the growth is uniform over the expansion period, then the *Excess* is zero. See Figure 1 for an illustration.

Excess would be a good measure to characterize the shape of expansions if they had a clear concave, convex or linear form but, in practice, cyclical phases are not always so stylized, as can be seen in Figure 2, so that this measure is not completely accurate.

To solve the difficulty in capturing the cycles depicted by the data, we propose a set of indicators that identify the evolution of the pattern of the expansions more comprehensively. If a recovery is quick (a V-shaped recovery), the effect of the recession is transitory and the economy continues its long-run growth trend but, if the improvement occurs slowly, it may have permanent effects on the economy (a L-shaped recovery). Specifically, we propose four

[3] Sichel (1993) suggests *steepness* and *deepness* and McQueen and Thorley (1993) introduce *sharpness*. However, these measures are calculated on filtered data, while ours are based on original data and therefore are invariant to future observations.

types of measures: the first one captures the evolution over time of the shape of expansion. The second one captures the early stages of expansions, the third one focuses on the middle of the expansionary path. Finally, the fourth one shows the long-run consequences of the recoveries for future economic growth.

1. Time varying measures:

   (a) *Pointwise excess* during the expansion (E_t), being the excess at each point in time $t = 1, 2, ...\tau...T$ defined as:[4]

$$E_t(\tau) = \int_0^{\tau} f(t)dt - (\overline{0\tau} * \overline{0l(\tau)})/2 \tag{1}$$

   (b) *Acceleration of excesses*: difference of pointwise excess between two consecutive periods (ΔE_t).

$$\Delta E_t(\tau) = E_t(\tau) - E_t(\tau - 1) \tag{2}$$

2. Early stages measures:

   (a) *Early shape*: the number of consecutive positive excesses at the beginning of the expansion or minus the number of consecutive negative excesses at the beginning of the expansion, in relation to the total duration of the expansion.

$$Early\ shape = \frac{\tau^{ES}}{\overline{0T}}, \tag{3}$$

   where τ^{ES} is "i" such that $E_t(i) > 0\ \forall i$ and "$-i$" such that $E_t(i) < 0\ \forall i$.

[4]Notice that E_t is computed until each t, that means E_{t+i} can be positive despite the shape turns to convex in $t + i$.

(b) *Inshape*: the number of consecutive periods with E_t positive and ΔE_t positive or minus the number of consecutive periods with E_t negative and ΔE_t negative. This measure captures changes in the shape, from concave to convex or from convex to concave.

$$Inshape = \frac{\tau^I}{\overline{0T}}, \tag{4}$$

where τ^I is "i" such that $E_t(i) > 0$ and $\Delta E_t(i) > 0\ \forall i$ and "$-i$" so that $E_t(i) < 0$ and $\Delta E_t(i) < 0\ \forall i$.

3. Middle of expansion measures:

(a) *Half life*: number of periods τ needed to obtain half of the cumulation, relative to the total duration. A value of $\frac{1}{\sqrt{2}}$ is equivalent to a triangular path. A higher value means that it has taken longer to recover the total area, while a smaller value corresponds to fast expansions.

$$Half\ life = \frac{\tau^{HL}}{\overline{0T}}, \tag{5}$$

so that $C(\tau^{HL}) = C(T)/2$.

(b) *Medium area*: area obtained in the middle of the duration of the expansion in relation to the hypothetical triangle. We normalize the measure so that a value of 1 is equivalent to a linear path, a value below (above) 1 means a growth slower (quicker) than linear.

$$MediumArea = 4\frac{Area(\overline{0T}/2)}{\overline{0T} * \overline{0P}/2} \tag{6}$$

4. Long-run trend measures:

   (a) *Welfare*: number of periods to recover the level of GDP previous to the recession in relation to the total duration of the expansion. Notice that this measure takes into account the depth of the recession.

$$Welfare = \frac{\tau^W}{\overline{0T}}, \tag{7}$$

   where τ^W, so that $f_t(\tau^W) = f_t P_{-1}$, where P_{-1} is the peak of the previous expansion.

3 Illustration: US recoveries

We apply the new measures to establish the features of post-war US expansions and distinguish some patterns among them. We use the business cycle dating provided by the NBER to identify turning points. Since 1949, there have been 11 expansions in the US economy. We include the recovery after the Great Recession, although it has not finished yet.

We begin by computing the measures suggested by Harding and Pagan (2002) for each of the US expansions (Table 1). It seems that expansions after 1984 (Great Moderation) tend to be longer than previous expansions. Regarding excess, we observe that the shape of expansions deviates substantially from a triangular path in most cases. However, we do not identify any pattern of excesses over time.

These measures are very useful but do not take into account the dynamics of expansion, as they do not pay attention to the different stages of recoveries and, in particular, to the early quarters.

The results of applying the new measures offer a more precise picture. The time-varying measures for each of the 11 expansions are shown in Figure 3. We observe that the *Pointwise excess* shows a very smooth path for expansions after 1984, with excesses being negative or very small. On the contrary, almost all the expansions prior to 1984 show positive E_t, which are very persistent, as displayed by *Acceleration of excesses*.

The scalar measures are shown in Table 2. Firstly, we present the measures that focus on the beginning of the phase. Before the Great Moderation, most of the expansions show positive excesses at the beginning, which continuously accelerate (*Inshape*). *Early shape* is 1 except for one expansion, whereas it is closer to 0 after 1984. The 90s expansion is always below the linear trend. Actually, it is a perfectly concave expansion (*Early shape* is -1 even though it is a 40 quarter expansion).[5] The 2000s expansion does not have a clear stylized form. It is convex at the beginning and then it turns into concave.[6] From Table 1 we can only say that it is a concave expansion, thus missing important features in our analysis.

Secondly, we introduce the measures that give us information about the middle path of the phase. Results of *Half life* and *Medium area* show that recoveries before the Great Moderation were quick, whereas those after it are slower.

Thirdly, we compute *Welfare* and obtain that after the 90s and the 2000s expansions, the GDP recovered its previous level very quickly; while after the Great Recession, it took 9 quarters to recover the GDP level of the previous peak due both to a very deep recession and a slow recovery.

[5] The size of these negative excesses increases during almost its whole duration and it only gains momentum close to the end (*Inshape*).

[6] It has just three positive pointwise excesses at the beginning and then, it decelerates. *Early shape* represents just 0.1 of its total duration.

In order to identify common patterns from our proposed scalar measures, we carry out a cluster analysis, using the *K-means* procedure.[7] We find that expansions can be classified into 3 clusters. As shown in panel A of Figure 4, the first group comprises expansions up to 1984; while the second includes the last three expansions, as well as that of 1975.[8] Finally, the third cluster consists of a single expansion, that of 1980.[9] The main difference between the two first clusters lies in the behavior during the first quarters of the recoveries.[10] The early stages of an expansion are known as the high growth recovery phase and its disappearance is recognized as one of the features characterizing the Great Moderation.[11]

Panel B of Figure 4 shows the cluster analysis using the standard Harding and Pagan (2002) measures. We identify no clear lesson from this classification that allows to relate each group with some macroeconomic events. On the contrary, the new measures clearly contribute to understanding expansion features behind the Great Moderation.

[7] This method creates a single level of clusters and assigns each expansion to a specific cluster. The algorithm finds a partition in which expansions within each cluster are as close to each other as possible and as far from the expansions in other clusters as possible. Each cluster is defined by its centroid, which is the point at which the sum of the distances from all the objects in the cluster is minimized. The number of groups has been selected considering the Silhouette value that indicates that the object is well matched to its own cluster and poorly matched to neighboring clusters.

[8] The dynamic of the early stages of the 1975 expansion is more similar to those of expansions after the beginning of the Great Moderation.

[9] It has the quickest cumulated recovery in the middle of expansion (*Half life* and *Medium area*), although it took several quarters to recover the GDP level previous to the recession (*Welfare*).

[10] In the first type of expansions, the averages of *Early shape*, *Inshape*, *Half life*, *Medium area* and *Welfare* are 0.67, 6.5, 0.61, 1.35, 0.11, respectively. In the second type, the figures are -0.26, -7.50, 0.67, 1.05 and 0.40, respectively.

[11] See Gadea et al. (2014), Camacho et al. (2011), and Gali et al. (2012).

4 Conclusions

We propose a set of measures to identify the features of expansions. We observe an increase in precision with respect to the very valuable measures proposed by Harding and Pagan (2002), as we consider the dynamics of recoveries. We find that the path of expansions is different in terms of evolution over time, speed of recoveries and welfare consequences. According to the new measures, we identify that expansions before and after the beginning of the Great Moderation (1984) are clearly different.

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5 Tables

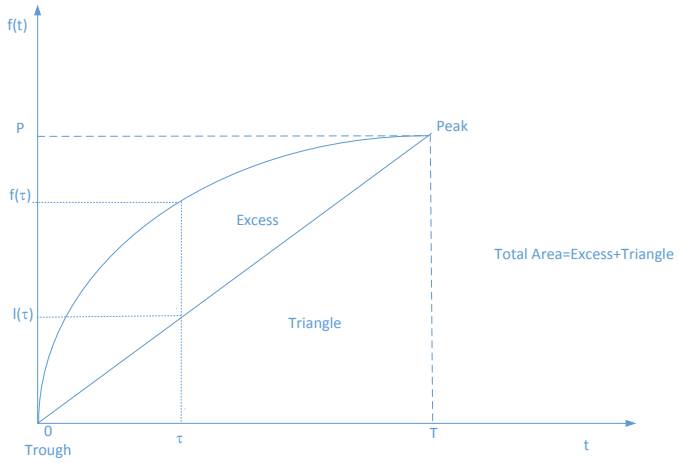
Table 1: Harding and Pagan measures

Measure	Duration	Amplitude	Cumulation	Excess
1949.4-1953.2	14.00	0.26	2.18	0.38
1954.2-1957.3	13.00	0.13	1.06	0.23
1958.2-1960.2	8.00	0.11	0.57	0.13
1961.1-1969.4	35.00	0.42	8.32	0.99
1970.4-1973.4	12.00	0.15	0.98	0.09
1975.1-1980.1	20.00	0.21	2.39	0.30
1980.3-1981.3	4.00	0.04	0.11	0.02
1982.4-1990.3	31.00	0.32	6.01	0.98
1991.1-2001.1	40.00	0.35	6.92	-0.18
2001.4-2007.4	24.00	0.17	2.12	0.14
2009.2-2016.2	28.00	0.14	2.09	0.08

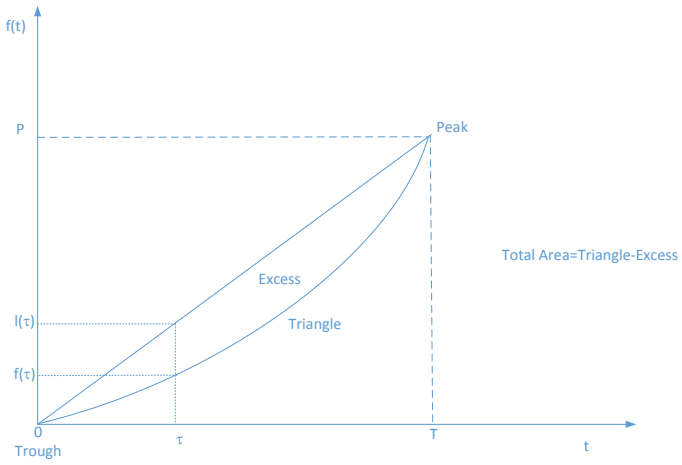
Table 2: New measures

Measure	Early shape	Inshape	Half life	Medium area	Welfare
1949.4-1953.2	1.00	13.00	0.57	1.61	0.07
1954.2-1957.3	1.00	12.00	0.56	1.72	0.15
1958.2-1960.2	1.00	7.00	0.53	1.63	0.25
1961.1-1969.4	1.00	34.00	0.66	1.19	0.03
1970.4-1973.4	1.00	3.00	0.62	1.09	0.08
1975.1-1980.1	-0.10	-1.00	0.65	1.18	0.15
1980.3-1981.3	1.00	3.00	0.37	1.76	0.50
1982.4-1990.3	1.00	30.00	0.64	1.45	0.06
1991.1-2001.1	-1.00	-30.00	0.70	0.88	0.07
2001.4-2007.4	0.13	2.00	0.66	1.03	0.00
2009.2-2016.2	-0.07	-1.00	0.67	1.09	0.32

6 Figures



(a) Concave



(b) Convex

Figure 1: Shape of recoveries

Notes: *Duration*: $\overline{0T}$; *Amplitude*: $\overline{0P}$; *Cumulation*: $\int_0^T f(t)dt$; and *Excess*: $\int_0^T f(t)dt - (\overline{0T} * \overline{0P})/2$.

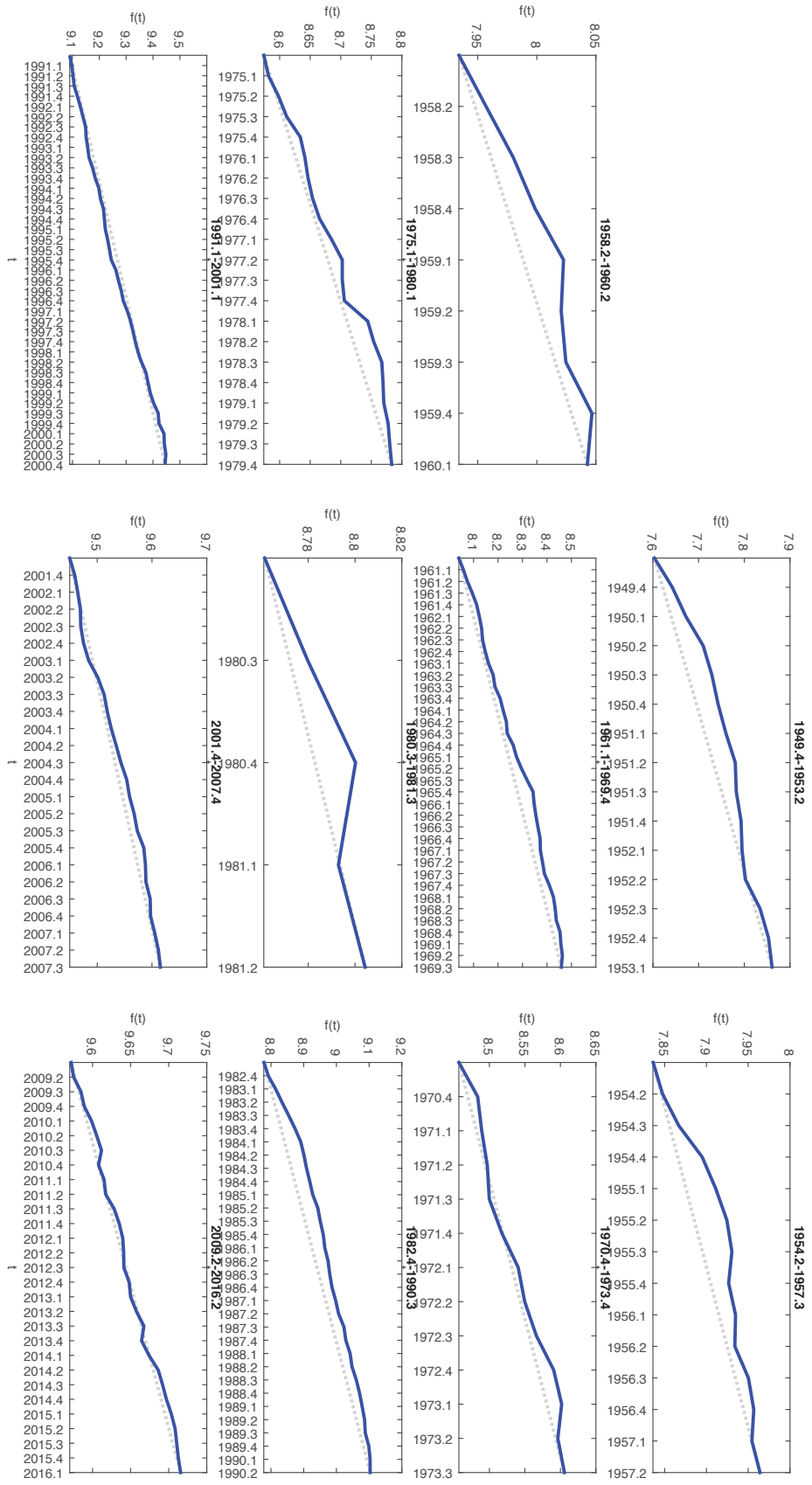


Figure 2: Shapes of US expansions

Note: This figure displays the evolution of log real GDP from through to peak for each of the postwar US expansions and a line representing linear growth between throughs and peaks.

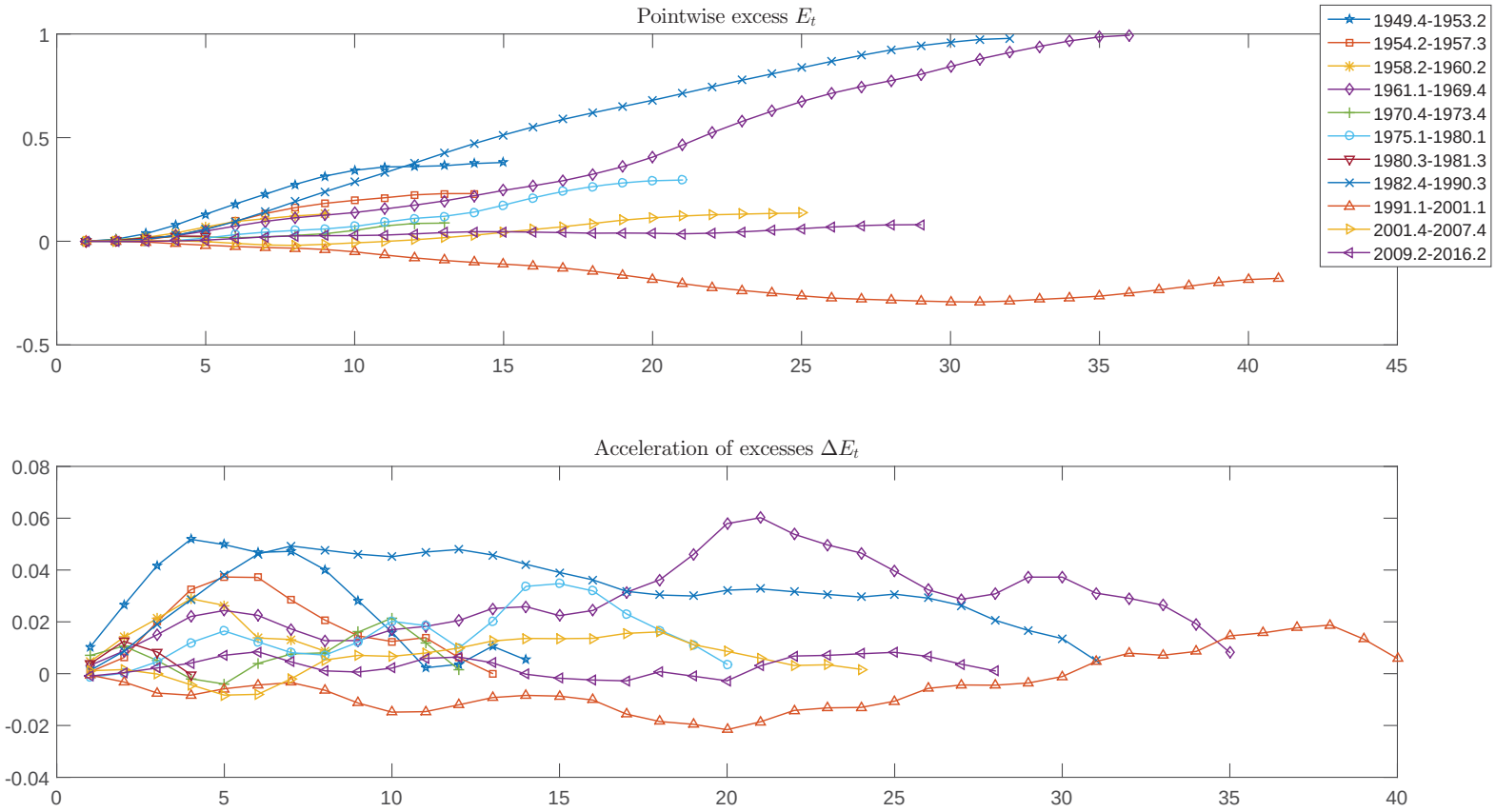
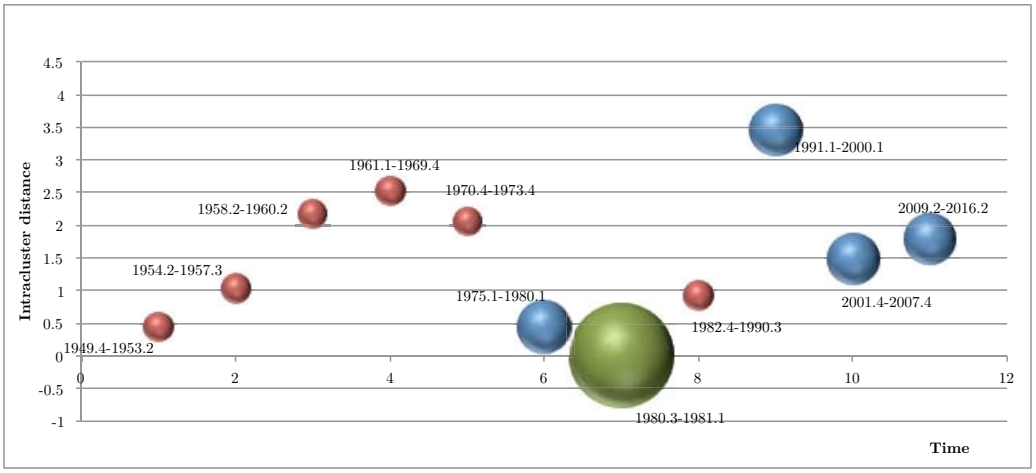
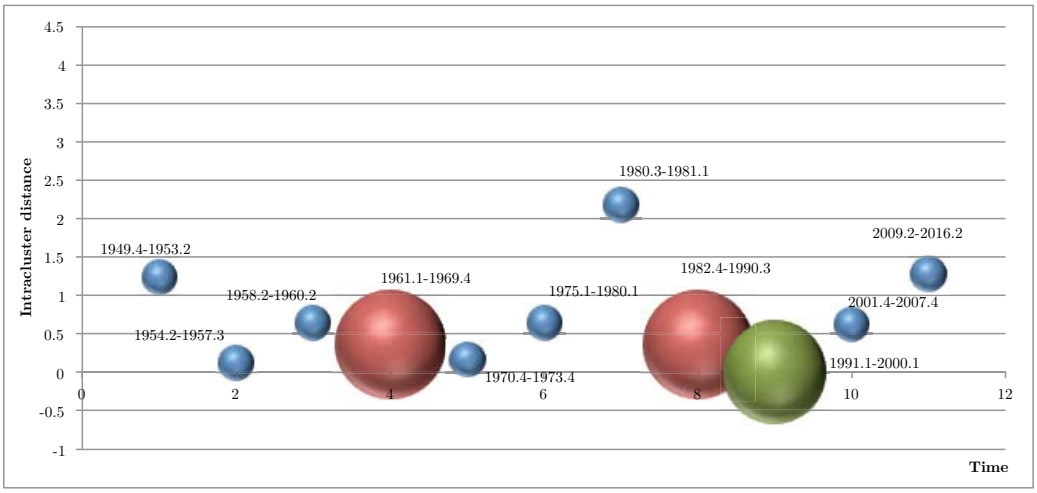


Figure 3: Time varying measures



(a) New measures



(b) Harding and Pagan measures

Figure 4: Clusters of US recoveries by measures

Note: Expansions in chronological order are displayed over the X axis. Intra-cluster distance is represented over the Y axis. The size of the ball represents the size of the corresponding centroid of each cluster, which is built from the Euclidean distance of all the characteristics included in the analysis.

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