Economic factors and psychiatric hospital beds – an analysis of historical trends

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Abstract

Purpose – The purpose of this paper is to explore the association between economic factors (consumer price index, real gross domestic product per capita, base discount rate, and rate of unemployment) and numbers of hospital psychiatric beds.

Design/methodology/approach – Time series analytical techniques (unit root and cointegration tests) were applied to two regional data sets from the nineteenth century (North Carolina, USA; Berkshire, UK) and three national data sets in the twentieth century (US; UK; Italy) to test the hypothesis of a relationship.

Findings – All data sets suggest a long-run relationship between economic factors and psychiatric bed numbers. Increase of consumer price predicted a decrease of hospital beds (and vice versa) in all data sets and was the strongest predictor of changes in psychiatric bed numbers. Hence, economic factors appear to be an important driver for the supply of hospital beds.

Research limitations/implications – Cointegration tests are not true causality tests as they only measure the ability to forecast the value of an X variable knowing the value of N other variables. Therefore, one cannot rule out that the relationship between economic factors and psychiatric hospital beds is an indirect one, caused by another unidentified factor. Also, this study alone does not provide evidence to decide whether economic factors mainly influence demand or supply, although various findings suggest the latter.

Practical implications – CPI is of particular significance for changes in psychiatric bed provision, and co-integration tests are a useful method to explore such association.

Originality/value – This study is the first one to apply time series analytical techniques to explore the role of economic factors in the processes of psychiatric institutionalisation and deinstitutionalisation.

Keywords Mental health services, Hospital beds, Unemployment, Time series analysis

Paper type Research paper

1. Introduction

The development of psychiatric care in North America and Europe since 1850 was dominated by the establishment and growth of large asylums. From the 1950s

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onwards, the asylums were downsized or closed in the process of so-called de-institutionalisation, which led to a radical shift in the paradigm of psychiatric treatment towards care in the community. Recently, it has been suggested that Western Europe is about to experience a new trend towards re-institutionalisation (Priebe *et al.*, 2005). For future policy decisions on the provision of psychiatric hospital care, it appears important to understand the reasons for the dramatic changes in the past.

These reasons have been the subject of an intensive and occasionally acrimonious debate. Increased prevalence of mental illness and socio-demographic changes are the two predominant explanations for the process of institutionalisation in the nineteenth century. Deinstitutionalisation has been mostly explained as resulting from either reduced need (lower prevalence and/or improved outcome) or general societal changes with different attitudes toward people with mental disorders and the way they should be cared for. An alternative economic explanation was first proposed by Brenner (1973) who correlated extensive economic and institutional data from New York State from 1841 to 1967 and concluded that instabilities in the national economy were the single most important reason for fluctuations in mental health hospital admission rates. Interpreting this data, Warner (2004) suggested that economic stress and unemployment can be linked to a true increase of symptoms of psychiatric illness. A rise in unemployment favoured psychiatric institutionalisation, because recovery from severe mental illness was worse during cycles of economic depression, due to reduced opportunities for rehabilitation and reintegration into society. Stancliffe *et al.*, (2005) proposed a different economic interpretation, by showing that the costs of institutional care increased two times above general inflation from 1982 to 2002, with this super-inflation being found to be a critical factor in the deinstitutionalisation process of the last 50 years. The same line of thinking led some pressure groups (such as the Treatment Advocacy Center, 2006) to believe that the de-institutionalisation process since the 1950s was driven mainly by economic factors rather than by changes in the needs of patients and carers. Nevertheless, empirical evidence in support of an economic interpretation is still inconclusive, and Laporte (2004) argued that the failure to account for the time-series properties (i.e. the potential for unit root behaviour) of macro level data is a key omission in Brenner's and other subsequent studies in the field. Therefore, the most widely held view is that the impetus for community versus hospital-based care can only be understood in terms of a changing discourse of psychiatry and psychiatric nursing (Prior, 1991).

The introduction of more robust statistical techniques to analyse economic time series data now makes it possible to revisit the hypothesis that economic factors played an important role in both psychiatric institutionalisation and deinstitutionalisation. The primary objective of this paper is to test the hypothesis of a long-term relationship between consumer price index (CPI) and rates of psychiatric hospitalisation in the USA and Europe during two important historical periods. In addition, we explore the relative importance of other economic factors, including unemployment, and the influence of economic factors on demand and supply of hospital beds. Namely in one data set (Berkshire, nineteenth century) we assess the relationship between macroeconomic factors and rates of new hospital admissions, readmissions and discharges, in an attempt to understand if the hospital expansion was primarily driven by truly increased morbidity or by other factors.

2. The model, methodology and data

The primary hypothesis tested in this study is the presence of a long-term equilibrium economic relationship between the CPI and hospital psychiatric bed (HPB) rates, used as proxy for psychiatric institutionalisation. This hypothesis was prompted by the work of Stancliffe *et al.* (2005) and also by empirical observations that psychiatric institutionalisation increased in both Europe and the USA during a period of deflation and conversely de-institutionalisation occurred during a period of inflation. This process has been shown in Italy when, during a period of one of the highest rates of inflation in Europe, it championed the deinstitutionalisation movement in the 1970s. Conversely, we were not aware of any other economic dimension having switched direction in synchrony with HPB. To have a clearer understanding of the relative impact of other economic factors on both the CPI and HPB, the relationship between these two variables and other economic ones, namely real gross domestic product (RGDP) per capita, base discount rates (DR), and employment measures was also explored. Both RGDP and employment measures were selected to re-test Brenner's hypothesis. DR was included as it was hypothesised that variations in the cost of borrowing could have a significant influence on any capital investment decision and confidence in the long-term sustainability of hospital overhead costs.

Data on psychiatric bed utilisation were obtained from the State of North Carolina, USA and the County of Berkshire, UK between 1871 and 1903. Data were also obtained from the USA, UK, and Italy for the years between 1975 and 2003.

The selection of North Carolina and Berkshire was opportunistic and dictated by the availability of relatively complete data sets for these two regions in the nineteenth century. The choice of contemporary data from the USA and UK was intended to act as a comparison with regional data from the previous century. Our interest in the contemporary data from Italy was dictated by the fact that Italy championed the process of deinstitutionalization in Europe during the last decades of the twentieth century. However, it was not possible to find reliable statistics on psychiatric bed rates in Italy in the nineteenth century.

Contemporary data were collected for the USA, UK, and Italy from the following sources: WHO, Eurostat (2005), National Departments of Health, National Offices of Statistics, and information published on internet web sites. In cases of conflicting data, it was assumed that the credibility of these sources would be in the listed order. Tables reporting raw data analysed here are available upon request.

2.1 North Carolina (1884-1903)

Data concerning bed utilisation was extracted from the Annual Reports of the three psychiatric hospitals that were operative in North Carolina at the end of the nineteenth century.

However, information about hospital inpatient service provision before 1884 was not available. In order to improve the reliability of the analysis, the incomplete data set from the Eastern Insane Asylum (Cherry Hospital), opened in 1880 for African Americans and other ethnic minorities, was not used. Therefore, only the rate of hospital beds used by white ethnic groups was computed and used in any further analysis.

The McCusker (2001) index, which has frequently been used in the field of economic history research, was used as a measure of CPI. For the real GDP the data provided by

Johnston and Williamson (2005) was used, with the per capita figures being computed using the estimated total US population reported in the 1904 Statistical Abstract (US Census Bureau – Statistical abstracts 1901-1950, 2005). The USA Call Money Rates, Mixed Collateral (NBER Series: 13001, 2006a) was used as a measure for the cost of borrowing. As there were no available statistics on unemployment rates, the US Index of Factory Employment (per cent rate) (NBER Series: 08005, 2006b) was used as a socio-economic indicator of employment/unemployment (FEMPL).

2.2 Berkshire, England (1871-1901)

The only psychiatric hospital that served the population of Berkshire County was Moulsford Lunatic Asylum, which was opened in 1871. Data on hospital beds rates were extracted from the hospitals Annual Reports. The Bowley's Cost of living Index (1914 = 100) (STATSED, 1980) was used for the CPI. For the real GDP, the per-capita GDP at constant (2002) market prices (Officer, 2005) was used. The average yearly cost of borrowing (DR) was computed using the "London open market rates of discount" (NBER Series: 13016, 2006c). The percentage rate of registered unemployed in trade unions was reported by STATSED – British History 1700-1980 Database (UNEMPL).

2.3 USA (1975-2003)

The rates of psychiatric hospital beds per 100,000 general population was computed from the time series number of psychiatric beds in Medicare participating Hospital Insurance and/or Supplementary (Centers for Medicare and Medicaid Services, 2005). Other variables analysed were: US Consumer Price Index (2006) (Federal Reserve Bank of Minneapolis), RGDP per capita (Johnston and Williamson, 2005); US Federal Reserve Discount Rate (December)[1] (Federal Reserve Bank of Minneapolis, 2006) and unemployment rate (UNEMPL) in the month of June (US Department of Labor – Bureau of Labor Statistics, 2006).

2.4 UK (1977-1997)

The rates of psychiatric hospital beds per 100,000 (HPB) were those reported in the WHO (2006) database. The other variables analysed were the retail price index (CPI) (UK National Statistics, 2005); RGDP per capita (WHO, 2006), unemployment rate in percentage (WHO, 2006) and the annual average of Bank of England Base Rate (DR) (Bank of England, 2006).

2.5 Italy (1975-2003)

The rates of psychiatric hospital beds per 100,000 were those reported in the WHO (2006) database. Other variables used in the analysis were the CPI, computed using coefficients published by ISTAT (2004), RGDP (WHO, 2006), unemployment rate in percentage (WHO, 2006) and the Italian Central Bank average percentage of DR (Tuttalafinanza.it, 2006).

2.6 Statistical analysis

Time series of economic variables are most frequently non stationary (i.e. they do not return quickly and frequently to their mean) and the same is also true for psychiatric institutionalisation rates in our data sets, which have followed long-term either ascending or descending curves during the two historical periods examined.

As described by many authors (including Okunade and Murphy, 2001) the ordinary least square statistical estimation procedure cannot be used to estimate the long-term relationship among non-stationary variables such as the ones considered in this paper. In fact, the regression of one non-stationary variable, a variable whose mean and variance are dependent on time, on other non-stationary variables can result in the phenomenon of spurious regressions, unless the variables, which are non-stationary individually, do exhibit collectively a stable long-term or cointegrating relationship[2].

The use of differencing and de-trending techniques to impose stationarity is not considered acceptable for time series analysis by several contemporary authors (see Ames *et al.*, 2006, for a review of the motives). Therefore, in this study the relationship between variables, after natural logarithmic transformation, was analysed using unit roots, and cointegration tests. Unemployment measures displayed a strong cyclical component in all data sets, except Italy. This could easily overwhelm the stochastic trend component in it thereby giving a reduced chance for revealing a possible cointegration relationship with HPB. For this reason, FEMPL and UNEMPL were subjected to a moving average transformation whenever they showed a strong cyclical component. Both the original variables and the moving average transformed ones were used in unit roots and cointegration analyses.

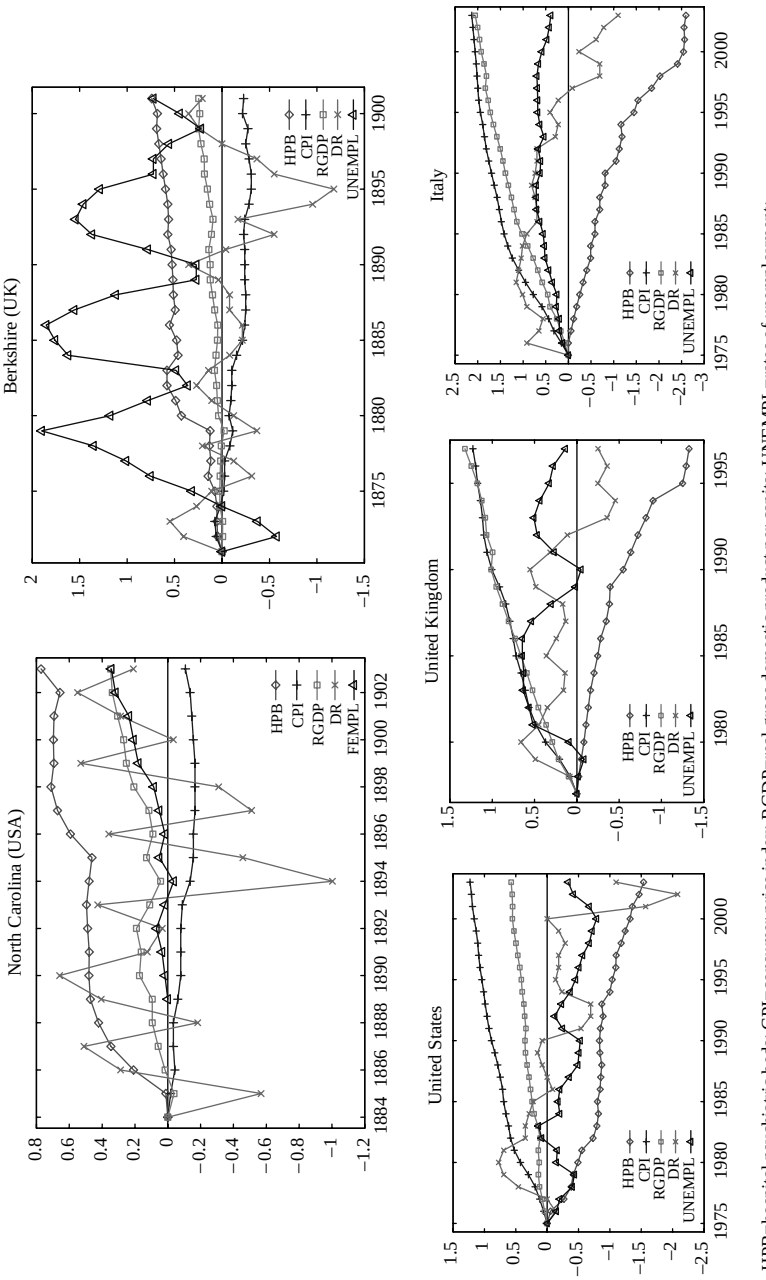
Unit root and cointegration tests were computed using EasyReg International software (Bierens, 2006). We tested the unit root (with drift) hypothesis against the (trend) stationarity hypothesis with the Phillips-Pierron tests. The test employs a Newey-West type variance estimator of the long-run variance of $u(t)$, with truncation lag $m = [c.n\hat{}r]$, where $c > 0$ and $0 < r < 1/2$.The default value of m suggested by EasyReg International, which are $c = 5$, $r = 0.25$ was always imposed.

Additionally we performed Bierens' (1997a) nonlinear Augmented Dickey-Fuller tests and nonparametric test of the unit root with drift hypothesis against nonlinear trend stationarity. The lag length p of the auxiliary regression was determined by the Schwarz criterion. Because unit root tests applied to time series of modest sample size have inadequate power and may suffer from size distortion, p-values were simulated on the basis of a Gaussian AR(q) model for $z(t) - z(t-1)$ in batches of 500 replications.

Cointegration was studied first using the Johansen's test. Johansen's cointegration analysis involves the computing of the lambda-max test of the null hypothesis that the cointegration rank is equal to r against the alternative that the cointegration rank is equal to $r + 1$ and also of the trace test of the null hypothesis that the cointegration rank is equal to r against the alternative that the cointegration rank is k. Following a recommendation made by Bierens (personal communication), we included a time trend in the vector error correction model (VECM) because the components of the vector $\mathbf{b}'X_t$ (or some of them) appeared to be trend stationary, that is they veered apart as shown in Figure 1.

The upperbound of the order p of VAR(p) order was determined using the maximum of either the Hannan-Quinn or the Schwarz information criteria, which are automatically computed in EasyReg COINTJ module.

Cointegration was also studied with the Bierens' non parametric test. As explained by its author, this nonparametric approach is in the same spirit as Johansen's LR method in that the test statistics involved are obtained from the solutions of a generalized eigenvalue problem, and the hypotheses to be tested are the same, but in Bierens (1997b) test, the two matrices in the generalized eigenvalue problem involved



HPB=hospital psychiatric beds; CPI=consumer price index; RGDP=real gross domestic product per capita; UNEMPL=rates of unemployment; FEMPL= factory employment index; DR=discount rate

Figure 1.
Time series plots: rates of HPBs and selected economic variables (all variables are natural logs less baseline value)

are constructed independently of the data-generating process. Based on comparisons of results produced by the two methods, it appears that for the Johansen's test it is crucial (and somewhat difficult) to find the correct order p of the ECM. Using a Monte Carlo simulations on a reference set of data, Bierens (1997b) showed that his nonparametric approach for testing the number of cointegrating vectors performed better than Johansen's lambda-max test, even when the correct VAR order had been identified. In the data analysed by Bierens, the nonparametric test gave in about 79 per cent of all cases the correct answer $r = 1$, whereas the corresponding percentages for Johansen's lambda-max test were 58 per cent if $p = 6$, 70 per cent if $p = 8$ and 56 per cent if $p = 10$.

Because of the importance (and relative difficulty) of finding the correct order p of the ECM in Johansen's cointegration test, new order p values (in addition to those determined with Hannan-Quinn or the Schwarz information criteria) were tested whenever Johansen's test did not confirm the finding of a cointegration equation with the Bierens' test.

Cointegration tests were first performed between HPB and each of the other variables (bivariate tests) and then by including all the variables or a particular combination of them until a significant cointegration model could be identified (multivariate tests).

3. Results

3.1 North Carolina, USA (1884-1903)

Figure 1 shows the change over time of all variables after log transformation. From 1884 to 1903, the total number of patients remaining in psychiatric institutions increased from approximately 600 to over 1,800 and the rate of psychiatric beds in the white population more than doubled, from 46 in 1884 to 99 in 1903 (per 100,000).

RGDP per capita and the factory employment index also increased but at a slower pace. The CPI index, which was 118 in 1884, progressively decreased to 100 in 1897, and then increased to 106, during the last three years of the period analysed. Interest rates remained relatively low during the entire period (3.49 per cent on average), oscillating from a low point of 1.1 per cent in 1894 to a peak of 5.2 per cent in 1902.

Table I summarises the main results of Phillips-Perron and Bierens' tests for unit roots. All variables in the data sets fulfilled the criteria for unit roots.

Table II reports a summary of pair-wise Johansen's tests of cointegration among rates of HPBs and the socio-economic variables. A statistically significant cointegration equation was found in all comparisons, except DR, with a VAR(p) order of either two or three and a VECM with intercepts and time trend, without cointegrating restrictions on the time trend. When all these cointegrating variables were entered in a multivariate Johansen's test of cointegration (Table III), both the lambda-max and trace tests indicated two cointegrating equations at the 0.05 significance level. Bivariate Bierens' contegrations tests confirmed the presence of significant cointegration between HPB-CPI and HPB-RGDP. Multivariate Bierens' tests identified three cointegrating models including all the variables.

3.2 Berkshire, England (1871-1901)

As shown in Figure 1, the rate of psychiatric beds per 100,000 inhabitants more than doubled during the examined period, namely from 127 in 1871 to 266 in 1901.

Variables	North Carolina (1884-1903) ok Test statistics	P^*	Berkshire (1871-1901) Test statistics	P^*	USA (1975-2003) Test statistics	P^*	UK (1977-1997) Test statistics	P^*	Italy (1975-2003) Test statistics	P^*
Phillips-Perron test 1; null hypothesis H0*: unit root; alternative hypothesis* H1*: stationary*										
HPBs	−2.44	0.55	−1.29	0.88	−1.49	0.70	1.66	0.66	0.85	0.80
CPI	−2.53	0.35	−1.62	0.82	−1.60	0.38	−1.57	0.41	−2.21	0.39
Real GDP	−0.03	0.94	1.03	0.97	−0.55	0.88	−0.85	0.67	−0.96	0.64
Interest rate (per cent)	−12.66	0.13	−7.13	0.22	−4.74	0.32	−3.80	0.29	−0.93	0.94
Unemployment[a]	1.71	0.97	−4.83	0.18	−4.85	0.18	−3.28	0.20	−4.93	0.32
Unempl. mov. average[b]	2.70	0.90	*− 9.22*	*0.04*	0.70	0.73	−3.79	0.30	Not tested	
Phillips-Perron test 2; null hypothesis H0*: unit root with drift; alternative hypothesis* H1*: trend stationary*										
HPBs	−3.77	0.41	−4.35	0.63	−7.06	0.18	−0.82	0.85	−2.61	0.82
CPI	3.72	0.97	−3.92	0.79	1.70	0.56	−1.97	0.42	−1.58	0.63
Real GDP	−3.14	0.91	−6.36	0.34	−4.14	0.48	−2.83	0.70	0.16	0.94
Interest rate (per cent)	−13.14	0.23	−6.58	0.52	−6.26	0.29	−4.52	0.23	−8.61	0.85
Unemployment[a]	−0.83	0.92	−4.24	0.59	−3.77	0.54	−1.35	0.70	−0.09	0.98
Unempl. mov. average[b]	−0.05	0.71	−4.01	0.39	−2.78	0.30	−4.51	0.38	Not tested	
Bierens test; Null hypothesis H0*: unit root with drift; alternative hypothesis* H1*: nonlinear trend stationary*										
HPBs	−2.45	0.55	−2.09	0.42	−4.63	0.18	−0.68	0.94	−1.07	0.83
CPI	0.39	0.89	−1.54	0.72	−3.23	0.30	−0.82	0.98	−2.56	0.45
Real GDP	−2.30	0.56	−2.27	0.50	−3.33	0.13	−2.22	0.60	−0.71	0.61
Interest rate (per cent)	−0.60	0.88	−2.52	0.37	−2.80	0.28	−2.38	0.48	−1.33	0.74
Unemployment[a]	−0.86	0.82	−3.94	0.07	−2.45	0.49	−2.21	0.41	−0.17	0.99
Unempl. mov. average[b]	−0.71	0.54	−1.08	0.91	−2.52	0.18	−5.72	0.02	Not tested	

Notes: *If P is NS, then the null hypothesis of a unit root is not rejected; p-value is computed with bootstrapping based on 500 simulations; [a]index of factory employment in the case of North Carolina data; [b]unemployment var. after moving average transformation (lag m: North Carolina=4, Berkshire=7; USA=9; UK=8)

Table I.
Phillips-Perron 1-2 and Bierens tests for unit roots

Table II. Johansen's and Bierens' tests of cointegration among rates of psychiatric hospital beds and selected economic variables

		CPI	RGDP	FEMPL or UNEMPL	Moving average (UNEMPL)	DR
North Carolina (1884-1903)	Johansen's tests estimation of *n* of *R* and error correction term.	1^a: Ln(CPI)(−2) +0.98 [1 to 0.39] Ln(HPB)(−2)	1^a: Ln(HPB)(−2) +0.22[−0.38 to 1] LRGDP(−2)	1^a: Ln(HPB)(−3) +0.06 [0 to 0.13]Ln(FEMPL)(−3)	1^a: LnHPB(−2) +0.30[0.50 to −0.29]MA4 [LnFEMPL](−3)	Inconclusive $(2)^b$
	Bierens' test estimation of *n* of *R* and standardised cointegration vector	1^a:Ln(CPI)+0.12 [1 to 0] Ln(HPB)	1^a: Ln(RGDP) − 0.34[−1 to 1]Ln(HPB)	Inconclusive $(2)^b$	Inconclusive $(2)^b$	0
Berkshire (1871-1901)	Johansen's tests estimation of *n* of *R* and error correction term.	1^a: LnCPI(−7)+0.83 [1 to 0.53]Ln(HPB)(−7)	Inconclusive $(2)^b$	1^a: LnHPB(−9) −0.013[−0.04 to 0.03] LnUNEMPL$(-9)^c$	1^a: LnHPB(−7)+0.01 [1 to −1] MA7[LnUNEMPL](−7)	Inconclusive $(2)^b$
	Bierens' test estimation of *n* of *R* and standardised cointegration vector	0	Inconclusive $(2)^b$	0	1^a:LnHPB − 0.34 [−0.22 to −0.48] MA7[LnUNEMPL]	0
USA (1975-2003)	Johansen's tests estimation of *n* of *R* and error correction term	1^a: LCPI(−2) −0.11[−0.45 to 0.12]LHPB(−2)	1^a: LnRGDP(−8)+0.04[0.03 to 0.05]LnHPB(−8)	Inconclusive $(2)^b$	Inconclusive $(2)^b$	Inconclusive $(2)^b$
	Bierens' test estimation of *n* of *R* and standardised cointegration vector	1^a: LnHPB+0.47[1 to 0]LnCPI	Inconclusive $(2)^b$	0	0	1^a: LnHPB +0.03[−0.1 to 0.15]LnDR

(*continued*)

		CPI	RGDP	FEMPL or UNEMPL	Moving average (UNEMPL)	DR
UK (1977-1997)	Johansen's tests estimation of n of R and error correction term.	1[a]: LCPI(−2) −0.32[−0.43 to −0.19]LHPB(−2)	1[a]: LnRGDP(−4) −0.10[−0.35 to 0]LnHPB(−4)	Inconclusive (2)[b]	1[a]: LHPB(−3)+0.98 [1 to 0.46] MA8-LnUNEMPL(−3)	Inconclusive (2)[b]
	Bierens' test estimation of n of R and standardised cointegration vector	1[a]: LnCPI − 0.68[−1 to 0]LnHPB	1[a]: LnRGDP − 0.29[−1 to 0]LnHPB	0	Inconclusive (2)	0
Italy (1975-2003)	Johansen's tests estimation of n of R and error correction term.	1[a]: LCPI(−8) −0.33[−0.36 to −0.31]LnHPB(−8)	1[a]: LnRGDP(−8) − 0.32 [−0.41 to −0.23]LnHPB(−8)	0	Not tested	0
	Bierens' test estimation of n of R and standardised cointegration vector	0	1[a]: LnRGDP −0.36[−1 to 0] LnHPB	0	Not tested	0

Notes: [a]The null hypothesis of no cointegration (i.e. r=0) is rejected at the 5 per cent significance level, whereas the null hypothesis r=1 is not rejected at the 10 per cent significance level; [b]both *H0* that R=0 and R=1 are rejected with significance at the 5 per cent; [c]using moving average transformation lag=7, the null hypothesis of no cointegration (i.e. r=0) is rejected at the 5 per cent significance level, whereas the null hypothesis r=1 is not rejected at the 10 per cent significance level; in [ ] brackets are reported the parameter restrictions, i.e. the critical values of H for which the null hypothesis of cointegration is not rejected at 5 per cent significance level

Table II.

Table III.
Multivariate Johansen's tests of cointegration among rates of psychiatric hospital beds and economic variables (all variables are natural logs)

Dataset	North Carolina (1884-1903) +	Berkshire (1871-1901)	USA (1975-2003)	UK (1977-1997)	Italy (1975-2003)
Variables	$Y(1)$ = LnHPB $Y(2)$ = LnCPI $Y(3)$ = LnRGDP $Y(4)$ = LnDR $Y(5)$ = LnFEMPL	$Y(1)$ = LnHPB $Y(2)$ = LnCPI $Y(3)$ = LnRGDP $Y(4)$ = LnDR $Y(5)$ = MA7LnUNEMPL	$Y(1)$ = LnHPB $Y(2)$ = LnCPI $Y(3)$ = LnRGDP $Y(4)$ = LnDR $Y(5)$ = LnUNEMPL or MA-LnUNEMPL	$Y(1)$ = LnHPB $Y(2)$ = LnCPI $Y(3)$ = LnRGDP $Y(4)$ = LnDR $Y(5)$ = LnUNEMPL or MA-LnUNEMPL	$Y(1)$ = LnHPB $Y(2)$ = LnCPI $Y(3)$ = LnRGDP $Y(4)$ = LnDR $Y(5)$ = LnUNEMPL
N. of cointegrating vectors (R) *	$R = 2$	$R = 1$	Inconclusive	$R = 2$	Inconclusive
Error correction term(s) (ECM)	ECM1 = LFEMPL(−1) + 0.24LnHPB(−1) − 0.64LnCPI(−1) − 0.49LnRGDP(−1) − 0.04LnDR(−1) ECM2 = LRGDP(−1) − 0.16LnHPB(−1) − 0.34LnCPI(−1) − 0.01LnDR(−1) − 0.54LnFEMPL(−1)	ECM1 = LCPI(−1) −0.59LnHPB(−1) −0.07LnRGDP(−1) −0.12LnDR(−1) + 0.13MA7[LnUNEMPL](−1)		ECM1 = LnRGDP(−1) − 0.01LnHPB(−1) − 0.21LnCPI(−1) − 0.19LnDR(−1) − 0.02LnUNEMPL(−1) ECM 2 = LnRGDP(−1) − 0.20LnHPB(−1) + 0.16LnCPI(−1) − 0.10LnDR(−1) − 0.22LnUNEMPL(−1)	
Variables of alternative model with best fit		$Y(1)$ = LnHPB $Y(2)$ = LnCPI $Y(3)$ = LnUNEMPL	$Y(1)$ = LnHPB $Y(2)$ = LnCPI $Y(3)$ = LnRGDP		$Y(1)$ = LnHPB $Y(2)$ = LnCPI $Y(3)$ = LnRGDP
N. of cointegrating vectors (R) *		$R = 1$	$R = 1$		$R = 2$
Error correction term(s) (ECM)		ECM = LnCPI(−5) −0.27LnHPB(−5) 0.15LnUNEMPL(−5)	ECM = LnRGDP(−2) − 0.04LnHPB(−2) + 0.59LnCPI(−2)		ECM1 = LnRGDP(−6) −0.12LnHPB(−6) −0.37LnCPI(−6) ECM2 = LnRGDP(−6) −0.08LnHPB(−6) −0.48LnCPI(−6)

Notes: *The null hypothesis of no cointegration (i.e. $r = 0$) is rejected at the 5 per cent significance level, whereas the null hypothesis $r = n$ is not rejected at the 10 per cent significance level; [a]$R = 1$ when LnUNEMPL is replaced with its moving average (lag = 7)

The same graph shows how CPI progressively decreased during the same period (from a high peak of 122 in 1873 to a low point of 83 in 1895-1896). RGDP increased. DR and unemployment showed a cyclical pattern.

Table I reports the main results of Phillips-Perron tests for unit roots. All variables in the data sets fulfilled the criteria for unit roots, except unemployment after moving average transformation.

As shown in Table II, a statistically significant Johansen's cointegration equation among rates of hospital beds and the socio-economic variables was found in the CPI and UNEMPL pairwise comparisons with VAR(p) orders either seven or nine and a VECM with intercepts and time trend, without imposed cointegrating restrictions. Only unemployment after moving average transformation and HPB pairwise comparison was significantly cointegrated using the Bierens' test. When all variables (including moving average unemployment), were entered in a multivariate Johansen's test of cointegration (Table III), both the lambda-max and trace tests indicated one cointegrating equation at the 0.05 significance level. Furthermore, also entering HPB, CPI and UNEMPL (without moving average transformation) resulted in a significant cointegration model. Multivariate Bierens' test identified two cointegrating models including all the variables, including unemployment after moving average transformation (Table IV).

3.3 USA (1975-2003)

As shown in Figure 1, the rates of Medicare HPBs × 100,000 decreased four-fold from 1975 to 2003, i.e. from 91 to less than 20. A mirror-like image of it was the gradual ascent of CPI, from 53.8 in 1975 to 184 in 2003. A clear ascending pattern was also observed for RGDP per capita. Rates of unemployment initially increased from 8.8 per cent in 1975 to 10.1 per cent in 1983, and then decreased to 6.3 in 2003, showing overall a cyclical pattern. The DR after reaching a peak in 1978 (9.5 per cent) dropped to an historical low in 2002 (0.75 per cent).

Table I reports the main results of Phillips-Perron and Bierens' tests for unit roots. As shown all variables in the data sets fulfilled the criteria for unit roots.

Table II reports a summary of pairwise Johansen's tests of cointegration among rates of HPBs and socio-economic variables. A statistically significant cointegration equation was found in the comparisons of HPB-CPI and HPB-RGDP, with VAR(p) orders either two or eight and a VECM with intercepts and time trend, without cointegrating restrictions on the time trend. When all variables were entered in multivariate Johansen's and Bierens' tests of cointegration (Tables III and IV), no significant cointegration equations could be found. Alternative significant cointegration models could be identified entering HPB, CPI and RGDP (Johansen's test) or HPB, CPI and DR (Bierens' test).

3.4 UK (1977-1997)

As shown in Figure 1, the rates of psychiatric hospital beds had an almost four-fold reduction, from 312 in 1977 to 82 in 1997. During the same period the CPI constantly grew from 48.78 to 166.5. The growth of M0 and RGDP grew with a slope similar to CPI. Unemployment and DR followed a more cyclical pattern.

According to Phillips-Perron and Bierens' tests (Table I), the null hypothesis of a unit root (with or without drift) was not rejected for any of the variables.

Table IV.
Multivariate Bierens' non parametric tests of cointegration among rates of psychiatric hospital beds and economic variables (all variables are natural logs)

Dataset	North Carolina (1884-1903) +	Berkshire (1871-1901)	USA (1975-2003)	UK (1977-1997)	Italy (1975-2003)
Variables	$Y(1)$ = LnHPB $Y(2)$ = LnCPI $Y(3)$ = LnRGDP $Y(4)$ = LnDR $Y(5)$ = LnFEMPL	$Y(1)$ = LnHPB $Y(2)$ = LnCPI $Y(3)$ = LnRGDP $Y(4)$ = LnDR $Y(5)$ = MA7 LnUNEMPL	$Y(1)$ = LnHPB $Y(2)$ = LnCPI $Y(3)$ = LnRGDP $Y(4)$ = LnDR $Y(5)$ = LnUNEMPL	$Y(1)$ = LnHPB $Y(2)$ = LnCPI $Y(3)$ = LnRGDP $Y(4)$ = LnDR $Y(5)$ = LnUNEMPL	$Y(1)$ = LnHPB $Y(2)$ = LnCPI $Y(3)$ = LnRGDP $Y(4)$ = LnDR $Y(5)$ = LnUNEMPL
N. of cointegrating vectors (R)*	$R = 3$	$R = 2$	Inconclusive	$R = 2$	Inconclusive
The space of cointegrating vectors is spanned by the following standardized vectors	−0.21 0.17 1.00 → LnHPB 1.00 0.46 0.15 → LnCPI 0.03 −0.64 0.19 → LnRGDP −0.02 −0.07 −0.10 → LnDR −0.41 1.00 −0.13 → LnFEMPL	0.08 −0.26 → LHPB 1.00 0.15 → LCPI −0.13 1.00 → LRGDP −0.04 0.00 → LDR 0.01 0.04 → MA7 LnUNEMPL		−0.01 −0.20 → LnHPB 1.00 −0.34 → LnCPI 0.37 1.00 → LnRGDP −0.24 −0.01 → LnDR −0.32 0.10 → LnUNEMPL	
Variables of alternative model with best fit			$Y(1)$ = LnHPB $Y(2)$ = LnCPI $Y(4)$ = LnDR		
N. of cointegrating vectors (R)*			$R = 1$		$R = 1$
The space of cointegrating vectors is spanned by the following standardized vectors			0.51 → LnHPB 1.00 → LnCPI −0.05 → LnDR		−0.45 → LnCPI −0.08 → LnHPB 1.00 → LnRGDP

Notes: *The null hypothesis of no cointegration (i.e. $r = 0$) is rejected at the 5 per cent significance level, whereas the null hypothesis $r = n$ is not rejected at the 10 per cent significance level

A statistically significant Johansen's cointegration equation was found among HPB-CPI, HPB-RGDP and HPB-MA8-LnUNEMPL pairwise comparisons with VAR(p) orders either two, four or three (Table II). When all variables were entered in multivariate Johansen's and Bierens' tests of cointegration (Tables III and IV), both tests indicated two cointegrating equations at the 0.05 significance level.

3.5 Italy (1975-2003)

The rates of psychiatric hospital beds per 100,000 fell even more dramatically than in the other countries, from 180 in 1975 to 13 in 2003 (Figure 1). Conversely, CPI constantly grew from 24 to 206 (the highest ascent among the three countries). The growth of RGDP grew with a slope similar to CPI. Unemployment rate did not follow the cyclical pattern seen in the other datasets; it gradually increased from 5.9 per cent in 1975 to 12 per cent in 1988 and the decreased to 8.7 per cent in 2003. The DR grew from 6 per cent in 1975 to a peak of 19 per cent in 1981, and then gradually descended to 2 per cent in 2003.

The null hypothesis of a unit root were not rejected for any of the variables with the other datasets (Table II).

Cointegration with HPB was demonstrated for CPI and RGDP but not with either UNEMPL nor DR (Table II). Bierens' test confirmed a significant cointegration equation only with RGDP. When all five variables were entered in multivariate Johansen's and Bierens' tests (Tables III and IV), no significant cointegration equation could be found. However, by entering HPB, CPI and RGDP, both tests produced one cointegrating equation at the 0.05 significance level.

3.6 Demand/supply and cost analysis for hospital psychiatric beds. Additional analyses on Berkshire (1871-1901) data

Changes in rates of HBP are the result of an imbalance between admission and discharge rates. Although not available for the other data sets, we found information on the annual reports of Moulsford Lunatic asylum about the number of new admissions (i.e. patients at their first admission to Moulsford), readmissions, discharges and deaths. These data were available without gaps only from 1871 to 1894. We also decided to exclude 1871 data because of a large number of patients, transferred from other hospitals after the opening of Moulsford, had been classified as new admissions and this would have biased our analysis. Our first interest was to understand the relative roles of these variables in causing an increase in the rates of psychiatric beds in Berkshire during that period.

Figures 2 and 3 show the time series plot for these variables. Although all variables showed a cyclical nature, readmissions gave the largest relative contribution to the increase in HPB rates, while changes in the rates of discharges and deaths gave a negligible contribution during the period of observation.

New admissions and readmissions variables were combined in a single variable (ADM). After four period moving average and logarithmic transformation, we tested this variable for unit roots and cointegration with economic variables. As shown in Table IV this variable fulfilled unit root tests criteria. Consistently with previous HPB analysis results, a statistically significant cointegration model (both Johansen's and Bierens') could be created using ADM, CPI and UNEMPL variables (Table V).

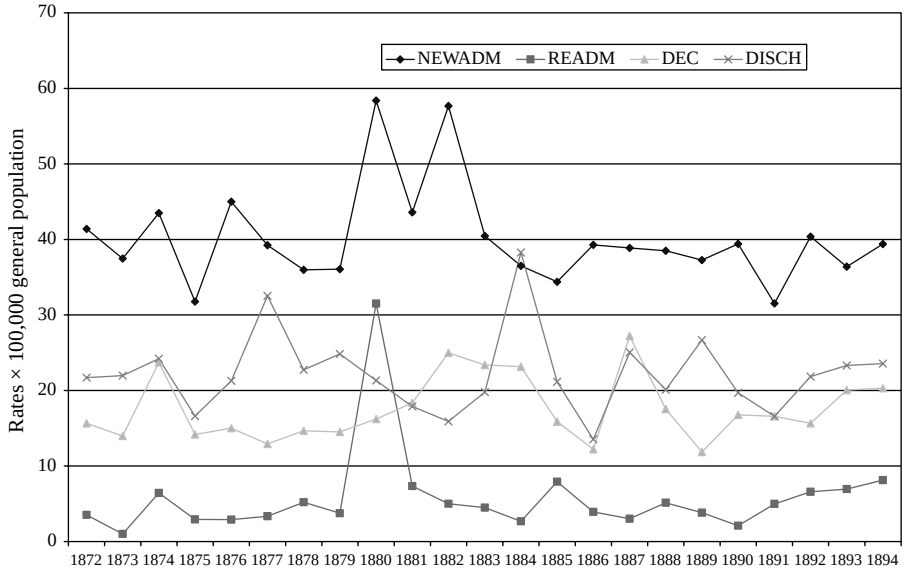


Figure 2.
Time series plot: rates of psychiatric new admissions, readmissions, deaths and discharges from hospital in Berkshire (1872-1894)

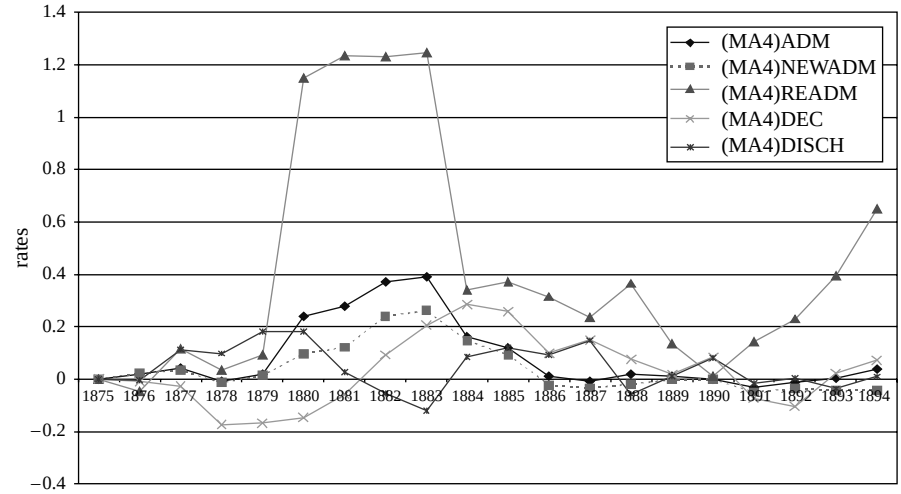


Figure 3.
Time series plot: rates of psychiatric admissions (new and repeated), deaths and discharges from hospital in Berkshire (1872-1894), all variables are baseline change four-year moving average after natural log transformation

	Test statistics	P^*
Phillips-Perron test 1	−3.46	0.21
Phillips-Perron test 2	−2.89	0.59
Bierens test	−3.50	0.10

Notes: *Null hypothesis *H0*: unit root; alternative hypothesis *H1*: stationary. If *P* is NS, then the null hypothesis of a unit root is not rejected; *p*-value is computed with bootstrapping based on 500 simulations

Table V.
Phillips-Perron 1-2 and Bierens tests for unit roots on variable four-year moving average all hospital admissions in Berkshire 1872-1894

We finally analysed the relationship between Bowley's Cost of living index and cost of care per patient per day at Moulsford asylum (Figure 4). As shown, the standardized cost of one day of care decreased more than standardized CPI on most years, confirming that Moulsford Asylum care costs decreased more than CPI from 1871 to 1901.

4. Discussion

We collected data concerning the rates of psychiatric hospital beds in the State of North Carolina, USA, and the County of Berkshire, UK, during the last three decades of the nineteenth century, and in three countries (USA, UK, Italy) 100 years later. Unit root and cointegration tests were used to analyse the relationship between psychiatric bed utilisation and some major economic variables (CPI, RGDP, interest rates, and employment measures). The primary research hypothesis tested in this study was if rates of HPBs fulfilled the criteria for unit roots and were cointegrated with CPI. The secondary hypothesis tested was the presence of a long-term relationship also of other socio economic variables such as RGDP, interest rates and unemployment, with HPBs. The main finding is that in all data sets, HPB was cointegrated with CPI in pairwise Johansen's cointegration tests. This relationship was also confirmed by Bierens' non-parametric cointegration test in three data sets (North Carolina, USA; the USA and in the UK). In bivariate Johansen's tests, no other variable was significantly cointegrated with HPB in any of the five data sets. Also in multivariate Johansens' tests of cointegration, CPI was the only variable in combination with HPB to be retained in a significant model of cointegration in all data sets. This finding was confirmed in three data sets with Bierens' bivariate cointegration test and all data sets in a multivariate Bierens cointegration model. Therefore, these findings are consistent with the hypothesis that changes in the CPI may predict future changes of psychiatric institutionalisation rates across different countries and different historical periods (Table VI).

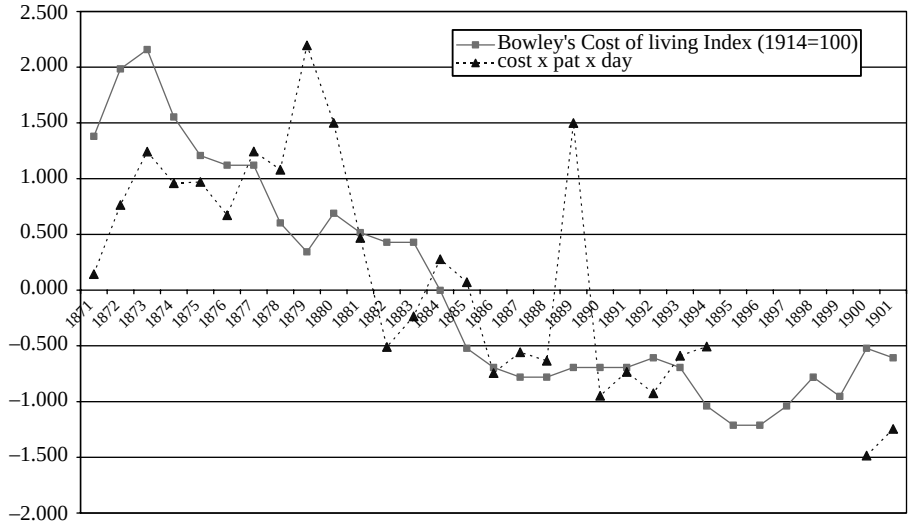


Figure 4.
Bowley's Cost of living index and cost of care per patient per day at Moulsford asylum (standardised values)

This finding alone does not explain all variation of inflation rates and hospital beds within the study periods. In particular, it remains unclear why the low rate of inflation from ca. 1990 onwards showed similar associations with changes of bed numbers as the much higher inflation rates between 1975 and 1990. There may several explanations for this including the delayed effect of CPI changes on HPB rates and a potentially diluting effect of other economic, social and cultural factors that also influenced HPB rates. Also, the psychological effect of the overall economic climate on investment decisions might have changed over time as a result of adjusted expectations and increasing experiences gained with investment decisions.

As we expected, other economic variables showed a long-term equilibrium relationship with psychiatric institutionalisation rates in individual data sets. In the nineteenth century data sets, unemployment measures (FEMPL, UNEMPL) were significantly cointegrated with HPB in bivariate and multivariate cointegration tests. Brenner (1973), who pioneered the study of the impact of economy on health, had already reported a significant correlation between unemployment and admissions to mental health hospitals in New York State from 1841 to 1967. However, Brenner's findings might have been spurious because of the limitations inherent in imposing stationarity with detrending techniques. Furthermore, limiting the focus of research to a single factor (i.e. unemployment) carries the risk of not recognising the role played by other economic factors, which are or are not linked with the level of occupation. Our study addressed these limitations and confirms the presence of cointegration between measures of unemployment and HPB in the two nineteenth century data sets used in this study (and also in the twentieth century, USA and UK data sets after moving average transformation) together with other macroeconomic dimensions, CPI in particular. The lack of any clear relationship between HPB and unemployment in twentieth century datasets (i.e. from 1975 onwards) is intriguing and still consistent with Brenner's findings, which were limited to a period of observation extended up to 1967. Therefore, the lack of a cointegration with unemployment from 1975 onwards in the data analysed here suggests that unemployment (in spite of ample fluctuations) is no longer a strong predictor of psychiatric institutionalisation rates, possibly as a result of the introduction of more effective welfare support measures during the second half of the twentieth century. A central argument is whether changes of HPB rates predominantly reflect a change of demand (i.e. changes in morbidity rates) or are driven by changes of supply of health care resources. If demand change were the

Dataset	Johansen's test	Bierens' non parametric test
Variables:	$Y(1)$=MA4(LnADM) $Y(2)$=LnCPI $Y(3)$=MA7 LnUNEMPL	$Y(1)$=MA4(LnADM) $Y(2)$=LnCPI $Y(3)$=MA7 LnUNEMPL
N. of cointegrating vectors (R)*	R=1	R=1
The space of cointegrating vectors is spanned by the following standardized vectors	1 → LCPI 0.43 → MA7[LnUNEMPL] 0.04 → MA4[ADM]	1.00 → LCPI − 0.03 → MA7[LUNEMPL] − 0.10 → MA4[ADM]

Table VI. Multivariate tests of cointegration among rates of psychiatric hospital beds and economic variables (all variables are natural logs)

Notes: * The null hypothesis of no cointegration ($r = 0$) is rejected at the 5 per cent significance level, whereas the null hypothesis r=n is not rejected at the 10 per cent significance level

primary cause, one would expect that the incidence of mental illness increased during the nineteenth century and then decreased during the latter half of the twentieth century. The picture of such changes in the nineteenth century is inconclusive. Hare (1983) argued in favour of a true increase in the incidence of schizophrenia over the course of the nineteenth century, whilst Scull (1984) firmly opposed the argument for a true increase and suggested that there had been an expansion of the "boundaries of what constituted committable madness". Yet, for the twentieth century there is little, if any, evidence suggesting a substantial decrease of morbidity levels might have led to the closure of asylums. Some researchers rather suggested the opposite, e.g. Healey *et al.* (2001) found a higher incidence of hospitalisation by detention in the North West Wales region for any psychiatric disorder in 1996 than in 1896.

Although only in one data set (Berkshire, nineteenth century) we were able to investigate further the demand versus supply question. Our findings suggest that an increase in the rates of psychiatric beds was not due to a reduction of discharge and death rates. Therefore, the increased institutionalisation rates were predominantly due to an increase of admission rates (either of new or old patients). Based on the socio-economic characteristics of Berkshire in the Victorian period, it is plausible to believe that the fluxes of patients in and out the County were minimal and that available rates of new admissions to hospital are a reliable estimate of the incidence of new psychiatric cases requiring hospitalisation. We showed that with the exception of two peaks in 1880 and 1882, the rates of new admissions hardly changed at all. The peak in admissions in 1880 was subsequent to the opening of Asylum's extensions, which allowed the transfer of 92 Berkshire patients from other County hospitals (1880 Annual Report). In 1882, the increase in the number of admissions was "chiefly due to the admission of 30 out-county patients from Brookwood Asylum, for the purpose of occupying the surplus accommodation resulting from the recent extension" (1882 Annual Report).

Rates of readmissions also peaked during the period of major expansions of the asylum; however, they showed a relative increase over time higher than any other variable. Our interpretation of these findings is that extra capacity obtained by expansions of the asylum was rapidly filled by new patients transferred from other asylums and by increasing the rates of readmission of old patients from the community and from the workhouse[3].

Turner (2006) recently suggested both a sociological and economic explanation for the expansion of Victorian asylums:

> Once an asylum was available, people became gradually more used to putting away their difficult relatives, and if asylums were cheaper than the workhouse (as they became in the 1870s), the parish guardians would have actively promoted their use. Asylum doctors had to admit whoever turned up with the appropriate certificates, and discharge was a slow legal process.

Therefore, our finding of a long run relationship between rates of admissions to Moulsford Asylum and rates of unemployment and CPI is compatible with Turner's assertion and it further strengthen the economic component of his explanatory model.

Based on the existing literature and the limited data of this study, one may conclude that the dramatic changes in the number of psychiatric hospital beds in the nineteenth and twentieth century were driven rather by factors directly influencing supply than variations of true morbidity. Any explanation of the impact of economic factors should

take this into account and consider how they might influence political, economic, administrative and clinical decisions on the supply level of hospital beds.

An important limitation of this study is that both Johansen's and Bierens' cointegration tests are not true causality tests as they only measure the ability to forecast the value of an X variable knowing the value of N other variables.

Therefore, at least theoretically, one cannot rule out that psychiatric institutionalisation and economic factors are actually independent from each other and may be influenced by another unidentified factor. These findings only allow us to state that changes in the economy predict changes in psychiatric-hospital bed numbers in the countries and the historical periods analysed here. They do not indicate any particular mechanistic explanation for such a relationship. Yet, since we found the hypothesized association in all five data sets that we were able to access for this study, one might assume that similar data sets from other countries might have revealed similar findings.

How can the identified cointegration of HPB and CPI across so diverse countries and historical periods be explained? One possible explanation is that a modest reduction in the CPI (in the late nineteenth century) encouraged capital investment and created confidence in the ability to meet the long-term running costs of ever expanding psychiatric hospitals. Furthermore, as suggested by Turner (2006), hospitalisation became more cost effective than placement in the workhouse. The data from Moulsford asylum support this point. In fact, the cost per patient per day decreased from £0.082 in 1871 to £0.065 in 1901 (£0.051 at 1871 prices). As shown in Figure 4, the Moulsford standardized cost of one day of care decreased more than standardized CPI on most years, confirming that Moulsford Asylum care costs decreased more than CPI from 1871 to 1901. The opposite phenomenon occurred at the end of the twentieth century, as reported by Stancliffe *et al.* (2005). The costs of institutional care in USA increased two times above general inflation from 1982 to 2002, and this super-inflation may have been a critical driver of deinstitutionalisation. Moulsford data at least indirectly support the view that institutional care price index started to grow above the CPI well before the 1980s. In fact, if the Moulsford hospital care costs had grown from 1901 to present at the same pace of CPI, in 2005 the cost of a day of inpatient care should have been £4.70, and even assuming that the cost had grown at the same pace of GDP, the cost should have been an unrealistic £42.06 (Officer, 2007). In reality, the average cost of one day of inpatient care in England was £201 in 2005/2006 (Curtis and Netten, 2006).

Cebula (1998) estimated the CPI for health care services increases with the general inflation, the population percentage over age 65, and real GDP growth, and decreases with the number of physicians per 100,000 population. Our findings are consistent with the model. The process of institutionalisation in the nineteenth century was facilitated by a gradual decrease of institutional costs per patient, made possible by a period of general deflation, rapid demographic expansion, and an increase of the medical workforce. The opposite phenomenon characterised de-institutionalisation. High inflation in the 1970s and 1980s acted as a deterrent from maintaining very large institutions, the running costs of which rose faster than the underlying general inflation. This economic climate is likely to have created a positive bias towards deinstitutionalization. The inflation paradigm could explain the recent data suggesting a trend towards re-institutionalisation in Europe (Priebe *et al.*, 2005), which follows a period of relatively low inflation.

The findings presented in this paper do not necessarily dismiss the far reaching influence of prominent advocates on mental health care such as Dorothea Dix, Samuel Tuke, Vincenzo Chiarugi, Thomas Szasz, Michel Focault, and Franco Basaglia – just to name few – who in different historical periods argued for the opening or closure of psychiatric hospitals. The results of this study, however, suggest that economic factors may have created a societal atmosphere in which the ideas of those and other advocates could prevail, whilst similar ideas were not implemented at times with different economic constellations. This may be illustrated by the fact that successful experiments with early in-patient models of care did not lead to the wide spread implementation of similar models and completely failed to initiate a new psychiatric era. For instance, one of the earliest asylums for the mentally ill in Europe, the Bethlehem Hospital in London, began admitting psychiatric patients in 1403, and as Alexander and Selesnick (1995) outlined "it was originally far different from the snake pit that later became known as Bedlam. In those early days patients were treated with much concern." As reviewed elsewhere (Schmiedebach and Priebe, 2004; Oosterhuis, 2004), once the asylums had been widely established, various authors like Gustav Kolb (1903), Max Fischer (1911), Arie Querido (1932) strongly advocated – and practiced – psychiatric care outside hospitals with new models resembling modern community mental health care services. However, although these models appeared successful – e.g. Querido's service in the community substantially reduced hospital admissions in Amsterdam – asylums continued to expand and be funded. One may argue that at least since the mid nineteenth century there have always been voices in psychiatry arguing for the provision of more institutional care, and others suggesting the reduction of HPB numbers. The results of this study suggest that a certain economic climate was required to implement those ideas, and that economic factors were instrumental in facilitating significant changes of psychiatric care provision within the last two centuries. Any analysis of current changes and any prediction of future trends should therefore consider economic factors as either drivers or at least facilitators of major decisions to build more psychiatric institutions or abolish them. More detailed analyses of historical trends and studies on other data sets might help to provide a more precise understanding of the influence of economic factors and their impact on health care provision.

It remains an open question how exactly the influence of macro-economic factors on HPB is mediated, and how it filters through to political and managerial levels on a local level, which often reflect more the mood of the time, i.e. the "Zeitgeist" than rational long-term investment strategies. In any case, the mood of the time at the end of the nineteenth century was one optimism about the capacity to support financially the future expansion of psychiatric hospitals, whilst hundred years later, in a period of high inflation, a different attitude prevailed, favouring the establishment of care in the community. Our study suggests that these different moods were linked with – or even due to – macro-economic factors.

Notes

1. Discount rate (US Federal Reserve Discount Rate – Federal Reserve Bank of Minneapolis, 2006) is the rate of interest set by the Federal Reserve that member banks are charged when they borrow money through the Federal Reserve System

2. Hamilton (1994) has defined cointegration as follows: "Cointegration means that although many developments can cause permanent changes in the individual elements of yt, there is some long-run equilibrium relation tying the individual components together, represented by the linear combination a'yt"
3. Additional information on the role of the workhouse in mental health care can be found on the website administered by Peter Higginbotham, available at: www.workhouses.org.uk/ (February 2007)

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