Suicide: the key role of short range ties

Bertrand M. Roehner

Institute for Theoretical and High Energy Physics
University Paris 7

Abstract  The paper explores the connection between short-range social ties (i.e. links with close relatives) and the occurrence of suicide. The objective is to discriminate between a model based on social ties and a model based on psychological traumas. Our methodological strategy is to focus on instances characterized by the severance of some social ties. We consider several situations of this kind. (i) Prisoners in the first days after their incarceration. (ii) Prisoners in solitary confinement. (iii) Prisoners who are transferred from one prison to another. (iv) Prisoners in closed versus open prisons. (v) Prisoners in the weeks following their release. (vi) Immigrants in the years following their relocation. (vii) Unmarried versus married people.

Furthermore, in order to test the impact of major shocks we consider the responses in terms of suicides to the following shocks. (i) The attack of September 11, 2001 in Manhattan. (ii) The Korean War. (iii) The two world wars. (iv) The Great Depression in the United States. (v) The hyperinflation episode of 1923 in Germany. Major global traumatic shocks such as 9/11 or wars have no influence on suicide rates once changing environment conditions have been controlled for.

Overall, it turns out that the observations have a natural interpretation in terms of short-range ties. In contrast, the trauma model seems unable to adequately account for many observations.

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1: Bertrand Roehner, LPTHE, University Paris 7, 2 place Jussieu, F-75005 Paris, France.
E-mail: roehner@lpthe.jussieu.fr
FAX: 33 1 44 27 79 90
1 Introduction

The paper examines two alternative interpretations of the phenomenon of suicide. The first one was put forward in a previous paper (Roehner 2005) while the second one was embodied in objections raised by this paper. The two interpretations are recalled in the introduction. The rest of the paper presents evidence specifically selected in order to provide “critical experiments” which should allow a clear choice to be made between the interpretations in competition.

In Roehner (2005), a paper which for the sake of concision will be referred to as Bridge, a parallel was drawn between the strength of intermolecular bonds on one hand and of interpersonal ties on the other hand. It was pointed out that, irrespective of the precise nature of the bonds, whether ion-ion, dipole-dipole, dipole-induced dipole, etc., it is their strength which explains a broad range of phenomena such as for instance boiling point, heat of vaporization, rate of evaporation, etc. Similarly, it was observed that, irrespective of their precise nature, whether husband-wife, parent-children, friend-friend and so forth, it is the strength of these ties which determine a broad range of social phenomena such as for instance school dropout, desertion, suicide, etc. In Bridge I suggested that, as we do not yet have adequate means for measuring the strength of social ties, one should focus on situations in which social ties have been severed. Imprisonment, emigration and divorce are three cases where former ties are severed. In the case of imprisonment all former links with family, friends or neighbors are cut off. In the case of emigration, only the links with the family members who emigrated together are preserved. In the case of divorce, the bond between husband and wife is broken; for one of the partner (usually the former husband) the links with the children are also weakened to a large extent.

I now come to the alternative interpretation as suggested by Professors Bernard Diu (oral communication) and Didier Sornette (email of May 16, 2004). The point is that the suicides occurring shortly after an arrest (which was one of the situations on which Bridge focused) can also be attributed to the psychological trauma of being arrested and incarcerated. Naturally, the same argument can be used in the two other cases as well. Instead of the severance of the social ties one would incriminate the shock and grief of the separation. For short, this perspective will be referred to as the trauma interpretation. Does it really matter whether one adopts one interpretation or the other? It does make a difference for at least two reasons. (i) The social tie framework is not dissimilar to what can be observed in physical or biological systems. On the contrary, the trauma mechanism relies on psychological reactions for which there is no parallel in the physical or biological worlds. If we settle for this interpretation we must definitely give up the prospect of a unified perspective. (ii) Even though we do not yet have any means for measuring the strength of social ties one can expect that this will become possible in the future. Once we will be able to measure the coupling strength between (for instance) husband and wife, one may expect that the same coupling will play a role (albeit not exactly the same role) in all phenomena in which this link is dissolved as for instance in the death, imprisonment or separation of one of the partners. On the contrary, in the trauma framework one has to resort to different (and largely ad hoc) shocks which have no reason to be related in any way. In short, the trauma perspective is hardly conducive to the building of a satisfactory theoretical framework.

In order to prevent any misinterpretation we must insist on the importance of the transient state between two equilibrium situations. When the social environment of an individual changes as in the case of imprisonment or emigration, the old ties are severed and it takes some time to establish new links even if the new environment is no less favorable than the old one. Thus, for instance, if a prisoner is moved from one prison to another, it will require some time to establish ties in the new establishment even if the latter is very similar to the previous one. This phenomenon is very similar to what happens when two liquids are mixed. There is a transient state during which new A − B bonds are established between the molecules of the two liquids. Naturally, at the molecular level the characteristic time of bond reorganization is very short (∼ 10−9 second) but before a new
A − B bond can be established the molecules must be close enough and this may take longer (it mainly depends upon the steering device).

The paper proceeds as follows. The second section provides evidence about the sharp increase in suicide rates which occurs consecutively to imprisonment, or consecutively to a change in imprisonment conditions. In the third section, I compare suicide rates for immigrants versus non-immigrants. In the fourth section I compare suicide rates for married versus non-married individuals. In the fifth section I show that macro-traumas such as wars or the attack of September 11, 2001 have no impact on suicide rates. All these cases have been selected with the purpose of discriminating between the two alternative interpretations.

Before we begin, we should explain how this study is related to the work centered on stock markets which was done by econophysicists in the last decade. If momentarily we forget the economic agents who buy and sell stocks, we can then see them as entities which move in a one-dimensional space defined by their prices. Their moves obviously are interdependent in the sense that closely related sectors (e.g. microprocessors, computers or softwares) move in parallel. This explains why the question of the interdependence between stocks is of central importance. Econophysics groups have been using various approaches to measure couplings between stocks. One of these is to analyze the properties of the correlation matrix of a broad sample of stock prices\(^1\), but there are several others. The interested reader can find more information in the following papers: Bonano et al. (2001), Drozdz et al. (2001), Kim et al. (2004), Mantegna et al. (2004), Plerou et al. (2001), Sornette et al. (2003), Stauffer et al. (1999). The question of interaction strength is not only of importance in finance, but also in economics. In this respect one can mention the exploration of the coupling strengths between several spatially separated commodity markets (see for instance Roehner 1995). In all these cases the links can be identified by probing the interdependence of prices. This raises an obvious question: for social ties do we have something similar to prices? If the thesis developed in this paper is correct, suicide rates can indeed be used for the purpose of measuring social ties just as prices permit to estimate economic ties.

## 2 Suicide in prison

The purpose of Fig. 1 is to summarize some of the evidence presented in Bridge. These data describe the evolution in suicide rate in the hours, days, weeks and years following an incarceration. The decrease roughly follows a power law at least until the plateau phase is reached. The exponent of the power law is 1.1, in other words:

\[
\text{suicide rate} \sim 1/\text{[time elapsed since incarceration]}^{1.1}
\]

Over the first week the average relaxation time is about 2 days. In itself this phenomenon does not allow us to discriminate between the two interpretations\(^2\). In the tie interpretation one would say that the propensity to commit suicide declines as new links are formed for instance with fellow inmates, police officers, wardens or layers. In the trauma perspective one would say that the trauma brought about by the incarceration recedes in the course of time in the minds of the inmates. One possible way for discriminating between the two explanations would be to identify a phenomenon which results in a sharp increase of suicide rates without involving an initial trauma. Another test would be to study a situation which involves an initial trauma but does not result in increased suicide rates. In what follows, these two tests will be used successively.

\(^1\)This approach is at the base of Markowitz's portfolio theory.

\(^2\)However, it will be useful by providing a broad overview of typical orders of magnitude to which subsequent suicide rates can be compared.
2.1 Impact of solitary confinement

The evidence on which we rely in this paragraph concerns suicides which occurred in solitary confinement cells in New York State prisons. These cells, also called “special housing units”, are used for the purpose of punishing inmates for rebellious behavior. The regime in these cells implies confinement 23 hours a day and little human contacts with the outside. On December 31, 2001 there were 3,654 inmates in solitary confinement cells representing 5.4% of the total population of inmates in New York State. The average time spent in these cells was 4.6 months in 2001. Under New York State law there is no limit to the amount of time an inmate can be kept in confinement. In 2001 the average annual suicide rate in prison was 26 per 100,000, but it reached 140 (i.e. 5.4 times higher) in solitary confinement. It is true that the number of suicides in a single year was small (∼ 6) but a a ratio of
5.4 is nevertheless highly significant. Furthermore, the same observation also holds for the 3-year period 1998-2000: in this case the suicide rate in confinement was 8.7 times higher than in prison. Over the four years 1998-2001 the average suicide rate in confinement is about 8 times higher than in prison. Let us now examine the possible explanations of this effect in the two perspectives. In the tie interpretation, the higher suicide rate would be attributed to the severance of the links with former inmates and wardens and the difficulty of building new ones due to confinement. In the trauma interpretation, one would argue that the shift from prison to confinement brought about a trauma which accounts for the higher suicide rate. According to this interpretation the suicide rate in confinement should decrease in the course of time as the trauma subsides. If one could know the distribution over time of the suicides which occur in confinement cells, that would provide a crucial test. Indeed, as few new ties are formed in confinement the tie hypothesis would lead us to predict that the suicide rate in confinement should decrease at a much slower rate than what we observed in Fig. 1. So far, we were not able to find such data.

2.2 The silent system

A related effect was observed in the 19th century. Starting from the premise that prisoners learn criminal ways from each other and that on the contrary isolation would put prisoners face to face with their conscience and encourage penitential reflection, prison reformers introduced what was called the silent system. In the Pennsylvania system, prisoners were kept isolated in individual cells all the time. In the Auburn (New York State) system they were kept in cells during night and evening; during the day they had to work together but in enforced silence. In 1842 the English writer Charles Dickens was authorized to visit the Pennsylvania’s penitentiary. In his account of the visit he wrote: “A prisoner sees the prison officers, but with that exception he never looks upon a human countenance or hears a human voice. He is a man buried alive” (Dickens 1842). Under such circumstances the tie interpretation would lead us to expect high suicide rates. This was indeed the case although there is only scant quantitative evidence.

- In a lecture given by the prominent British lawyer Louis Blom-Cooper (1987), we learn that in 1877, after adoption of the silent system in Britain, “the suicide rate among prisoners was as high as 1,760 per 100,000”.
- Going into the same direction are the high levels of suicide rates in prison mentioned in Bridge (table 2). For instance 190/10^5 in Belgium (1872) and 860/10^5 in Saxony (1872), two places where we know the silent system was adopted.
- At a more qualitative level, we read that the Pennsylvania system “led to high rates of suicide and insanity” (Telzrow 2002).^5

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^3 The argument goes as follows. The expression of the standard deviation \( \sigma_m \) of the mathematical expectation \( m \) of the suicide rate is: \( \sigma_m = \sqrt{D/n} \), where \( D \) is the variance of the suicide rate and \( n \) the number of inmates (Ventsel 1973, p. 307). To get an estimate for \( \sigma_m \) one first needs an estimate for \( D \). It can be obtained from a time series of suicide rates. By taking for instance the county of Chautauqua in New York State (which has about 65,000 male inhabitants) over 20 years (1979-1998) one gets \( D = 36 \) and \( \sigma_m = 1.3 \) for the total population of 65,000 inmates in New York State. For the inmates in confinement the \( \sigma_m \) will be \( \sqrt{1/0.054} = 4.2 \) times larger, which gives \( \sigma_m = 5.5 \). Thus, the difference \( 140 - 26 = 114 \) of suicide rates in confinement versus in prison represents 20 times the standard deviation. The probability of occurrence of a statistical fluctuation of this magnitude is exceedingly small. For \( x = 20 \) one gets: \( 1 - \Phi(x) = (1/\sqrt{2})\text{erfc}(x/2) \sim (\sqrt{2/\pi}) \exp(-x^2/4/x) \sim 10^{-44} \).

^4 Naturally, such a prediction is conditioned by the availability of means for committing suicide. If there are not sheets, towels, glasses, windows nor anything sharp that could be used as a knife, committing suicide becomes nearly impossible. Naturally, living in a cell deprived of almost everything would be a nightmare that is likely to affect the prisoner’s mental health. Under such circumstances, he may commit suicide not in the confinement cell but as soon as allowed to leave it. It is the difficulty of controlling for all these factors which makes the task difficult.

^5 A dissenting note is introduced by Dickens. In the account of his visit, he writes that “suicide rates are rare among...
2.3 Effects of a reorganization of social ties

As already noted a change in the social environment results in a disruption followed by a reorganization of social ties. This effect is fairly similar to a trauma effect with the result that the two effects can be easily mistaken one for the other. It is therefore important to get detailed information. Prison and army statistics offer useful quasi-experiments.

The test of remand centers  A first test is offered by remand centers in Britain. Prisoners who are waiting to be sentenced but were remanded in custody by the courts stay in the remand areas of local jails. Because these remand centers are used for short stays their population is in majority composed of “new” prisoners. The following table shows that the transient state which characterizes these prisoners results in suicide rates which are about three times as high as the average prison rate.

| Type of prison                      | Annualized suicide rate (per 100,000 of average daily population), 1996-1998 |
|-------------------------------------|--------------------------------------------------------------------------------|
| Remand centers (stays shorter than 6 months) | 389                                                                           |
| Total prison population             | 119                                                                           |

Source: Marshall et al. (2000)

This observation is interesting in two respects. (i) The fact that the suicide rate in remand centers is higher than in solitary confinement is at first surprising. Probably the simplest explanation is that prisoners have much more means of committing suicide in remand centers than in solitary confinement cells. (ii) The analogues in the U.S. of the British remand centers are the jails. But whereas in remand centers stays are limited to 6 months, in jails they are limited to one year. This is probably the reason why suicide rates in remand centers are twice as high as in jail (for suicide rates in jail see the data given in Bridge, table 2, cases 3 to 6).

Moving from one prison to another  In a study done by MacDonald and Sexton (2002) we learn that suicide rates are increased every time a prisoner is moved from one prison to another. If the time is counted from the day a prisoner arrives in a prison, the data show that there are approximately as many suicides during the first 6 days as during the following 53 days. The observation should be considered as fairly robust because it relies on a set of data which covers the 11 years 1990-2000. In other words the annualized suicide rate is about 9 times higher in the first 6 days as in the two following months. Unfortunately, this observation does not distinguish between initial incarceration (for which there is a very high suicide rate as we have seen in Fig.1) and subsequent relocations.

Release from prison  When a prisoner is released there is a transient state as well. Table 1a shows that the standard mortality rate of released prisoners in the first week after release is about 4 times as high as in prison. At first sight this could seem as a perfect argument against the trauma interpretation. Indeed, normally one would not interpret the fact of being released as a trauma, quite the contrary. In the tie perspective the surge in the first week has a natural interpretation as being caused by a transient readjustment of social ties. However, we will see below that it would be inappropriate to jump too quickly to definitive conclusions.

The fact that some caution must be exercised is suggested by the second column in table 1a. It shows that for accidental deaths too, there is also a surge in the first week after release. In contrast to suicide however the rate remains almost 5 times higher than in prison even in subsequent weeks. This is not really surprising for in prison the risk of being run over by a car or to freeze to death while sleeping in the street is zero. Table 1b provides additional information about the decrease in standard mortality rates in the weeks after release. We see that the pattern is basically the same either for suicide, for
**Table 1a  Standardized mortality rates in prison and after release (1996-1997)**

| Situation                                      | Suicide: standardized mortality rate with respect to general population [=100] | Accident: standardized mortality rate with respect to general population [=100] |
|------------------------------------------------|-------------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| Prisoners in prison                            | 860                                                                          | 150                                                                           |
| Released prisoners, first week after release    | 4,500                                                                        | 2,100                                                                         |
| Released prisoners, 6-month period after release| 1,140                                                                        | 700                                                                           |

Notes: The tables 1a,b are based on a sample of 233 deaths of ex-prisoners under community supervision.  
Source: Sattar (2001, p. 47-49)

**Table 1b  Number of deaths per week of ex-prisoners in the weeks after their release.**

| Situation   | Suicide: number of deaths per week | Natural causes: number of deaths per week | Accidents: number of deaths per week |
|-------------|-----------------------------------|------------------------------------------|-------------------------------------|
| Week 1      | 4.00 [1.00]                       | 4.00 [1.00]                              | 13. [1.00]                          |
| Weeks 2,3,4 | 1.70 [0.42]                       | 2.33 [0.57]                              | 8.3 [0.64]                          |
| Weeks 5-12  | 0.87 [0.22]                       | 1.63 [0.40]                              | 6.2 [0.47]                          |
| Weeks 13-24 | 0.54 [0.13]                       | 0.66 [0.16]                              | 5.9 [0.45]                          |

Notes: The number within brackets show the data in normalized form (first week=1). At first sight one may be tempted to interpret the decrease in the number of suicides per week as reflecting a transient state marked by a reorganization of social ties. However, the parallel observations for deaths by natural causes and by accidents clearly require different explanations. In the case of death by natural causes a key-factor is the fact that terminally ill prisoners are released so they can die at home or in hospital. Alcohol is also an important factor.  
Source: Sattar (2001, p. 34)

deaths by natural causes or for deaths by accident. The following precisions may be useful for the interpretation of these data.  
• Prisoners afflicted with a fatal illness are often released in their last weeks of life. This policy may well account for the fact that the standard mortality rate for overall deaths is about 3 times higher for ex-prisoners than for prisoners. It may also account for the surge of natural deaths in the first week after release if the policy is to release prisoners in the very last stage of their illness. To make that point clearer one would need to know the criteria on which release is decided.  
• While the availability of alcohol is fairly limited in prison, all of a sudden it becomes available once a prisoner is released. In a general way, one knows that there is a strong link between alcohol consumption and suicide rates. This effect is documented convincingly by Nizard (1998, p. 2). Naturally, it can be argued that the excessive consumption of alcohol is in itself a kind of suicidal behavior. The point that we made for alcohol can also be made for drugs.  
• The ex-prisoners considered in Sattar’s study on which the present discussion is based were under community supervision. In fact, it is for this very reason that their death could be recorded. However, when the period of supervision of an ex-prisoner comes to an end he leaves the sample and his death will no longer be recorded. If the period of supervision of an ex-prisoner lasts only
4 weeks his death will not be recorded even if it occurs only 5 weeks after release. Naturally, this procedure tends to inflate the number of deaths which occur shortly after release. To some extent this may explain the decrease pattern observed in the three columns of table 1b. Unfortunately, this effect cannot be controlled for.

**Transition from civil to military status**  Being enlisted represents a major change in social environment and requires a reorganization of social ties. One would therefore expect a surge in suicide rate followed by subsequent decrease just as observed in Fig. 1 after incarceration. In a thesis published in France almost a century ago, Botte (1911) provides a comparison between the suicide rate of soldiers in their first army year (we call them “new”) and soldiers who had been in the army for more than one year (we call them “old”). Remember that at the time military service lasted 3 years for French draftees. On average, for the 1888-1907 period for which Botte provides data, the suicide rates for new and old soldiers were $26.0/10^5$ and $20.6/10^5$ respectively. The ratio “new”/“old” is 1.26. As expected this ratio is indeed larger than one. However, it is markedly smaller than for the shift to prison life. From the data given in Bridge it results that for jail inmates (i.e. for less than one year) the average suicide rate is $130/10^5$ (over the period 1981-1987) while it is $21/10^5$ for inmates in prison for more than a year). In this case, the ratio is: $130/21 = 6.2$.

Botte also gives another comparison which can be of interest in connection with our subsequent discussion of family ties. He shows that over the period 1878-1908, the average suicide rate was twice as high for troops stationed in the French colony of Algeria as for troops stationed in France. A similar result is given in another study for the earlier period 1865-1869: the average suicide rate was 1.28 times larger for troops in Algeria than for the total army (Cristau 1874). The troops in Algeria differed from those in France in two main respects: (i) They were separated from their relatives to a greater extent than troops stationed in France. (ii) They comprised indigenous soldiers. Both factors may have contributed to the higher rate; the first factor can be connected to our subsequent discussion regarding the impact of family links.

### 2.4 Open vs. closed prisons

Open prisons are without walls or bars and offer the possibility to work or study outside of prison during working hours, the evenings and nights being spent in the prison. Open prisons are for prisoners who are believed not to be a risk to the public. For instance, total objectors who refuse all service in the conscription system including non-military service may be assigned to an open prison. The data on which we rely in this paragraph come from two detailed reports published by the British Home Office (Prison Statistics 2001, HPMS Annual Report 2004).

Table 2 shows that suicide rates are at least 10 times higher in closed than in open institutions. The decision to affect a prisoner to an open rather than to a closed institution is taken in the days or weeks following the incarceration. In other words, the initial trauma caused by the incarceration is the same for all prisoners whatever institutions they belong to subsequently. In short, this observation seems to disprove the trauma explanation. On the contrary, it has a natural explanation in the tie perspective in so far as open prisons are of course more conducive to the establishment of social ties. One could be tempted to say that the two populations are not the same which is quite true. However, it is by no means obvious that a prisoner who represents a threat to the public (and for that reason will be affected to a closed prison), necessarily has a higher “propensity” for committing suicide.

In the next section we turn to another situation which results in the severance of social ties, namely emigration.
Table 2  Comparison of suicide rates in open versus closed prisons, 1994-2001

| Category of prisoners | Average population of prisoners | Average number of suicides per year | Annual suicide rate per 100,000 |
|-----------------------|---------------------------------|------------------------------------|--------------------------------|
| Young prisoners (15-21) |                                 |                                    |                                |
| 1 Open Young Offender Institution | 380                      | 0                                  | 0                              |
| 2 Closed Young Offender Institution | 4,690                     | 6                                  | 138                            |
| Adult prisoners (over 21) |                                 |                                    |                                |
| 3 Open Male Training Institution | 3,430                     | 0.12                               | 3.6                            |
| 4 Closed Male Training Institution | 19,190                    | 11.1                               | 47.4                           |

Notes: There is a difference of at least a factor 10 for suicide rates in open versus closed institutions. Are the populations in the different categories large enough to lead to substantial suicide rates. Under the assumption of a suicide rate of about $15/10^5$ it would require a sample of more than $10^5/(15 \times 8) = 830$ prisoners to get at least one suicide per year. On this basis it can be seen that all samples are large enough except possibly the first one. In the later case, over the 8 years one would expect $380 \times 8 \times (15/10^5) = 0.46$ deaths. The observation gave 0, but it could have been 1, 2 or 3 without altering our conclusion. Note that the closed male institutions belong to the categories B and C defined in the statistics of the Home Office.

Sources: Prison Statistics, England and Wales 2001, HPMS Annual Report 2004.

3  Suicide rates of immigrants

In the previous section we considered the weakening of social ties when a person is put into custody. Naturally, this is only one of many possible mechanisms leading to a weakening of social ties. The process of emigration is another obvious candidate. Back in the 19th century, when an individual or a family emigrated from, say, Italy to the United States, it meant an almost total severance of the contacts with relatives, friends and neighbors left behind in Italy. Furthermore, until the language barrier was surmounted, it was not easy to establish new social ties in the United States except of course with other Italian immigrants. As a matter of fact, this is certainly the main factor which made Italian immigrants live together in areas such as “Little Italy” in South Manhattan.

The tie perspective would make us expect suicide rates of Italian immigrants in New York City to be higher; but higher than what? Higher than the average suicide rate in New York or higher than the average suicide rate in their region of origin? Fig. 2 answers this question. It turns out that there is a high correlation between the suicide rates of immigrants in New York and the suicide rates prevailing in their country of origin. In other words, suicide rates seem to display a great inertia. For groups of immigrants their suicide rate seems to be a cultural attribute just like their language or religion. We do not yet have a comprehensive explanation of this effect but in a sense it is not completely surprising. For instance, the fact that suicide is strongly prohibited by the Catholic Church will tend to lower the impact of suicide among Catholics both in the country of origin and in New York. The difficulty is that this can be understood in a number of different ways. (i) It can induce families and physicians (at least if they are Catholic too) to fake the evidence. In this case, it would be nothing but a statistical bias. (ii) Alternatively, one can also suppose that suicide rates are really lower among Catholics.

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6This kind of arguments was developed by Douglas (1967) who expressed great doubts about the validity of suicide statistics. That there are indeed measurement problems can hardly be denied. For instance, in 1987 the official suicide rate in Egypt was equal to $0.1/10^5$ for males and to $0.0/10^5$ for females (Schmidtke et al. 1999). However, the above correlation shows that if this effect exists, it is only of marginal importance for European countries. On average, the rates of suicide recorded in New York (mostly by American physicians one can suppose) are consistent with the rates recorded...
It can be seen that the suicide rates in New York City are higher than in the region of origin which is consistent with the rearrangement of social ties brought about by the process of emigration. There is a marked correlation between the levels recorded in the country of origin and in New York City. This consistency provides an overall reliability check of suicide statistics. The correlation is equal to 0.70 (with a confidence interval at probability 0.95 extending from 0.21 to 0.91) and the slope of the regression line is 1.5 ± 1. The line \( y = x \) is shown for the purpose of comparison. Sources: Durkheim (1897), Krose (1906), Nagle (1882).

Before trying to find an explanation one would have to check whether this is really true everywhere or also depends upon broad regional traditions. We plan to study this question more carefully in a subsequent paper.

Let us now come back to the question of the two interpretations. Fig. 2 shows that for each country of origin the suicide rate in New York is increased, the increment being of the order of 18 per 100,000. This increment has a natural interpretation in the tie perspective. At first sight, one may think that it is also consistent with the trauma hypothesis. It cannot be denied that the act of emigrating represents in the countries of origin which shows that the latter are on the whole trustworthy.
a cultural and psychological shock. However, there is a problem with the way this shock subsides in the course of time. In the case of an incarceration we have seen that suicide rates revert to their pre-incarceration level within two years approximately. In the case of Fig. 2 we do not know how long these immigrants had been in New York, but it is probably safe to assume that on average they had been in New York for more than two years. It would be difficult to understand then why the emigration shock (presumably less traumatic than an incarceration) would last several years. On the contrary, a transient period of several years for the formation of new links is in agreement with the time it takes to learn English and to make new acquaintances.

To our best knowledge there have been very few studies documenting suicide rates among immigrants. The topic which we consider in the next section, namely the influence of family links, has given rise to a larger number of studies.

4 Influence of family ties

One of the best discriminating tests between the trauma and tie models is to observe the effect of changing family ties. Table 3 summarizes the evidence for four different countries and for time intervals which cover more than one century. On average, the suicide rate for unmarried men is 2.4 times higher than for married men; for women the ratio is 1.9. We deliberately excluded the evidence for separated, divorced or widowed individuals. For these categories the suicide rates are also higher than for married people but they imply a traumatic event which could serve as an alternative explanation. On the contrary, for people who never married one can hardly invoke a possible trauma.

| Time interval | Country       | Males ratio of suicide rates: not married / married | Females ratio of suicide rates: not married / married |
|---------------|---------------|---------------------------------------------------|---------------------------------------------------|
| 1 1889 − 1891 | France        | 2.80 ± 0.23                                       | 1.56 ± 0.43                                       |
| 2 1881 − 1890 | Switzerland   | 1.66 ± 0.24                                       | 1.34 ± 0.41                                       |
| 3 1968 − 1978 | France        | 2.69 ± 0.66                                       | 2.24 ± 1.10                                       |
| 4 1981 − 1993 | France        | 2.34 ± 0.33                                       | 2.15 ± 0.91                                       |
| 5 1990 − 1992 | Queensland    | 2.67 ± 1.20                                       | 2.11 ± 1.60                                       |
| 6 1998        | Australia     | 2.21                                               | 2.00                                               |
| 7 1970 − 1985 | Norway        |                                                   | 1.78 ± 0.24                                       |
| Average       |               | 2.40 ± 0.24                                       | 1.88 ± 0.32                                       |

Notes: In most cases (except 6) detailed data by age interval were available. We computed the ratio of the suicide rates in each age interval and then the average $m$ and the standard deviation $\sigma$ of the ratios. The results in the table are given in the form $m \pm \sigma$. It should be noticed that the category “married” includes both “married without children” and “married with children”; consequently, the reduced suicide rates for “married” should not be attributed solely to marriage but to the combined effect of being married and having children.

Sources: 1: Durkheim (1897); 2: Halbwachs (1930); 3, 4: Besnard (1997); 5: Cantor et al. (1995); 6: Steenkamp et al. (2000); 7: Høyer et al. (1993).

Furthermore, there is evidence in the literature showing that married people with children have smaller suicide rates than married people without children. Unfortunately, most of these observations are
indirect because death certificates usually do not indicate the number of children of the deceased. As a result these data require careful discussions which we leave for a subsequent study.

To sum up, one can say that the tie perspective provides a natural interpretation for suicide rate differentials in various family situations. However, there is one observation which, at first sight, it is not able to accommodate, namely the differential between males and females. In European countries and in the United States\(^7\), whatever their respective family situations, males have suicide rates which are 2 to 3 times higher than females in same family situations. If one tries to interpret this effect in the tie model one is led to assume that females have stronger family ties than males. While this makes sense for married women with children (especially if they are housewives) it does hardly explain why it is also true for unmarried women respective to unmarried men. In that case one would have to assume stronger links with parents, brothers, sisters and other close relatives.

It is possible to perform a plausibility test of the former argument. Over the past 60 years, as more and more women have taken up a job their links with their family tended to become similar to those of working men. If the tie model holds one would therefore expect a narrowing of the suicide rate gap. This is indeed what one observes as shown in table 4.

| Table 4 Suicide rates of unmarried people: male vs. female |
|----------------------------------------------------------|
| 1889–1891 | 1968–1973 | 1979–1983 | 1989–1993 |
| Unmarried males, 30-59 y. | 101 | 65.4 | 76.5 | 65.8 |
| Unmarried females, 30-59 y. | 16.7 | 17.2 | 24.0 | 23.1 |
| Ratio M/F | 6.0 | 3.8 | 3.2 | 2.8 |

Notes: For married males versus married females, the decrease in the ratio of suicide rates was smaller: from 3.20 in 1889-1891 to 2.45 in 1989-1991 (for the same 30-59 year interval).
Source: Besnard (1997).

5 Effect of global traumas

The expression “global traumas” refers to dramatic event which affect the society as a whole. The outbreak of a war or a major disaster belong to this class of events. It has been claimed that such events reduce the suicide rate because, allegedly, of the polarization they create in human minds. If true, this effect would be a strong argument in favor of the trauma model. In the tie model one would not expect any effect based on purely psychological factors. In the case of a war lasting several years, the expectation must take into account the rearrangement of family ties occasioned by the war conditions (e.g. the fact that many husbands are enlisted).

In this section we make the following points.

- Short events which do no imply a reorganization of social ties do not have any incidence on suicide rates. We consider two episodes of this kind (i) The hyperinflation in Germany in 1923 (Fig. 3a) (ii) September 11, 2001 (Fig. 3b).
- Wars lasting several years have no clear-cut influence on the suicide rate of females. As far as males are concerned, there is a decrease in suicide rates. This decrease is difficult to interpret as we explain below. We consider 3 episodes of this kind (i,ii) World War I in Germany and in the United States (Fig. 3a and 3c) (iii) World War II in the United States (Fig. 3c) (iv) The Korean War in the United States (Fig. 3c).

\(^7\)It does not seem to be true in China or in some parts of India.
In addition we also consider the period of the Great Depression in the United States. This an episode which is of a somewhat different kind than the previous ones. It is marked by a substantial increase in the suicide rates of males but the suicide rate of females increase only slightly (Fig. 3c).

![Graph showing suicide rates in Germany 1911-1924](image)

**Fig. 3a: Number of suicides in Germany 1911-1924.** The fact that the direction of variation is not the same for males and females during the war and the hyperinflation episode shows that even major events have little effect on suicide rates. *Source: Statistisches Jahrbuch für das deutsche Reich (various years).*

Next we discuss these episodes in more detail.

**Hyperinflation of 1923 in Germany** It should be recalled that this inflationary episode suppressed the huge internal war debt of the German government. The hyperinflation ended in November 1923 when a new mark (the so-called *Rentenmark*) was introduced on the basis of $1 \text{ new mark} = 10^{12} \text{ old mark} = 0.24 \text{ US dollar}$. Needless to say, at the same time as it extinguished the debt the hyperinflation also obliterated all savings which had not been exchanged for dollars. In other words, it was really a traumatic event for a large part of the population. Yet, Fig. 3a shows that there is no clear-cut effect on suicide rates: the suicide rate of males increases (but it may well have been the continuation of a trend which began in 1918) while the suicide rate of women shows a small decrease.

**September 11, 2001** We selected the data in a way aimed at magnifying any possible effect, even
a small one. (i) Instead of looking at suicide rates for the U.S. or for New York State, we focused on data for New York City where the impact of September 11 would be expected to be largest. (ii) Instead of annual or quarterly data, we analyzed monthly data so as to be able to identify even an effect of short duration. Nonetheless, Fig. 3b shows that there is no perceptible effect.

Wars Two preliminary remarks are in order. (i) One should concentrate on countries whose territory was not occupied. Why? Consider the case of France. During the duration of Word War I the northern part of its territory was occupied by Germany. As a result the suicide statistics could not be collected

\[ \text{Fig.3b: Number of suicides in New York City before and after September 11, 2001.} \]

The graphic shows the number of suicides in each month of the years 2000, 2001 and 2002. The data for 2000 and 2002 are for the purpose of comparison. It can be seen that between August and December the curves for 2000 and 2001 are very close which indicates that 9/11 has had no significant impact on suicide rates. Source: I would like to express all my gratitude to Dr. Joseph Kennedy of the New York City Department of Health for sending me these data.

\[ \text{It would be meaningless to perform a test of significance. Such a test would rely on assumptions regarding the statistical distribution of suicides (in particular its standard deviation) and would not in this case be more reliable than visual inspection. We see that over September-December, the 2001 curve is very close to the 2000 curve; on the contrary the 2002 curve deviates from the two others in spite of the fact that there was no major shock in the fall of 2002.} \]
Fig. 3c: Suicide rates in the United States during global shocks. The broken lines and the thick solid lines give the suicide rate for males and females respectively (left-hand scale); the thin solid lines provide a magnification of the fluctuations of female rates (right-hand scale). The Great Depression is the only case where the female and male rates move in the same direction. For the three other cases, suicide rates do not respond in a consistent and significant way. Source: Historical Statistics of the United States (1975). Prior to 1930, the data must be handled with caution because several states (especially in the West) do not belong to the Registration Area. The dates of entry of each state into the Registration Area can be found in Candiotti et al. (1948).

and recorded by the French statistical agency. A similar observation applies to World War II because the departments of the north and east came under direct German rule and were no longer considered as belonging to France. (ii) It is not at all obvious that suicides occurring in the army in times of war are truthfully recorded. Why? in a general way committing suicide is seen negatively both by the military and the families. This is far more true in times of war. For field commanders suicides are seen as a form of desertion. As a result, it is likely that many suicides are declared as being accidents. “Unfortunately, he shot himself while cleaning his rifle”. Unless one has positive proof to the contrary, suicide rates among enlisted men should therefore not be considered as reliable, especially if they are low. For these two reasons one must be particularly careful in selecting the
Effect of World War I in Germany  Fig. 3a shows that between 1914 and 1918 there was a 10% increase in the suicide rate of women. There is therefore no ground for a psychological effect due to the war.

Effect of World War I in the United States  As in Germany we observe an increase in the suicide rate of women, (albeit of small magnitude). In the tie model these increases can be attributed to the severance (temporarily or permanently) of the link between husbands and wives. This interpretation could be tested against suicide rate data by age.

Effect of World War II and of the Korean War in the United States  Once again we have a similar pattern: small increase in the suicide rate of females (if one leaves apart the initial drop which continued the previous trend) and a drop in the suicide rate of men.

Effect of the Great Depression in the United States  The Great Depression was much more than a psychological trauma; it deeply affected the life of millions of people. Therefore it is hardly surprising that it has had a substantial influence on suicide rates. In this case we see that the rates of both males and females display parallel evolutions.

6 Conclusion

We have collected, selected and compared data sets in order to discriminate between the tie model and the trauma model. It turns out that there is a broad array of evidence in favor of the tie model. Fig. 4 schematically summarizes this model.

Fig.4a: Schematic representation of interpersonal ties.

The box labeled “State” symbolizes the society considered as a global entity.

What remains to be done? To see this point more clearly it may be helpful to physicists to draw on a comparison with physics. Suppose we want to study the movements of a number of pendulums which

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9In Chesnais (1976, p. 56,61) there are two graphics comparing suicide rate changes in several countries (Britain, France, Germany, Sweden Switzerland, USA) during World War I and II. As many of the curves show a marked dip, the evidence at first seems quite impressive. In both wars the dips are particularly large in France. However, as France cumulates the two causes of bias these dips are largely meaningless. In World War I Switzerland has a big trough. This would be a good argument in favor of a purely psychological effect for in this case none of the above bias can be invoked. However, in World War II Switzerland does not display any trough whatsoever.

10There is a 50% decrease in the suicide rate of men. Its magnitude remains an open question for the trough is too big to be explained away by unrecorded suicides among the military.
Fig.4b: Schematic representation of the social ties in three situations considered in the paper.

differ in their initial velocities as well as in their shapes. This will be a very difficult task because the movements are superpositions of (at least) three different effects: movement of a spherical pendulum, movement of a pendulum whose mass is not a sphere, movement of a Foucault pendulum. It is only by distinguishing and sorting out these different mechanisms that it will become possible to get insight and understanding. The situation is similar with suicides. In this paper we studied the effect of severing ties. This gave rise to transient and permanent effects. Furthermore there are several side effects which must be “filtered out”; one can for instance mention the following: (i) The means and agencies for self-harm available to a potential suicidee greatly affect the suicide rates. (ii) The availability of drugs, whether medical drugs, narcotics or alcohol, can have a marked effect on suicide rates.

A last word is in order. Often econophysicists are blamed by social scientists for not giving full credit to former studies. Did we commit the same fault in this paper? It is true that the phenomenon of suicide has been studied at least since 1850\textsuperscript{11}. However, very few studies have been conducted in the comparative and analytical spirit pioneered by Emile Durkheim. Even among the later, one finds many comparisons which have not been conducted carefully enough (an example was given above for the effect of wars on suicides) Instead of bringing more light such comparisons just add to the confusion. Physicists can rely on a century-long tradition of eliminating spurious effects, chasing up main determinants and disentangling complicated phenomena. Accordingly, econophysicists should be in a good position to throw some new light on this question.

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\textsuperscript{11}In Bridgethe reader will find a selected bibliography which goes back to the mid-nineteenth century.
References

Besnard (P.) 1997: Mariage et suicide: la théorie durkheimienne de la régulation conjugale à l’épreuve d’un siècle. Revue Française de Sociologie 38,735-758.

Blom-Cooper (L.) 1987: The penalty of imprisonment. Tanner Lectures on Human Values. Delivered at Clare Hall, Cambridge University, November 30 - December 2, 1987.

Bonanno (G.), Lillo (F.), Mantegna (R.) 2001: Levels of complexity in financial markets. Physica A 299,16-27.

Botte (G.) 1911: Le suicide dans l’armée. Etude statistique, étiologique, et prophylactique. Thesis. Lyon.

Candiotti (C.), Dérobert (L.), Moine (C.), Moine (M.) 1948: Considérations statistiques sur le suicide en France et à l’étranger. Institut National d’Hygiène.

Cantor (C.H.), Slater (P.J.) 1995: Marital breakdown, parenthood, and suicide. Journal of Family Studies 1,2,91-102.

Central Bureau of Statistics of Norway 1978: Historical statistics. Oslo.

Chesnais (J.-C.) 1976: Les morts violentes en France depuis 1826. Presses Universitaires de France. Paris.

Cristau (C.-A.) 1874: Du suicide dans l’armée. Thesis. Paris.

Dickens (C.) 1842, 1996: Philadelphia and its solitary prison. Chapter 7 of American Notes. Reedited by Modern Library. New York.

Douglas (J.) 1967: The social meaning of suicide. Princeton University Press. Princeton.

Drozdz (S.), Kwapien (J.), Grümmer, Ruf (F.), Speth (J.) 2001: Quantifying the dynamics of financial correlations. Physica A 299,144-153.

Halbwachs (M.) 1930: Les causes du suicide. Félix Alcan, Paris.

Hayes (L.M.), Rowan (J.R.) 1988: National study of jail suicides: seven years later. National Center on Institutions and Alternatives.

Høyer (G.), Lund (E.) 1993: Suicide among women related to number of children in marriage. Archive General of Psychiatry 50,134-136.

HPMS (Her Majesty’s Prison Service) annual report 2004, Appendix 1: Statistical information.

Kim (K.), Yoon (S.-M.), Choi (J.S.), Takayasu (H.) 2004: Herd behaviors in financial markets. Preprint available on: http://arXiv.org/abs/cond-mat/0405172 (9 May).

Krose (H.A.) 1906: Der Selbsmord im 19. Jahrhundert. Herdersche Verlagshandlung, Friburg.

MacDonald (M.), Sexton (S.) 2002: Self-harm and suicide policy: implementation in West Middlands prisons. University of Central England Report. Birmingham.

Mantegna (R.N.) 1999: Hierarchical structure in financial markets. The European Physical Journal B 11,193-197.

Marshall (T.), Simpson (S.), Stevens (A.) 2000: Health care in prisons. University of Birmingham Report (February 2000).

Meer (F.) 1976: Race and suicide in South Africa. Routledge. London.

Menezes (M.A. de), Barabási (A.-L.) 2004: Separating internal and external dynamics of complex systems. Preprint available on: http://arXiv.org/abs/cond-mat/0406421 (18 June).

Nagle (J.T.) 1882: Suicides in New York cities during the 11 years ending December 31, 1880. Riverside Press. Cambridge (Mass.).

Nizard (A.) 1998: Suicide et mal-être social. Population et Sociétés 334, April.
Pfeiffer (M.B.) 2001: Suicides high in prison box. Poughkeepsie Journal [New York State], December 16, 2001.

Pfeiffer (M.B.) 2002: Suicides in solitary confinement are abnormaly high. Poughkeepsie Journal [New York State], April 14, 2002.

Plerou (V.), Gopikrishnan (P.), Rosenow (B.), Amaral (L.A.N.), Stanley (H.E.) 2001: Collective behavior of stock price movements: A random matrix theory approach. Physica 299,175-180.

Prison statistics: England and Wales 2001: Home Office. National Statistics. London.

Roehner (B.M.) 1995: Theory of markets. Springer. Berlin.

Roehner (B.M.) 2005: A bridge between liquids and socio-economic systems: the key role of interaction strengths. Physica A 348, 659-682.

Ropp (P.S.), Zamperini (P.), Zurndorfer (H.T.) eds 2001: Passionate women: female suicide in late imperial China. Brill, Boston.

Sattar (G.) 2001: Rates and causes of death among prisoners and offenders under community supervision. Home Office Research Study 231 [available on the website of the Home Office].

Schmidtke (A.) et al. [26 co-authors] 1999: Suicide rates in the world: update. Archives of Suicide Research 5,81-89.

Sornette (D.), Deschatres (F.), T. Gilbert (T.), Y. Ageon (Y.) 2004: Endogenous Versus Exogenous Shocks in Complex Networks: an Empirical Test Using Book Sale Ranking. Physical Review Letters 93,22, 228701

Stauffer (D.), Sornette (D.) 1999: Self-organized percolation model for stock market fluctuations. Physica A 271, 496-506.

Steenkamp (M.), Harrison (J.) 2000: Suicide and hospitalized self-harm in Australia. Australian Institute of Health and Welfare. [Available on the Internet].

Telzrow (M.E.) 2002: Punishment and reform: the Wisconsin State reformatory. Voyageur, Winter-Spring, p. 25. [Available on the Internet].