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# Curriculum vitae method in science policy and research evaluation: the state-of-the-art

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This is a state-of-the-art assessment for a small but burgeoning research approach, use of curricula vitae in research evaluation. The accumulated research remains sufficiently modest for us to consider nearly all published studies and the full range of research purposes to which CV analysis has been applied. CV analysis has been theory-driven, and theory and tools have increasingly converged. Advances in method and technique have been abetted especially by the push for a scientific and technical human capital theory to explain the role of capacity in research evaluation. We summarize the theoretical rationale for CV analysis, and present three major foci: career trajectories, mobility, and the mapping of collective capacity. We assess progress in solving methodological and practical problems and the future research possibilities and remaining needs in developing methods. We reflect on some new research topics that could benefit from CV analysis. We draw on the papers in this special issue of Research Evaluation to illustrate research developments and to show the place of specific contributions in the developing CV literature.

FOR THE ACADEMIC researcher, the curriculum vitae (CV) represents, all at the same time, a record of scientific accomplishment, a brief history of the professional life course, an obligation to administrative superiors, and a job search resource. Because of its multiple functions, but especially because it serves as a personal services advertisement, researchers have a strong incentive to provide timely, accurate data and to make the CV readily available. In short, it is one of the few scientific artifacts nearly universal in its availability and nearly standard in its meaning.

For researchers and science policy analysts, these characteristics make the CV an attractive data resource. Thus, it is perhaps surprising that the analysis of CVs for science policy and research evaluation purposes began in earnest less than a decade ago. In the 1990s at least a few researchers (e.g. Bonzi, 1992; Gomez-Mejia and Balkin, 1992; Long *et al*, 1993) employed CVs, but usually as a supplemental source of information, almost as an afterthought. Only recently has the analysis of CVs taken on the character of self-conscious and reflective methodology as opposed to one of many data sources. Is this more serious orientation to the CV warranted? It is perhaps too early to provide a confident answer to that question. However, this special issue of *Research Evaluation* and the research described herein at least suggest that CV methodology has begun to develop and to progress.

Our editors' introduction plays the conventional roles — commenting on the contributions contained herein and suggesting thematic issues among them. However, we also provide a state-of-the-art assessment for a still small but burgeoning research approach. The accumulated research remains sufficiently modest to permit us to consider nearly all published studies and the full range of research purposes to which CV analysis has been applied. The assessment begins by pointing out that CV analysis has been theory-driven and that theory and tool have increasingly converged.

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## Research capacity assessment: the theoretical rationale for curriculum vitae analysis

In the late 1990s, researchers affiliated with the Research Value Mapping Program (RVM), then housed at Georgia Tech,[1] pioneered work under which curricula vitae started to be systematically applied to evaluate 'research collectives' (projects, programs, centers, and research groups). The approach coincided nicely with the researchers' interest in assessing the value of scientific and technological knowledge on broader bases than normally employed under traditional economic conceptualizations, according to which value is determined by either market forces or public bodies when markets fail to correctly measure the value of knowledge that is considered to be a 'public good', that is, basic science (Bozeman and Rogers, 2002). Within the more traditional economic approaches to knowledge value, it is the outputs of the research process that are measured and eventually valued if they are converted into goods exchangeable in markets (e.g. product innovations). Therefore, research evaluation has traditionally focused on tangible and easily computable research output, such as scientific publications and patents.

Bozeman and RVM colleagues (2001) (and Bozeman, 2008) proposed a change in the paradigm for evaluating the research activities performed by individuals and organizations. This change consists of moving from the 'output paradigm' to the 'capacity paradigm'. The new approach shifts the evaluation focus to 'scientific and technological human capital', which regroups the abilities of persons, institutions and social aggregates to contribute to scientific and technological knowledge. From this new perspective, the success or failure of policy actions (such as project-funding and programs) should be evaluated in terms of their ability to enhance individual and organizational capacities to produce knowledge or to apply it in technology. In this view, it is the long-run productive capacity that is crucial, not particular knowledge products at particular times.

The capacity-focused approach acknowledges the relevance of neoclassical human capital theory, but also points to its lacunae, particularly in relation to the assumption of agent homogeneity and autonomy. To overcome the neoclassical theoretical limitations, the RVM researchers bring elements from social capital theory into their conceptual framework (Dietz, 2000). As a result, 'scientific and technological social capital' is equivalent to the network assets researchers bring to their work and to their external connections (e.g. with other researchers, research funding organizations, professional associations). According to Bozeman (2008), social capital and cognitive and scientific abilities are uniquely configured for each scientist and evolve over time in planned and unplanned ways. The evaluation method consists of following the evolution of these abilities over time, which will provide information on whether or not the capacity to generate and diffuse knowledge is increasing in the system under consideration.

**The proposal of the capacity-based paradigm and scientific and technical human capital conceptual framework raised new challenges for empirical research, especially 'How may capacity be observed and measured?'**

Three major conceptual changes distinguish the 'capacity paradigm' as compared to the 'output paradigm':

1. The consideration of scientists' and organizations' heterogeneity and interdependency;
2. The assumption that connections and networks emerge from interaction and determine individual and collective capacity; and
3. The uncertain, dynamic and evolving nature of capacity, which changes over time depending on a large variety of events and connections.

The proposal of the capacity-based paradigm and scientific and technical human capital (STHC) conceptual framework raised new challenges for empirical research, especially 'How may capacity be observed and measured?' New empirical approaches were developed to actually observe capacity and STHC building processes at the individual and collective level. The capacity analysis focused especially on researchers' curricula vitae. The CV provides a rich source of longitudinal information addressing nearly all dimensions of a researcher's career (Bozeman *et al*, 2001) including their connections to other researchers and to different types of research collectives. Despite its apparent potential, the CV had been only very rarely used as a research evaluation tool before the applications under the RVM program (see Dietz *et al*, 2000).

With a certain temporal perspective on the research literature, we can conclude that the marriage between a theoretical approach that takes into account the dynamism of STHC and a technical approach employing CV analysis is a strong and thus far harmonious one. The sections below illustrate and support this assessment by summarizing the progress that has been made and by addressing the main methodological challenges, both those that seem to have been overcome and those that remain to be solved.

Finally we address how the application of information and communication technologies to research

policy is affecting researchers' CV management, storage and use in certain countries. The development of electronic CV databases is opening up new opportunities but also new challenges for science policy researchers and for policy-makers. Within this overview and assessment we highlight the contributions of the articles included in this special issue.

## Major foci of CV analyses

In this section we review CV data-based studies according to the three topical areas that have dominated the literature: career trajectories, mobility, and mapping of collective capacity.

### *Career trajectories*

As discussed earlier, the RVM program pioneered the systematic use of CVs in research evaluation. The program initially focused on the study of how institutional changes in the way research was organized and funded in the USA were influencing the careers of scientists and the products of their work, with special attention to the gender dimension. Researchers studied how the creation of multidisciplinary university-based research centers was influencing the trajectories, collaboration dynamics and productivities of scientists associated with these centers, compared to non-affiliated scientists. The construction of a large CV database from individuals who had already responded to a structured questionnaire provided two inter-related data sources useful for addressing dimensions of scientists' careers.

Using CV data, Gaughan and Bozeman (2002) found evidence that the impacts of center-based grants differ from investigator-initiated grants with respect to scientific productivity and industrial engagement. Corley *et al* (2003) assessed the impacts of grants on men and women's scientific careers, which was complemented by a study based on survey data on gender differences in participation in university research centers (Corley and Gaughan, 2005). The development of a new CV database has recently allowed these researchers to improve their CV study methodologies and assess the effects of center affiliation (in the field of reproductive health research in the USA) on productivity, collaboration and grants velocity (Gaughan and Pronomariov, 2008) and on the training trajectories of young researchers (Gaughan, in this issue).

The studies discussed above provided new evidence about scientists' careers but, as a by-product, contributed to knowledge about CV coding methods, CV data treatment and combination of CV information with data from other sources, including not only survey questionnaires but also patent registers (Dietz and Bozeman, 2005). The collaboration of the RVM program research team with European researchers contributed to exporting the method of CV analysis beyond the USA and led to useful comparative studies of research careers. Gaughan and Robin (2004) compared the effects of job mobility in career trajectories in France and the USA, showing relevant differences between the two national science systems. Mangematin (2000) looked at the influence on trajectories of certain incentives during the PhD in France, such as collaboration with industry or mentoring. Sabatier *et al* (2006) used French data to study gender differences in time of promotion, looking at variables that are difficult to obtain by other means than CV analysis or *ad-hoc* surveys, such as job mobility.

### *Mobility*

A second research theme examined by CV researchers is mobility, in both its geographical and organizational dimensions. International organizations such as the OECD or the European Commission have been claiming the need for researchers' mobility indicators since the late 1990s (CEC, 2000, 2001, 2003, 2007). The OECD, sometimes in collaboration with the UNESCO (Auriol *et al*, 2007), has encouraged the study of international mobility of highly skilled human resources in general and researchers in particular (OECD, 2001, 2008). Despite the policy-makers' evident belief in the positive impact of researchers' mobility for knowledge diffusion and creation, the channels through which this impact might take place are complex (OECD, 2008). The European Commission recognizes that the impact of mobility differs depending on the individuals concerned, the organizations involved, the research world itself and society at large (CEC, 2001).

Mobility is dynamic and relational, changing configurations of individual and collective scientific and technological human capital. The physical movement of researchers is not always easy to track over time and space, for individuals and collectives. When the focus is on changes in STHC, the tracking becomes even more complex. CV analysis has opened-up new possibilities for the study of the mobility impacts, especially when combined with other information sources. Previous work on the topic includes the analysis of links between mobility and:

1. Career progress and promotions (Gaughan and Robin, 2004; Sabatier *et al*, 2007);
2. International collaboration (Fontes, 2007; Jonkers and Tijssen, 2008); and
3. Scientific productivity (Dietz and Bozeman, 2005; Cañibano *et al*, 2008; Jonkers and Tijssen, 2008).

Among the eight articles included in this issue, three assess the impacts of mobility in different ways. Sandström and Zubieta focus their respective studies on the association between mobility and publication productivity while Woolley and Turpin analyze the links between mobility and the emergence and

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development of distributive knowledge networks. The use of CVs combined with other data sources is contributing to shedding light on the actual effects of mobility at the individual (career trajectories and productivity) and the collective (collaborations and network formation) levels. Zubieta's contribution shows, for example, how the patterns of mobility differ between disciplines,[2] concluding that it is not advisable to design general policies for scientists' mobility without taking the disciplinary differences into account.

### *Mapping collective capacity*

The CVs of researchers are a resource for mapping individual trajectories. However, as stressed by the STHC conceptual framework, individual professional trajectories do not deploy in isolation but in constantly evolving social configurations that both shape and are shaped by individual social and human capitals. The STHC framework builds on the assumption that *capacity* is embedded in social and professional networks. Bozeman (2008) points out that any social configuration can be mapped against the individual's S&T human capital resources to depict their deployment (a research program, a laboratory, or any social organization or set of social interactions). For example Lepori and Probst (in this issue) study the structure and dynamics of a specific research field.

Woolley and Turpin (in this issue) state that, from an STHC perspective:

> a researcher's CV can be understood as a record of processes of capital accumulation. These processes are both individual and collective and CVs contain traces of both relatively individualized human capital accumulation and relatively collective social capital accumulation.

These authors employ CVs to study how mobility affects the dynamics of formation and deployment of research networks ('Distributive Knowledge Networks'). The set of variables that can be obtained from CVs to trace the social connections of researchers is not negligible: mainly the sequence of job positions, co-authorships, partnerships in projects, grants and patenting activities, and mentoring activities. It could be argued that the connections between the different sections of a CV are in fact, at least to some extent, the reflection of some social (and usually also individual) capability-building process. Connections may be found, for example, between a researcher's job trajectory and the organizational affiliation of his or her co-authors, partners and students.

Lee and Bozeman (2005) stress the complexity of research collaboration dynamics and the difficulties of assessing their impacts on capacity building. A major methodological question is: 'How to measure social ties?' By the number of collaborations, for example (as do Lee and Bozeman, 2005)? According to the number of collaborators? Or the number of co-authors? Perhaps the number of co-authored publications? Jonkers and Tijssen (2008) use the number of international co-publications as an indicator of international collaboration to assess the links of collaborations with international mobility.

Recent attempts to study collaboration dynamics may be found in Lin and Bozeman (2006) and Fontes (2007). Fontes uses survey-based data to complete CV data and assess the collaborative connections that followed mobility for a sample of Portuguese researchers. Lin and Bozeman (2006) show how previous experience in industry leads researchers based in university research centers to support more students compared to those that did not have this kind of experience. In other words, they show how different trajectories produce different kinds of capabilities and social capitals. While more research is undoubtedly needed on these topics, the use of CVs to analyze collaborative dynamics in research opens-up new possibilities.

## Progress in solving methodological and practical problems in curriculum vitae analysis

While the CV provides a useful source of data, several methodological problems had to be overcome for valid use of CVs and some such problems remain to be resolved. We consider below some of the practical and methodological obstacles to using CVs.

### *Availability*

CVs are not available via unobtrusive means such as the Internet. In most cases a special CV request has to be sent to the population under study (Dietz *et al*, 2000; Dietz, 2004). Recent work in the United States has confirmed the unavailability problem in this country (Gaughan and Ponomariov, 2008; Gaughan, in this issue). All empirical studies presented in this issue are based on specific requests of CVs addressed to sampled researchers, with the exception of the articles by Lepori and Probst, and by Cañibano, Otamendi and Andújar. Lepori and Probst's study shows that the best CV collection system may well be specific to the research question. Their study

applies a 'passive' system of CV gathering through Internet searches, which is sufficient for their purpose of mapping a specific scientific field combining CV data with other information sources.

Sabatier and colleagues (2006) and Cañibano and colleagues (2008; in this issue) obtained the CVs from registers available through institutional channels (the National Institute for Agricultural Research and the Ministry of Education and Science respectively). The systematic collection and storage of researchers' CVs by institutions imply that the number of potentially available CVs may be high once access to them has been accorded to a particular research team.

As will be addressed in the following section, changes in the availability problem will follow the modalities of electronic CV database development and of changes in countries' cultures and idiosyncrasies. For example, the LATTES electronic platform in Brazil permits one to freely access in the Internet a standardized and quite complete CV of most Brazilian researchers.[3] The same is expected to happen in Portugal once the Portuguese equivalent to LATTES — the DeGois platform — is successfully implemented. Researchers from other countries such as France and the UK seem to be much more reluctant to adapt their CVs to specific standards and to freely display them on the Internet.[4]

### *Heterogeneity*

CVs are usually not presented in a standard format. They vary in length (short and long formats) and ordering of the information (Dietz *et al*, 2000; Corley *et al*, 2003; Dietz, 2004). Among the papers presented in this issue, the heterogeneity problem is pointed out by Sandström, Lepori and Probst, and Woolley and Turpin. The latter underline specifically 'inconsistency' problems when coding information on research visits, for example. The next section addresses how some nations are moving towards CV standardization and therefore homogenization.

However, homogeneity does not necessarily imply complete consistency. Spanish CVs, for example, are highly homogeneous. They follow a standard format provided by national research policy and management agencies. However, the section concerning 'mobility' and 'visits to other research centers' shows high inconsistency levels that make the coding process difficult (Cañibano *et al*, 2008). Even if all researchers are reporting visits (homogeneity) some of them might be including visits of down to one day of duration while others consider only those which implied a minimum stay in the host institution (inconsistency). Therefore, the progress toward more standardized CV formats in some countries will facilitate CV-based research evaluation studies, but will not prevent the need for researchers to consider consistency of the information.

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### *Truncation*

While most CVs seem to be useful and valid records, the records often are not as complete as the CV research might wish. Increasingly, the CVs available online are truncated (Dietz *et al*, 2000; Corley *et al*, 2003). While it is sometimes possible simply to request and receive a full CV, another alternative is complementing the truncated CV with data from other sources. Several studies that have addressed publication productivity and used CV data have also looked at bibliographic data sources (Sabatier *et al*, 2006; Jonkers and Tijssen, 2008; Zubieta, in this issue; Sandström, in this issue). The development of electronic CV information systems is complemented in some cases by the implementation of reliability control mechanisms as discussed below.

### *Missing information*

According to Dietz and colleagues (2000) and Dietz (2004), important information is usually missing from CVs. This mainly concerns:

1. Career trajectory, such as the beginning and end of job durations and the year in which the degree was completed;
2. Grants: missing duration of the award, unclear identification of the respondent as principal or co-principal investigator;
3. Quality of publications; and
4. Patent data.

Again, the way to solve this problem is to complement the information provided by the CV with the exploitation of other data sources (e.g. bibliometrics and patent data [Dietz and Bozeman, 2005; Sabatier *et al*, 2006; Fontes, 2007]). For example, Lee and Bozeman (2005) and Lin and Bozeman (2006) achieve their assessment of the influence of collaborations and industry linkages on productivity by complementing CV data with survey-based data. In this issue, Woolley and Turpin also provide insights into the potential of complementing survey information with additional CV analysis.

### Data coding

Coding the CV for subsequent data analysis involves enormous work. The work is not only time-consuming, but it is also tedious and runs the risk of introducing error due to coder fatigue and to inter-coder reliability (Dietz *et al*, 2000; Corley *et al*, 2003). Researchers have improved the coding methods over time by relying on tools such as Access databases (Gaughan and Pronomariov, 2008 and Gaughan, in this issue) or electronic web-based templates (Sandström, in this issue). However, the major problems associated with coding remain unchanged. To avoid unnecessary coding it is especially important, as discussed earlier, to have clear research targets and well-defined research questions that determine the nature of the variables needed (Gaughan, in this issue).

The development of CV electronic databases in some countries will ease the conversion of the CV data into sets of variables that are ready to be analyzed to address specific evaluation questions without coding work. Several variables, such as gender, age, research organization, or field of research, are automatically downloadable from this type of database and ready to be used for analysis. However, some careful reflection and experimentation is required to make other sets of variables useful for evaluation, variables including publications, mobility, grants and projects activity. Corley and colleagues (2003) point out how the abundance of information CVs provide may be a blessing and a curse. This is also true when information is electronically stored and downloadable, as shown by exploratory work (Cañibano *et al*, 2008). The coding problem is in these cases replaced by other methodological issues such as data cleaning or selection of downloading criteria.

In summary, researchers are well aware of the strengths and weaknesses of CV data and relevant progress has been made to cope with the major shortcomings. This includes improvements in the coding methodologies, the clear definition of research questions before the data-gathering is conducted, and augmentation of CV data by information from other sources. In countries where CVs are highly standardized and increasingly electronically stored (e.g. Portugal, Spain, Norway, Brazil), typical methodological problems such as heterogeneity, availability or coding might very likely be replaced by new methodological problems pertaining to treatment of heavy data loads or definition of downloading priorities.

## Future research possibilities and remaining needs in developing curriculum vitae methods

Electronic CV data platforms and information systems are under development in several countries, which to our knowledge include many in Latin American nations, as described by D'Onofrio (in this issue), Spain (Báez *et al*, 2008; Cañibano *et al* in this issue), Portugal and Norway. The development of such data sources opens up new possibilities for CV data analysis, research evaluation and science policy design.

In Europe, moving towards a generalized standardization and digitalization of researchers' CVs is part of the research policy strategy in a few countries. There are three major benchmarks that should be mentioned: Spain, Norway and Portugal. The cases of Spain and Norway are close in the sense that flexible and reliable electronic curricular information systems have been implemented. Several electronic CV registers were developed in Spain at the beginning of the 2000s at universities and public research management agencies. However, the Spanish Foundation for Science and Technology identified in 2003 a list of obstacles related to researchers' CVs management that jeopardized the correct functioning of the science and technology system and which also have been pointed out by most researchers that have used CV data as a basis for their analyses. These obstacles include:

- Dispersion of CV data
- Electronically untreatable information (without additional treatment or coding)
- Lack of content homogeneity
- Difficulty in checking reliability of the data
- High management cost and
- Incompatibility with other international formats (Báez *et al*, 2008: 215).

The development of an integrated CV information system, based on a XML exchange protocol, has already allowed the collection of CV data that covers 56% of researchers in Spain (Cañibano *et al*, in this issue). The purpose is that in the near future the national CV information system will emulate the functioning of the regional scientific system in Andalucía (SICA), which was implemented in 2001. The SICA database currently covers all researchers working for research organizations in the region (20,000 researchers).

The typical limitations of CV data make researchers recommend complementing it with other information sources, such as bibliometric databases, when the purpose is to study the publication productivity dynamics (Sandström, in this issue). The development of CV electronic information systems leads to easier electronic connection between CVs and bibliometric databases. SICA is automatically updated by importing publication information from major databases such as ISI, SCOPUS, CINDOC and MEDLINE.

Moreover, the SICA personnel are in charge of validating the information that researchers introduce in the system by checking the contents of the corresponding databases.

This is also the case of FRIDA in Norway, which has been in use since 2003 in Norwegian universities. FRIDA covers 75% of the higher education sector in Norway. Information provided by this system plays a major role in the annual funding of universities and in research evaluation. The database functions also on the basis of a standard CV-XML format that permits institutions to exchange electronic curricular information concerning individuals and research groups. The system allows importing data from major Norwegian and international bibliographical databases and its reliability, as in the case of SICA, is controlled by its administrators (Lingjærde and Sjøgren, 2008).

The Portuguese system under construction is slightly different from the former two. The development of the DeGois platform results from the adaptation of the Brazilian LATTES CV platform (see D'Onofrio in this issue) to the Portuguese idiosyncrasy (Fontes *et al*, 2008). The platform facilitates the standardization and digitalization of CV data but is not automatically updated and validated as SICA or FRIDA are. So far, 5,000 electronic CVs have been collected in Portugal through the platform (Fontes *et al*, 2008).

The coverage of the above electronic systems is increasing in the three countries[5] as policy and research institutions are compelling researchers to fill in (or update) their electronic CVs each time they apply for public funding, evaluation, work positions, etc. These practices are thus converting the storage and treatment of curricular information into a major pillar for research policy design, management and evaluation.

The development of electronic CV information systems helps in overcoming most of the commonly mentioned obstacles of CV data (such as heterogeneity, untreatable formats, and unavailability). As discussed above, new methodological problems arise, however, for social scientists using electronic CV data collected from policy institutions out of these databases, such as preserving researchers' rights and confidentiality of data and determining the downloading priorities. The adaptation of data to the adequate treatable format and variables needed to conduct the analyses will also likely be a major issue. Despite the increase in the availability of CV treatable data in some countries, researchers should keep in mind the recommendations made by Gaughan, and Lepori and Probst (in this issue): precise research questions should be planned in advance, before data is collected, and should be based on specific theoretical frameworks and hypotheses.

The scenario under development raises challenges for the international comparison of data. While a few countries are moving towards increased digitalization and standardization and even availability of researchers' curricular information, others maintain the traditional system according to which the researcher decides the structure, format and availability to the public of his or her CV data.

**Future international studies relying on curricular information will need to tackle a variety of methodological issues to achieve some comparability**

Future international studies relying on curricular information will therefore need to tackle a variety of methodological issues to achieve some comparability. This challenge opens up, however, interesting opportunities to learn about the actual potential of the new electronic systems compared to the more 'traditional' ones.

Methodological progress should lead to an increased capacity of using CVs to address the complex dynamics and diversity that characterize scientific work. In particular we found of special interest and importance the advancement of the method to study the social configurations that underlie the production, use, and diffusion of scientific knowledge, such as the formation and development of networks.

## Conclusion

We began by noting the interplay between method and theory and we conclude in the same fashion. The development of CV method and technique was greatly abetted by a theory need: the desire for data and analytical approaches useful in developing scientific and technical human capital theory and a capacity-focused approach to research evaluation. The complementarities between STHC theory and CV method continues; indeed, much remains to be learned about the co-evolution of human capital and network ties and about the interplay between the individual-level scientific and technical capacity and collectives such as research programs, centers, and even scientific fields and disciplines. The story continues. But are there other avenues of investigation where the CV method and a theoretical need come together? We conclude by suggesting a few likely problem-solution sets.

### *Network theory*

Science studies of advances in network theory have been extensive, chiefly due to the advance of bibliometric data and attendant techniques. But the CV has potential to identify information about networks not easily distilled from bibliometrics. The CV often shows the various institutional settings in which careers develop and provide the possibility of tracking various forms of network exposure having nothing to do with publications *per se*. The CV does

allow one to go more deeply into acquaintance and common background and, as such, provides a useful complement to bibliometric data. Most important, bibliometric data are generally limited to the definition of networks according to co-authorship. While co-authorship networks are vitally important, the CV reveals information about a broader set of network activities.

### *Research marketing*

A related topic for which CV analysis could prove useful is for understanding 'research (and researcher) marketing'. In years past, the researcher interested in advertising his or her brilliance and enhancing career opportunities had a relatively small number of communication vehicles. The CV was available for sharing but had the disadvantage of not being in the public domain. Thus, one could hope that publications would be read, one could send and receive 'pre-prints' and one could attend conferences and hope for notice. During those earlier pre-cyber science days, publication was clearly the coin of the realm, regardless of how embodied.

Nowadays we see a rapid expansion of personal marketing media for scientists. Many researchers now have their own webpage, essentially advertising their knowledge wares. Some, especially illustrious researchers, have blogs that receive considerable attention. Group sites are used for collaboration but also implicit marketing. Aside from personally developed sites there are brokered sites.

One of many examples is the RePEc (research papers in economics) website, a non-profit brokering institution run by volunteers and aimed at increasing the dissemination of research in economics. The RePEc project includes in its database tens of thousands of working papers, journal articles and even associated 'freeware' and data, all available at no charge.

Why is this relevant to CVs? The point is that research marketing has taken on entirely new dimensions and, more than ever, the CV is one of a portfolio of research marketing tools. The potential implications of these trends for the vetting of science and for its applications are enormous. Arguably, institutions for certification have begun to break down and the individual role in promulgation of knowledge is expanding. The CV, in its old and new uses, is a basic datum for understanding this trend.

### *Tracking virtual research organizations*

The authors of this article have both been involved in developing data and analyzing a variety of research institutions including programs, centers and inter-organizational consortia. This task is complicated by the fact that many of the organizations of interest do not fit earlier standards of monolithic research organizations. Many new organizations are more distributed networks than conventional organizations. When asking 'Who is a member of this organization?' or 'What resources are brought to bear in this organization?' or 'What is the capacity of this organization?' the CV often is a useful tool. In some cases the CV is useful for identifying membership but in other cases it is even more useful for identifying 'phantom membership'. That is, when a virtual research center has a long roster of researchers and then, upon inspection, one finds that only one or two of those listed on the roster show in their CV any indication of affiliation, then one is perhaps able to sort through the complexities of formalization to identify actual affiliations and relevant research activity.

These are just a few of the research topics we feel could benefit from the application of CV methods. We expect that in each new application, as in previous applications, the development of CV methodology will itself benefit from application in new domains. The papers in this special issue provide an excellent snapshot of contemporary uses of CV methodology and perhaps some further indication of uses yet to come.

## Notes

1. The RVM Program was initially founded at the Georgia Institute of Technology and is now based at Arizona State University. See <http://www.cspo.org/rvm/>.
2. Cañibano *et al* (2008) find also different patterns of mobility between researchers working in three different disciplines: molecular biology, space science and humanities.
3. <http://lattes.cnpq.br/>.
4. This appreciation is part of the results of the EURO-CV-PRIME project: 'Building new indicators for researchers' careers and mobility based on electronic curriculum vitae', funded by the European 6th Framework Program through PRIME Network of Excellence (January–December 2008). The participating countries are: France, Israel, Norway, Portugal, Spain (Coord.), Switzerland and the UK See: <http://www.uam.es/docencia/degin/prime/webprime/prime6.htm>.
5. Although the Latin-American region had the pioneer initiative, administrative, financial, political and technical problems are slowing down the implementation process of CV databases (D'Onofrio, in this issue).

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