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Challenging the Ontology of Technoscientific Artefacts:
Actor-Network Theory in Developing Countries

JOÃO PORTO DE ALBUQUERQUE, HENRIQUE LUIZ CUKIERMAN, IVAN DA COSTA MARQUES & PAULO HENRIQUE FIDELIS FEITOSA

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João Porto de Albuquerque[1], Henrique Luiz Cukierman[2], Ivan da Costa Marques[2] & Paulo Henrique Fidelis Feitosa[2]
Email: jporto@icmc.usp.br

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Abstract

Developing countries often encounter technoscientific artefacts that originally stem from the developed world and reach them in forms that are more stabilized and fixed than they are in their origins. As a result, these artefacts are often dealt with like icebergs of which one can see only the tips, but which are regarded as self-contained wholes. The central argument of this paper is that the Actor-Network Theory (ANT) opens up the prospect of adopting a practical approach which can clarify issues of development by enacting a suitable (and non-traditional) ontology, by looking at scientific and technological entities in a new way, whether they be facts, artefacts, institutions or policies.

The ontological perspective of ANT is able to unveil the hidden and 'taken-for-granted' parts of technoscientific knowledge and artefacts, in such a way that their implications and the way in which they are handled, can become a matter of serious concern. In this manner, the local practices, circumstances and constraints imposed on developing countries that are normally invisible (and hence not a part of the mainstream of concepts and initiatives towards development) are allowed to come to the fore. By means of a case study on the Information and Communication Technologies (ICT) used to support the social policy for the alleviation of poverty in Brazil, called "Programa Bolsa Família" [Family Welfare Scheme], we seek to show how ANT can enact an ontologically different and politically more productive approach to conceive and deal with technoscientific artefacts in development.

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[1] University of São Paulo
[2] Federal University of Rio de Janeiro

1. Introduction

Recent work in the area of Science and Technology Studies, particularly with regard to the Actor-Network Theory, have made it possible to reconfigure the way scientific and technological practices in developed and developing countries are conceived, and thus allowed technoscientific and social matters to be viewed from a new perspective. One of the major challenges brought about by this new perspective lies in the fact that it involves a new ontology for technoscientific products – such as scientific theories and technological artefacts – or, in other words, it provides a new philosophical basis for conceiving technoscientific objects as resulting from contingent, hybrid networks that comprise human and non-human entities. Whilst in developed countries this ontological challenge has so far provoked little more than heated philosophical debates in academic circles, in developing countries, and in the area of development studies, the new ontology of technoscientific objects may well have more immediate practical implications.

Developing countries often encounter 'entities' that are widespread in the world – i.e. objects, theories, facts, bodies – which originally stem from the developed world (the West) and reach them in forms that are stabilized and fixed. As such, in the case of developing countries these "entities" are like icebergs of which developing countries see only the tips and which they regard as self-contained wholes (that is, as neutral and universal objects of the natural or social sciences). A large proportion of the stabilizing and configurative processes of entities (scientific and technological facts, laws, customs, and markets) take place in the developed countries so that it seems 'almost' self-evident that these entities should arrive in developing countries in an 'almost' complete form. Moreover, this is also what often happens with models of development strategies, concepts, or technologies.

It is thus argued in this article that the new ontology of ANT has the potential to open up a new perspective on the way developing countries encounter technoscientific objects, and hence on how development practices, initiatives and technologies are conceived. In the next section, we provide a theoretical examination of the underlying ontological premises about technoscientific objects (the diffusion model), in order to contrast them later on with the ontological challenges posed by ANT for developing countries. Following this, we explore the implications of the ontological options of ANT by conducting an analysis of an illustrative case that refers specifically to development: the information and communication technologies used to support the Brazilian government's "Programa Bolsa Família" (Family Welfare Scheme).

2. The traditional ontological premises about technoscientific objects: the diffusion model

The dominant analyses and explanations of the way that technoscientific facts and artefacts are encountered in Brazil enact the diffusion model[3] with its associated notion of 'impact' and powerful mechanistic appeal. The diffusion model postulates that knowledge exists in an epistemological world that is divided into two irreconcilable domains of reality - Nature and Society - but claims that the discoveries (or inventions) that are made in the sphere of Nature are conveyed across an empty space between the two spheres where they can reach and have an impact upon Society. The objects or technoscientific entities, whether they be scientific laws or facts, or technological artefacts, thus reach Society in certain forms that have emerged from another world, the world of Nature. This is the world of Kantian "things-in-themselves" or of objects that possess qualities (essential properties) that make them disjoint from the questions of "humans-among-themselves" (Latour, 1999). As a result, through the lens of the diffusion model, these objects, which are a product of the technosciences, make an 'impact' when they encounter the Society which will make use of them. In other words, there is a widespread assumption among those using technologies that these arise within one world, of Nature, and then encounter, in a fairly stabilised form, a second world, of Society.

In simple terms, in this practice of constructing meaning, the technoscientific facts and artefacts are determined by means of an interaction with Nature, but once a discovery is made (of a scientific fact) or an invention created (of a technological artefact), it is released to the outside world without any modifications, and then able to make a 'social impact'. However, the value of the diffusion model is in fact highly questionable, since in practice, sociotechnical constructive and interactive practices occur from the moment any scientific or technological innovation is first introduced, although these practices are concealed in the ontology of the diffusion model – and this is particularly the case in developing countries. In Brazil, where so much of science and technology is derived from the global North and there is thus relatively little exposure to the sociotechnical, constructive and interactive practices, an even stronger adherence to the diffusion model can be found, as also a failure to understand what lies behind the technoscientific facts and artefacts that are available for use there.

For instance, most of the modern technological products that reach Brazil are manufactured by multinational companies. Since the laboratories of multinational companies tend to be outside Brazil, in general the local professional communities do not have experience of what lies beneath "the tip of the iceberg" with regard to their technological products, i.e. the decision-making and possible hesitations within the sociotechnical constructive process that occur before the final (albeit

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[3] For a detailed introduction to the diffusion model, see Latour (1987), especially Chapter 3, part C.

provisional) "stabilization" of the technoscientific facts and artefacts. The diffusion model and the mode of thinking and acting it entails, strengthen the perception that the part of the technoscientific artefacts that is visible to Brazilians come to them in forms that are seemingly determined a priori in the sphere of Nature, by neutral universal laws that are non-human and detached from history.

A brief introductory example that illustrates the problematic nature and inadequacy of the diffusion model is the car industry. In this case, we should not just be concerned with Fordism as a model of manufacturing organization but with the car artefact "itself" as well. We highlight the fact that a car in Brazil is not the same as a car in the US – it embodies social practices both in its development and in its use. In the same way that 'Fordism' has never been the same for Detroit as for São Paulo, the car "itself" is also different if it is defined by its performance. When viewed from this standpoint, it is clear that a car never acts in isolation, but is always linked with other heterogeneous elements or entities – such as a road, fuel, a driver, and a legislation. For example, Brazilian roads are very different from American roads, what means that a car does not cover the same distance under the same speed conditions, provides the same degree of comfort or undergoes the same amount of wear-and-tear. In addition, the suspension might have to be modified. As well as this, in Brazil, gasoline includes a certain amount of ethanol which requires alterations to be made in the engine. The driving habits of motorists are also very different as any tourist can see and this means that there will be differences in issues of safety (and insurance policies).

Moreover, workers and managers of each country "do things differently" in their manufacturing process and this affects the resulting product. The list of differences can be extended to the open outside world. The same car in Detroit and São Paulo can only be conceived in terms of the diffusion model that takes the tip of the iceberg for the whole iceberg. Even a mechanic outside his workshop will readily agree that a car can be regarded in isolation only for very specific and well-defined conditions and purposes, and even inside his shop there will be a wide range of diverse materials in each of the isolated components of the car. In opposition to acknowledging all this complexity and diversity involved, the diffusion model assumes that isolated and stable forms are conveyed across an empty and mysterious space between Nature and Society (Latour, 1993).

At present, the diffusion model is treated as a matter of common sense and is surreptitiously embedded in most current discussions about development. However, this model is not only clearly unsuitable, but also the implications of its application can have a harmful effect on developing countries like Brazil. As a consequence of the diffusion model, in countries or regions where technology has traditionally been imported, as is the case of developing countries like Brazil, the technoscientific facts and artefacts can be configured in terms of a controversial retardation or backwardness along a linear path of technoscientific development, i.e. when compared with the exporting developed countries (once they have attained a degree of stability and standardization). This is principally the case when, with regard to their origins, these facts and artefacts are concentrated in large laboratories where

extensive and distinct operational networks give birth to the spheres of nature and society by drawing a boundary-line between them. This association with backwardness or retardation (which is bound up with the traditional view of development) makes it easier to see the adoption of technoscientific facts and artefacts as a diffusion of something that is ready-made rather than as the translation-transfer of something that, when adopted or if it were locally developed in Brazil, would be transformed into something different. In places where popular wisdom says that "technology is imported magic" (like developing countries), it is easier to stick to "the tip of the iceberg" and allow the diffusion model to appear to be supported by a larger body of evidence, than to examine the places where the facts and artefacts of science and technology undergo intense translations-transfers in the process of creation-adoption which leads to their stabilized forms (as occurs in developed countries).

In this way, the ontology of the diffusion model helps to keep the concerns of developing countries restricted to the tip of the icebergs of technoscientific entities and hence dominated by 'foreign' and frequently inappropriate ideas and technologies; this strengthens the view that developing countries are "colonies" whose development must inevitably imitate that of the metropolis. Furthermore, when the diffusion model is treated as an ontological premise, the technoscientific knowledge and artefacts employed as part of development initiatives tend to be conceived and dealt with in a way that relegates to the background (or stifles debate about) important issues that reflect the reality of developing countries – such as local practices, constraints, social conditions, forms of being, and local knowledge. Since they are unable to grasp these issues, developing countries are prevented from finding out development concepts and technologies that are more suited to their own realities. This raises a crucial question: how can developing countries recognize and overcome the restrictions imposed by the diffusion model and then work out alternatives that are appropriate for their own development?

Our argument in this paper is that the ontological basis provided by ANT is capable of changing the way technoscientific artefacts and knowledge are understood, thus broadening the scope of developing countries in addressing questions such as development practices, initiatives and technologies. The next section describes the ANT ontological approach.

3. The ANT approach: going beyond the diffusion model (and moving away from Euro-American metaphysics)

The ANT approach enacts different ontological assumptions for the technosciences by acknowledging that they not only describe but also actively participate in the creation of the facts and artefacts that inhabit the world. As a result, ANT offers the prospect of going beyond the domain that configures and is configured by the diffusion model, particularly in developmental issues.

Issues of development, at least when considered from the standpoint of most developing countries (or places), are not separable from issues of modernization. And modernization is historically intertwined with colonization. Historically, colonization is an asymmetrical process that enacts a model of development (the "diffusion model" explained in the previous section) according to which there is a place which knows best (the metropolis, or ¨Europe¨, to use a crude abbreviation) what the world *really* is and a place that should follow or imitate the metropolis (a colony). Development and colonization are virtually synonyms for the practices, though not necessarily in the minds, of most people who handle the steering of 'development' in the so-called developing countries – among them economists and policy-makers in particular.

In developing countries, a crucial part of the diffusion model is the idea, notion or belief that modern technoscientific knowledge is universal and neutral. Naturally, it follows, on the part of the colony, that modern technoscientific knowledge should be accepted, since it would make no sense to resist something that is universal and neutral. Moreover, the colony has fewer resources to question the veracity of the claim to universality and neutrality – that are called "counter-laboratories" by Latour (1987). That is where ANT may come into play by introducing a more suitable ontology for 'development'. With its greater capacity to historicize modern entities, especially modern scientific facts and artefacts, an ANT approach is capable of providing a new ontology for them. In other words, ANT is able to describe the emergence of modern scientific and technological knowledge as a process that, far from being universal and neutral, is local and situated predominantly in the metropolis, originally in Europe and now in the global North. It strongly supports the perception that what Law calls "Euro-American metaphysics" (Law, 2004) plays a role for development that is comparable to the role played by Kuhn's paradigm (Kuhn, 1996). What this implies is that the Euro-American views of the world or "version of reality" (Latour, 2005) have been adopted in establishing not only modern scientific knowledge but the notion of development as well, at least until the last decades of the 20th century. The specificities of the Euro-American version of reality are hence embedded in those constructs.

It is well-known that paradigms or versions of reality are useful to reveal and provide explanations of certain things, but it is equally well-known that they also (and necessarily) hide other things. A lot of things, actually most things, are hidden, and invisible. In this sense, the visible part of technoscientific knowledge, the part that is explicitly spread around the rest of the world in the developing-colonizing process by means of the diffusion model, is like the tip of an iceberg. We argue that by abandoning the ontology of the diffusion model that accepts technoscience as a "matter of fact" and adopting an ontology that is akin to an ANT approach, the hidden parts of technoscientific knowledge, as well as their effects and how they are handled, may become a "matter of concern" (Latour, 2004). Primarily, what comes to the fore, as a result of this approach, is a part of the world of developing countries such as their local practices, circumstances and the constraints imposed on their

lives; this part is not visible, and hence not treated by the (mainstream) technoscientific knowledge of development.

The instrument that can be employed to achieve this visibility, (as outlined by ANT) is to think of the world as populated by actor-networks, i.e. entities of the world (actors) are constitutively defined by the set of relations they perform with other entities (the network). As such, actor-networks are the main building blocks for the ANT ontology, which can be called an "ontology of mediators" (Latour, 1993, p. 86), or an ontology "circulating entities", if one follows the definition provided by Latour (2005, p. 132) when discussing what should be understood by the term 'network':

> a network is not made of nylon thread, words or any durable substance but is the trace left behind by some moving agent. You can hang your fish nets to dry, but you can't hang an actor-network: it has to be traced anew by the passage of another vehicle, another circulating entity.

Latour (2005, p. 237) shows the way to understand the new ANT ontology in precise terms, and at the same time, also provides the clue to mastering methodological research procedures: "Just follow the flow. Yes, follow the actors themselves or rather that which makes them act, namely the circulating entities".

When following the circulating entities, forming and evaluating technological practices that are committed to highlighting relevant technopolitical decisions, must involve an attempt to understand how the so-called technical areas and any other entities (both human and non-human) are interrelated. If this complex task is carried out with the usual tools from the diffusion model of "universality" and "neutrality" of science and technology, it can be simplified in a reductionist way. The hegemonic tools allow one to run through the shortcuts that have already been established, as well as the already known formulas, that explain in advance "what it is" and "how to do it". However, if this kind of "universality" and "neutrality" are no longer suitable, or, in a more radical view, no longer exist, a slower and more tortuous path to understand technoscientific objects must be employed. This is a pathway with no shortcuts or explanatory leaps, one that is followed step by step in an attempt to clarify and detect the traces left by the relationships between things and people. This tortuous path, which is focused on materiality and details, is the one outlined by ANT, a tool for which:

> […] to explain is not a mysterious cognitive feat, but a very practical world-building enterprise that consists in connecting entities with other entities, that is, in tracing a network." (Latour, 2005, p. 103)

Thus, what one must search for is evidence of connections between entities and their mutual construction, by tracing a network, i.e. by the establishment of a collective of heterogeneous entities. These connections follow through a slower pathway, one through which there is an unceasing flow of circulating entities, which have to be taken into account as a basic requirement of the new ANT ontology.

In our view, the new ontology is more productive for (a new kind of) development and provides the means to overcome the limitations of the diffusion model. The reason for this is that it empowers the 'colonized' to think, construct, and adopt

alternatives to the references and frameworks that come from the colonizers' centres of calculation. Thus, ANT provides a basis for making the 'colonized' aware of the problematic nature of their situation and enables them to escape the universal and neutral attributes that makes their local knowledge a liability when faced with the "globalization" of the colonizers.

As regards the colonizers, ANT provides a road to awareness of their problematic situation and allows them to escape from their own trap and achieve a degree of flexibility when engaged in dialogue with the colonized, which involves a willingness to negotiate without demanding that everyone must accept a reality that is centred on their own terms. This situation is no longer tenable for at least two different reasons. The first is that the emergence of the countries of the global South – the most striking instances being China and India – is making it impossible to sustain the Euro-American metaphysics as the provider of a universal and neutral view of Nature, when Chinese and Indian constructions of knowledge come to the fore in the international scene.

The second reason is that these emerging countries now have a significant section of their population with living standards and employing technoscientific practices that are the equivalent of those in developed countries in the West, and that thus act in practice as 'colonizers' vis-à-vis the impoverished majority of their populations. On the other hand, the changing economic landscape of developed countries as a result of the recession that has existed since 2008 is making large numbers of people to be excluded from the material benefits of development. In addition to the pre-existing excluded minorities of the North (e.g. immigrants), this excluded population is thus enlarging the 'colonized' group compared with their better-off fellow countrymen. As a result of these two complementary movements of global change, the distinction between developed and developing countries is becoming less clear-cut. Moreover, the ANT ontology may provide an approach that matches the increasing need to be attentive to the contrasts between colonizer and colonized groups within the same country, be this country in the global North or South – whilst also keeping in mind the differentiated implications of the diffusion model for the less developed world, as previously discussed.

By means of a case study, in the next section we aim to show how ANT may enact a fresh, ontologically different and politically more productive approach to be employed for conceiving and dealing with development issues and technologies.

4. The ANT approach regarding Information and Communication Technologies (ICTs): the case of the PBF – "Programa Bolsa Familia" (Family Welfare Scheme)

Perhaps one of the most representative technologies of the diffusion model described above is Information and Communication Technologies (ICTs). In usual forms of discourse, ICTs are often considered to be natural vectors of development in various areas. Underlying these discourses is the ontology of the diffusion model, which in the particular case of the ICTs, rests on their scientific conceptualization as formal artefacts for symbolic processing. Following this conceptualization, an intrinsic feature which ICTs possess is their ability to behave in accordance with logical, precisely-defined procedures (i.e. algorithms) which makes them, in essence, superior to the vague informal practices of the social world.

Thus owing to its greater level of abstraction and inherent rationality, the formal model is able to reflect the essence of the elements of the social world it represents. On the basis of this standpoint, the formalization process can be understood as a purification technique leading from the vague to the precise (Agre, 1992). This occurs in a way that allows the main problems that have to be confronted in the construction of ICTs, to be concentrated on the work required to eliminate the ambiguities and imprecision of the procedures of the social world, by representing them through symbols and defining operations that must be executed by formal artefacts by means of these symbols (de Albuquerque, 2009). After it has been developed, the generated piece of software can be applied to any social context to "rationalize" its practices.

In this manner, these discourses adhere to the diffusion model, naturalizing the software object as an exclusively "formal" artefact (understood as existing in a self-contained domain of reality in the world of Nature), and rendering invisible the amalgam of people and things which are required for ICT to conform to the model of a deterministic logical machine. An example of this is in the way that the users are often "configured" to meet the expectations of software (Woolgar, 1991) not to mention the indispensable and complex power supply network, with its various human and material features (Hughes, 1983). Once they have been purified of these elements and associations in the ontology of the diffusion model, the ICTs, (which can be regarded as black boxes developed in the world of Nature), spread out in Society and acquire the technologically predictable attributes that, in short, lead to further development.

If one abandons the ontological reference of the diffusion model and replaces it with the one offered by the ANT, the ICTs and information systems in particular, can be seen as examples of technologies whose decisions are technopolitical, from the time of their formulation to their implementation and use. In terms of their effects on citizens, information systems also operate as classification systems. They deal with a

representation of reality, which when transferred to the system, is inevitably represented in a limited set of categories that are established in database structures in advance. In other words, the transfer of a representation of reality to an information system is not carried out without any categorization or classification. The manner in which this classification is undertaken – i.e. the choice of categories used in the framing - , is an important question, since as Bowker and Star point out, "each standard and each category valorizes some point of view and silences another" (Bowker & Star, 2000, p. 5).

To be more specific, the bearing information systems have on citizenship is increasingly being established through codification - i.e. owing to the growing presence and mediation processes of information systems citizenship tends to be produced as an effect of the actions of databases. However, these implications are frequently invisible to the people involved in ICT-enabled development projects, since information systems are commonly viewed through the lens of the diffusion model.

The PBF is an illustrative example of how the ANT ontology can provide a better understanding of the implications of the kind of categorization inherent to the ICTs used in development projects in Brazil, as will be shown in the following sections.

4.1 What is the PBF? [Family Welfare Scheme]

The PBF is a welfare policy initiative of the Brazilian government (see Fig. 3) involving the direct payment of allowances to poor families, in exchange for meeting certain requirements called "condicionalidades" (undertakings). These are as follows: the beneficiaries must agree to maintain school- age children and teenagers in school and fulfil basic health requirements, which include complying with a vaccination calendar for children between 0 and 6 years of age; and following a pre and post-pregnancy schedule for pregnant women and mothers who are breastfeeding. The welfare scheme is run by the Ministry for Social Development and Eradication of Hunger (MDS), and by 2010 was giving social assistance to more than eleven million families in every Brazilian municipality.

Figure 1. Logo of the Family Welfare Scheme
Source: www.mds.gov.br/bolsafamilia

The administration and management of the PBF is decentralized, with responsibilities being devolved to all the entities of the Federation – the Union, the States, and the Municipalities, and is thus a nationwide program, with an extremely large number of people involved in all phases of its implementation and support. This undertaking is based on an enormous structure of great interest since it brings together a wide range of activities, including a vast network of information systems that are constantly being (re)constructed to support the Program, while at the same time also being responsible for expanding it.

One of the Program's main aims is to combat "poverty" and "extreme poverty", classifications which raise one of the principal questions that confronts those concerned with describing how the scheme works. In the definition provided by the Program, families in situations of poverty and extreme poverty are those that have a monthly family income of up to R$140.00 and R$70.00 (approximately US$ 80 and US$40 in the rate of exchange for May 2011) respectively. Income per capita is calculated on a basis that includes sporadic income, wages, retirement pensions, benefits and annuities, and it is based on the declarations of the applicants. Poor families are only eligible for the PBF if they have children or teenagers up to 17 years of age. Families in extreme poverty are eligible regardless of the ages of their family members.

Each month, the MDS selects the families that are entitled to receive PBF benefits based on the data supplied by the municipalities in the *Unified Register for Federal Government Social Programs (CadÚnico),* which has come to be the central information system for recording the state of poor Brazilian families. CadÚnico comprises a huge national and centralized network of consolidated local databases. For this network to function adequately, various systems are employed, from local data entry to the submission and consolidation of data in a centralized database.

In the *CadÚnico*, each council registers and updates the data related to the low-income families in its municipality. Apart from per capita family income, the inclusion of these families in the PBF depends on other variables, like the current annual budget of the municipal authorities, the extent of the coverage of the PBF in each municipality and the expansion strategies of the PBF throughout the country. For this reason, simply registering does not ensure immediate entry to the Program: the family might meet the inclusion criteria but despite this, be unable to enter due to a lack of "vacancies" in the municipality.

Families receiving the PBF benefits can be given allowances ranging from R$22.00 to R$200,00 (approximately US$ 13 and US$118 in May 2011) depending on monthly per capita income and the number of children up to 15 years of age and teenagers from 16 to 17 years.

4.2 Researching the PBF

A research study of PBF was conducted in the municipality of Piraí, a small city with about 25 thousand inhabitants located in the state of Rio de Janeiro, and Brasília, Brazil's capital city, during the months of September and October 2009 (Feitosa, 2010). In Piraí it was possible to follow the actors (both humans and non-humans) during the process of registering families in the PBF, while also allowing observation of how the network was constituted and how the registration data were collated. In addition, interviews were carried out with technical staff and the program's beneficiaries. In Brasília, on the other hand, it was possible to collect data through the centralized information processing system and to interview the people who had originally set out the policies and procedures for the PBF.

Twenty-five people were interviewed, including beneficiaries, former beneficiaries, administrators of the registration, local management staff, national management staff, and politicians. As well as this, there was extensive research into documents, manuals, staff- training courses, videos, and the laws, decrees and regulations that govern the operation of the PBF; this material was provided by the government and local coordinators of the program. Seven days were spent visiting the research field – five in Piraí and two in Brasília.

More specifically, the research monitored the personnel involved in the Program in their daily routines. Several hours were devoted to observing the activities of those involved while they were interviewing the beneficiaries and would-be beneficiaries, or were working on information systems and reporting on everyday common issues. At the PBF headquarters in Brasília, it was possible to gain access to the centralized database and find out how the flow of information from the municipalities (local databases) to the main database is designed.

The research study viewed the PBF as a technologically complex artefact, whose construction required a wide collective of techniques, ranging from database design to the building of categories. Due to its complexity, it was treated as an information system, built on an intricate network of relationships between humans (from software engineers and politicians to the PBF's beneficiaries) and non-humans (from huge database servers to simple pocket calculators). What will be examined in the next section is a small research sample, which, on the basis of the ontological perspective of ANT, seeks to restore some visibility to the 'invisible part of the iceberg'. This is undertaken by means of the performance of the categories which allow the poor to be sorted out, so as to draw the line which separates those who can from those who cannot benefit from the PBF.

4.3 From person to code, from code to person

Databases are representations of the world. Ultimately, what is required from these spaces of data organization is to be able to model a web of complex relations drawn from the world and life, in a way that allows them to be combined or displaced in order to facilitate calculation and memory. These technological artefacts are used

with the aim of both knowing the world and controlling it. However, their representations of the world tend to be regarded as "natural" and pass by unnoticed, which means that their creative processes and support systems remain hidden. This invisibility is one of the characteristics of information systems when they become (or approach the state of) an information infrastructure (Monteiro & Hanseth, 1995).

For example, according to *CadÚnico* (November 2009), it can be stated that in Piraí, the poor make up 28.31% of the population4. On the basis of this statement alone, without further elaboration, a great leap can be made from the world to language, as if it were possible to travel "directly from objects to words, from the referent to the sign" (Latour, 1999, p. 40). However, the path is not quite like that, or in other words, its trajectory is "always through a risky intermediary pathway" (idem, p. 40).

As observed earlier, this is the route where the representations of the world are constructed, and through which circulating entities flow. Latour (2005) approaches this issue by means of the proposition that a representation of the world, in the ontology provided by ANT, is formed by a chain of transformations that includes several steps and intermediate elements, and does not solely occur through a direct transformation. This means that the reference "is not there"; it is not something that can be pointed out but a result of connections between entities, and a product of a chain of transformations.

It is this succession of connections and transformations that remains hidden when it is stated that "in Piraí the poor make up 28.31% of the population". For this representation to be constructed, one must follow a long and risky path from the people to the databases where classifications and accounts of the people are transformed into codes, and allow statements like this to be formulated.

What follows is an example of how taking on the challenge of slowly accompanying and tracking the series of transformations can help to illustrate the complexities traced by circulating entities on the route covered, from the person to the code and from the code to the person.

4.4 Framing the 'odd job' (how to classify economic informality?)

Apart from the serious effects of its failure to provide legal protection for the workers, the informal economy is difficult to frame and classify, since it occurs in numerous ways and fails to conform to established standards.

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[4] This value takes into account the total number of inhabitants in the municipality (based on the national census) and the number of poor and extremely poor people (from the CadÚnico). The CadÚnico, in November 2009, recorded 7,446 people as either poor or extremely poor in the municipality of Piraí. According to the estimates of the national census, available at http://www.ibge.gov.br/cidadesat/topwindow.htm?1, the total number of inhabitants in the municipality in November, 2009 was 26,114.

In the case of the registration of families in the CadÚnico, the inevitable presence of economic informality also causes difficulties. The interviewer, who has in front of him/her blank spaces on a form (as illustrated in Figure 2), recognizes the practical challenge of faithfully filling in the blank spaces and at the same time trying to represent the family's situation that is sometimes outside the narrow range of classifications. At times, being aware of the family's great need, the interviewer completes the registration form in the hope that it will assist the family to be included in the PBF. As a Piraí Health Agent points out:

> Generally when there is a family and we see its destitute financial situation, we offer to do it [to make the registration]. (MARGARIDA, 2009)

Figure 2. A part of the Applicant's Identification Form, referring to work status, income and family expenses.
Source: (MDS, 2010a)[5]

One of the main difficulties encountered is the lack of standard criteria when it comes to informal activities. The procedure that is recommended is to record income - even what is earned from informal work – as indicated in the spaces in the

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[5] **Professional qualifications**

242 - Situation in the Job Market 1) Employer 2) Formally employed with regular salary 3)Informally employed with regular salary 4) Freelance with Social Security 5) Freelance without Social Security 6) Retiree/Pensioner 7) Rural worker 8) Rural Employer 9) Not working 10) Other; 243 - Name of the company for which one works, if unemployed state last employment; 244 – Business Number/Social Security Number; 245 – Date of Admission; 246 – Occupation; 247 – Income from this employment; 248 – Income from superannuation[retirement]/pension; 249 – Income from unemployment benefits ; 250 – Meal allowance; 251 – Other income

Family details

252 – Period living at current residence (Years/Months)

Monthly family expenses (only the mother/person legally responsible for the family to fill in)

253 – Rent; 254 – Mortgage payments; 255 – Food; 256 – Water; 257 – Electricity; 258 – Transport; 259 – Medicine; 260 – Gas; 261 – Other expenses; 262 – Number of people dependent on this family's income

printed form and the MDS recommendations. However, the form does not have an item for recording sporadic activities. If an income is given, it is assumed (and thus recorded), that the person earns that same amount every month, without any variation or intervals. Although the form is drawn on to map the situation of the poor, the mindset that is implicit in the form, to a great extent, reflects the routine of the steady wage earner, who has some kind of income security or regular income. However, this is invariably not the case with the poor who live a hand-to-mouth existence on a day-to-day basis (or if they are more fortunate, on a week-to-week basis).

This anomaly has led the Supervisor of the Program in Piraí to suggest, for example, (and without much concern for accuracy), calculating an average of what has been earned in recent months, without establishing the recommended number of months in a precise way. In fact, there are no guidelines on how to register erratic or recently commenced activities that have no guarantee of generating any income in the coming months, let alone earning a regular amount.

The following scene, which was witnessed in the course of field research carried out in Piraí, reveals the insecurity of an interviewer during the registration of a family. While the Health Agent tries to record and make decisions in face of an apparent dilemma, the head of the family, in turn, takes advantage of the uncertainty to avoid declaring information that could lead to an unfavourable outcome – a per capita income higher than R$140.00 which would lead to her exclusion from PBF.

> *Health Agent* – How can I record that she only lives off R$60.00 if her purchases are worth R$180.00? She might do some odd jobs, some cleaning… When someone does odd jobs, as I was saying, it is being entered as fixed income, and that is where people are missing out [on the prospect of being included in PBF]. *So now we are no longer doing this [registering odd job income], because it has to be on a case- by- case basis.* I am with an elderly man who is given assistance by the Secretary for Social Advancement for gas and food. So I did the update [in the register] for him. He is given a monthly allowance of R$60.00. I put [another] R$100.00 for odd jobs/miscellaneous. But it is not every day, or every week that he gets it, only sometimes. What happened? They blocked his benefit! I had to call the [Program supervisor], to explain the situation because we saw the patient was in a dire situation. So the supervisor reconsidered the application, and erased the miscellaneous income [..] to allow him to continue receiving the allowance. […] The ¨patient¨ thinks that it was we who blocked the benefit.
>
> [the head of the family that was being registered showed a copy of the electricity bill, but did not present a copy of the water bill because she doesn't pay for water (low income), she also takes advantage of the tax exemption for low income earners on the electricity bill. The Health Agent faced a dilemma on the question of how the family income should be recorded]
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> *Health Agent* – And now what? What do I register? (ROSA; HORTÊNCIA, 2009)

It is interesting to note that the Health Agents have a habit of calling the people "patients". Since they work in Piraí both in the health assistance and the Family Welfare Scheme, in their view, everyone is a "patient", regardless of the program. This is one more example of how policy practices can mould the categories. In the

case of the interviewers, it is difficult to separate these matters and they regard everyone seeking welfare as suffering from a health problem.

The form (see Figure 2) has ten possible categories for the area "242 – Situation in the job market", as shown in Table 1. At least two of these categories can be used to register the informal worker: "5 – Freelance without social security" and "10 – Other". But the question is not about which option to choose but rather about the consequences of using a certain option. If the field form is filled in with either of the two options, the recorder feels obliged to state a recurring monthly income, which does not accurately portray the situation of the informal worker. Faced with this difficulty, the preferred choice is to mark the field with option "9 – Not working". The following table (Table 1) shows the distribution of responses for adults recorded in the Piraí CadÚnico (October 2009), and finds that in 66.41% of cases "not working" was the choice. Moreover, if we add the cases in which no option was selected, this percentage increases to 72.13%. Options 5 and 10, which better characterize informal work, when added together, account for only 7.72% of the total number of records.

Table 1. Number of adults registered in each possible option regarding their Situation in the Job Market

Situation in the Job Market	No.	Percentage
9 – Not working	3114	66.41%
2 – Formally employed with regular salary	451	9.62%
x – No answer	268	5.72%
3 - Informally employed with regular salary	224	4.78%
10 – Other	222	4.73%
6 – Retiree/Pensioner	174	3.71%
5 – Freelance without Social Security	140	2.99%
7 – Rural worker	84	1.79%
4 – Freelance with Social Security	11	0.23%
1 – Employer	1	0.02%
8 – Rural employer	0	0.00%
Total number of adults(active registrations)	**4689**	**100.00%**

Source: Own research based on data from CadÚnico of Piraí (oct/2009).

It is unlikely that the majority of adults are not engaged in any income-earning activity. The large concentration in option "9 – Not working" could suggest, without a more detailed analysis of the registration process, that a large proportion of the adults do not even earn enough income for survival. However, on the basis of the recognised registration procedures, it can be presumed with a high degree of certainty, that this distribution is a result of a deliberate decision made by the recorders not to make use of the other options to avoid the difficulty of having to give information about a recurring income.

Another Community Health Agent explains how to deal with the registration of informal activities, by drawing attention to a certain tension that exists between the

personal nature of the relationship with the interviewees and the impersonal character of the data supplied by the form:

> Generally we do it like this; for example, when a cleaner states: "Ah, I do some cleaning here, it's R$30.00", we ask "How much do you earn per month?" Then we add it up, because generally it involves a cleaning session each day in a house, so you have to do the math. […] I say that I need an amount. So they give me this amount. But what happens here is […], we know most of the people, we know when they are lying or not. We live here because we have to, so they hardly ever lie to us. […] I was born and raised here, so we know everyone. (MARGARIDA, 2009)

The lack of clear guidelines on how to cope with the economic informality causes insecurity and confusion. It shows that in practice there is no straightforward relationship between, on the one hand a person, and on the other, the data that is designed to categorize the person, as if this data were an intrinsic part of understanding that person. What actually exists is a continuous negotiation; a construction of what someone wants to represent.

5. Discussion of the case

Coming back to the ontological perspective provided by ANT, 'income' can be seen as a circulating entity, whose meaning and coding is negotiated along the route which goes from person to code and from code to person. If this flow is ignored, and the old ontology of fixed entities of the diffusion model is employed, this implies a failure to take into account all the translations and mediations that lie beneath the apparent stabilization of a given income, a stabilization which is only 'the tip of the iceberg'.

By following the slower pathway travelled by the circulating entities in the study of the Programa Bolsa Familia - PBF, an alternative perspective is disclosed with regard to the design and development of an information system, where the tensions between two distinct ontologies emerge in a powerful way: one ontology being that of a technically represented world, made up of fixed entities – the world of calculation, design, and data models; in short, of technoscientific excellence. The other ontology is of a world made up of circulating entities, some made out of flesh, as is the case of an impoverished population who, hardly knowing how to survive each day, have to depend on calculation practices that are derived from an accounting system in conflict with the "best practices" for database design. This new ontology allows research to reach beyond a fixed form with clear-cut fields and categories, and thus grasp a richer circulation of entities – i.e. interviewers and interviewees who engage in complex and fluid negotiations to fill in the fixed form. This provides room for a wide range of local procedures, which are overlooked (and hence not made efficient) by the rule-driven algorithms and ready-made database technologies based on the ontology of the diffusion model.

How can this new ontology help the colonized to go further and experiment in new ways of development? By carrying out a detailed description and investigating the circulating entities (as here in the case of 'income'), the colonized can go beyond

merely 'adapting' to the accountability and categorization practices required by the colonizer. Indeed, by taking the 'whole iceberg' into account, they can embody their own categories within their own accountability, which will lead to new knowledge and hence new tools for development.

The narrative of the *CadÚnico* case shows, by slowly following a long trajectory "from the person to the code and from the code to the person", a wide range of translations that are needed to make registration serve as an "obligatory passage point" (Latour, 1987 p. 163) for the poor in Federal Government social programs. In examining these negotiations, the new perspective opened up by the ANT found there was a need to abandon the referential framework defined by the diffusion model, and reject the essentialist Formal/Informal dichotomy. It was also necessary to redefine the ontological status of the information systems and databases that support the PBF, while at the same time, to analyze its routine practices. This was accomplished to avoid having to regard these features either as pure forms arising from technical and social domains, or as an aggregate of the "pure" elements of these two domains.

Hence, we suggest conducting an analysis of the information system artefact within its construction and utilization practices, and treating it as a hybrid that is both formal and informal, or as Latour (1993, p. 51 ss.) states, a "quasi-object", "quasi-subject" – i.e. a genuinely sociotechnical artefact located outside the axis that links the poles of Nature and Society, somewhere between and below these two poles. The information system and its database can thus be regarded as informal-formal hybrid mediators of a variable ontology (Latour, 1993, p. 85) – i.e. the terms 'technical/social' and 'formal/informal' are not viewed as essential categories capable of providing ready-made explanations about the effects of a technoscientific artefact, but rather as the result of a provisional stabilization of their sociomaterial development/utilization practices – results for which explanations are required.

An acceptance of this ontological challenge, as outlined by ANT, thus means questioning the more traditional theories of knowledge and information, which tend to be conceived in terms of a logical sequence, involving the image of a Pyramid of Knowledge, that links data, information, knowledge and wisdom (Ackoff, 1989) (some authors do not include 'wisdom'). Although these more traditional theories treat data as an "objective fact", the account of the difficulty of grasping the reality of informal work through the formal categories of the PBF database, serves as a means of challenging this kind of objectivity. Extracting some apparently simple information, like the income earned by a person, is in reality not a simple, objective task. Even the question of filling in this information in a pre-defined field form "is not there", or something that is self-evident, but rather an issue that has to be defined in practice. The most important data field for the CadÚnico, is based on whether citizens should be classified as 'poor' or 'extremely poor' - i.e. establishing cut-off lines, that either include or exclude them from the PBF and other social programs – and this process results from a translation-transfer that is constructed through a wide range of negotiations.

In these negotiations, the worldview that is incorporated and inscribed in the formal scheme of the databases – i.e. the 'colonizers' of the Brazilian government – is challenged by the multi-faceted reality of the world of economic informality – i.e. the reality of the 'colonized' poor population. The database categories that are designated as "formal" are negotiated in the registration practices by their association with the practices of informality, at the same time that these practices, in this same process, are given new meaning. In other words, the traditional logical sequence "data, information, knowledge, wisdom" is, in practice, a construction. Even the "data" in this sequence cannot be said to be logical and objective, or simply given (according to its Latin etymology, 'data' is the plural of 'datum', which means 'given'). The argument here is that nothing is given, everything is constructed. The data is not a 'given', a 'gift', but rather only the 'tip of the iceberg' resulting from a complex construction process, in which the "formal" classification categories and classified "informal" practices are co-constituted. Thus, by unveiling the complex sociotechnical processes that underlie the categorization of databases, ANT's ontology of circulating entities allows one to think of databases as bases of negotiations.

6. Concluding Remarks

This paper has argued that the Actor-Network Theory (ANT) poses a challenge to the widely accepted ontological premises that underpin the way the technoscientific artefacts used for development projects and strategies are conceived. Rather than regarding technoscientific artefacts as universal "matters of fact" originating from the world of nature, the ANT ontology of circulating entities envisages the provisional stability and the universality of the technoscientific artefacts as being only the "tip of the iceberg", insofar as they conceal a multifarious and complex set of sociotechnical practices. This means of revealing the implicit parts of these technoscientific artefacts, makes them a "matter of concern" (Latour, 2005) for developing countries, while at the same time, broadening the scope of their ideas about development practices, initiatives and technologies.

When broadened in this way, the ontological perspective of ANT enables less developed countries and human groups (the 'colonized') to recognize and reflect on some of the premises (which are hidden and taken for granted) that are embedded in the technoscentific artefacts. These premises largely refer to the environment where the artefacts were first designed (mostly elsewhere within the society of the 'colonizers', and particularly in the global North), and are often not suited to other local practices, constraints and conditions. Furthermore, this new ontology enlarges the repertoire of potential entities that may inhabit the world by including neglected aspects of the less developed world. Thus it expands their horizons with regard to development issues by allowing them to acquire and reflect on new technologies and knowledge that are better suited to their circumstances.

From the perspective of development research, the ANT ontology is hence capable of laying down new intellectual foundations to help overcome the restrictions of the

diffusion model with regard to its ability to conceive, analyse, and shape technological artefacts used for development purposes. As regards the implications of this in practice, in view of the increasing use of technoscientific artefacts in strategies and programs for development, an ANT analysis of this process entails continuous monitoring of the overflow effects i.e. of what falls out of (or indirectly emerges from) their inherent framing categories.

In other words, if the ontological challenge posed by ANT is taken up, it must be accompanied by an acute awareness of the need to describe the situations in which the ontology of day-to-day practices in less developed countries and regions confront the conventional categories and processes designed in the scientific artefacts; this will lead to a spiral of co-constitution and mutual redefinition. Ultimately, what is at stake in technoscientific artefacts used for development purposes – such as the databases of the PBF case analysed – is the important task of building citizenship. Technologies designed to meet areas of public concern are continuously structuring the everyday life of the public, with effects that are particularly important for the poor and underprivileged social classes. Far from being neutral, the effects of technoscientific artefacts – when viewed as the outcome of sociotechnical negotiations – can thus either lead to restrictions being imposed, or else bring about conditions that are conducive to the full enjoyment of citizenship rights.

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