Towards a Holographic Rendering of the US Economy

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As the work of other NIST funded projects start to produce more information on civil infrastructure, energy, manufacturing and other complex societal systems, an already prominent need for a new way to unify, articulate and express the meaning produced by these sources will become more evident.   We outline the need for a new collaborative virtual rendering of the US economy. The basic visual and ontological technologies required to implement this now exist. NIST support would accelerate and generate interlinking of existing standards and the deployment of scalable data routing infrastructure for a unified virtual representations of our nation from an economic data perspective.

TIP WHITE PAPER

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Contents

Overview

This paper outlines the critical national need to demystify our economy and make it transparent to key decision makers and the general public by building a technology-enhanced virtual representation of the economy that is comprehensible, accessible, and timely. The recent meltdown of our financial institutions and its drastic reverberations throughout the economy blindsided not only the experts who were supposed to oversee the financial sector, but also ordinary people whose hopes and aspirations for a better life were shattered almost overnight. These catastrophic events and the uncertainty about what remedial actions to take and the expected results of such actions highlight the need for a great leap forward in our shared understanding of how the economy works.

A. Selection Criteria: Maps to Administration Guidance

Transparent Policy Process
The current Administration has made it a major campaign promise to promote transparency in executive decision-making and in the legislative process, to the point of specifying a holding period during which bills could be scrutinized by the people prior to becoming part of the law of the land.

Micro Foundation of Macroeconomics
Efforts to bring to the forefront the heretofore hidden micro mechanisms underlying the economy and presenting them as parts of a unified whole are evident in academic studies sponsored by, among others, the National Research Council (NRC). In 2007, the NRC-funded Committee on National Statistics published the results of their studies in the book, "Understanding Business Dynamics, An Integrated Data System for America's Future", wherein they argued for the building of a business register containing all business units operating within the United States. The register will be the focal point of integration of business data from different sources.

Data Sharing
Recognizing the decentralized nature of the Federal Statistical System and consequently the fragmented views it provides to users, the Committee on National Statistics published in 2006 the book, "Improving Business Statistics through Interagency Data Sharing", wherein they recommended actions needed to overcome legal and administrative barriers to data sharing among the agencies collecting business data from individual micro units.

Microsimulation Modeling
The importance of micro data grew along with the increasing interest in using microsimulations to support policy analysis. The NRC published in 1991 the 2-volume book, "The Uses of Microsimulation Modeling", wherein the advantages of microsimulation models over the more popular macro-econometric models and other aggregate level statistical constructs are presented convincingly.   The main stumbling block, however, to widespread use of microsimulation models is the difficulty in collecting and processing the voluminous micro data required for building and running the models.

A common thread running through all these efforts is the recognition of the existence of a single economic reality that is somehow being measured from many different angles under many different contexts. Following from this is the realization that there needs to be a single, unified representation of this reality.

B. Selection Criteria: Justification for Government Attention

(1) Magnitude and Nature of the Problem

How we collectively understand the economy is determined to a large extent by how we share and understand its representation. Currently, the economy can only be understood through its statistical representation: the statistical data collected by various public and private agencies and processed into standard account tables and indicators.

These complex statistical artifacts, however, were designed by experts for the use of experts. The ordinary citizens are left to fend for themselves, trying to comprehend the multifaceted meaning of these artifacts as they make day-to-day economic choices. The aggregate, global orientation of the statistical representation was simply not designed to serve their individual, local needs. That people seldom try or the perception that understanding our economy is a task left to specialists is testimony to the depth of the problem.

Expert users may have no problem understanding the statistical representation, but they are concerned about its flexibility. The standard account tables and indicators are "set pieces", fixed and frozen views of the economy specified by their designers. New data that do not fit into the existing categories of the representation are adjusted and transformed until they fit, thereby obliterating their original purpose and meaning. The current representation is a non-reactive and non-evolving monolith, which is not conducive to the interplay of alternative views and interpretations.

The benefits from using standard accounts and indicators are offset by the inordinate amount of time and human resources needed to build them. Consistency, coherence, and comprehensiveness in statistical data are often achieved at the expense of timeliness. Users are forced to rely on early preliminary estimates that later are modified when data become available or after adjustments have been made. This leads to frustration on the part of policymakers, who need reliable, stable, and timely empirical justifications for their policies.

The Micro to Macro Gap
Adjusting the micro data to derive the macro-level accounts and indicators effectively severs the link between macro data and their micro data foundations. Users can no longer understand the data in terms of how they are derived from other data. Restricted access to most of the micro data limits the capability of the statistical representation to provide images of the economy at various levels of granularity.

The issues discussed demand a solution that is simple in concept, sweeping in scope, and quick in execution. The existing economic representation needs new scaffolding in the form of advanced software technology to transform it into a reasonable facsimile of a unified and transparent economy, affording full visibility to all its constituents, from the smallest economic unit to the largest aggregation of units in one, continuous, knowing glance.

The magnitude of the societal challenge that is not being met adequately by others

The prosperity of a nation, geographical region, business or individual depends on their ability to navigate the knowledge space. We have entered an era when the higher order complexities of the US economy – manifest in sector topics ranging from financial instruments to technological supply chains – exceeds and overcomes inherited mediums of reference and management. Whether viewed from the vantage point of a policy maker, business leader, researcher or voting citizen we are never more than one three hundred millionth of the total collective perception and experience that is the United States economy at the beginning of the 21st century. At the same time, while making decisions for one's family, organization or country, the medium and model through which we access the broader knowledge space remains essentially the same toolbox that was accessible to pre-industrial literate societies.

The very medium of our collective understanding has not kept pace with the underlying evolution of our life world's complexities. Our community knowledge pool needs a more robust medium than traditional pre-digital era literary technologies of paper based words and numbers. The continued growth, prosperity and risk management of our shared economy requires an enhanced medium for articulating the architecture, patterns, behaviors, dynamics, interconnections of the systemic topology that is our economy and the context for the decisions we make.

The Internet has brought an ease and speed to how we share and collaborate information. Prior to the Internet, tremendous expenditures of social and physical energy were required to aggregate and pool our shared intelligence. News papers, trade journals and other publications served general to specialized knowledge interest groups that have always remained constrained by the amount of time available in any given day to consume these resources. While the Internet has reduced the cost of production and dissemination, it has not significantly enhanced the demand or utilization of the contained intelligence. What is needed is a new medium through which the details and total view can be connected through an interceding model that captures both the complexity and simplicity of our economic world.

A number of private and public enterprises pursue intelligence on different scales of resolution but no one organization has been organized or charged with addressing the need for a single unified model of our economy. The results of private sector efforts are the result of initiatives designed to harvest strategic advantage over market competitors; these results seldom see the light of our shared knowledge space since such sharing would eliminate the strategic advantage for the investor funding such work. Academic activities in the domain share

another challenge of private enterprise efforts to understand our economy; besides a few notable exceptions the resources and scope of work entailed in creating a unified framework are simply too great for any single company, academic institution or individual to address.

The focus of publicly funded institutions can be defined according to a simple tripartite division of the economy into 'macro', 'meso' and 'micro' scales, but the results of their analysis seldom connect.   For example, the Federal policy makers, the Federal Reserve Banking System, the Treasury, the Bureau of Economic Analysis are predominate organizations charged with monitoring and managing the macroeconomic knowledge space.   For knowledge on 'meso' economic scales covering industries and their intersection, one needs to turn to the department of commerce, the Census Bureau and over three thousand industry associations that specialize in knowledge for their given industry.   Finally, for microeconomics, we can look to market prices that cover the fate and fortunes of individual companies.

We can also define state, county and regional divisions and economic sub-domains down to the scale of an individual citizen's experience.   This is all the same 'economy' but there is no organization, place or means to unify and connect insights across scale and complexity within this broader system.   Isolated academic research simply does not scale to address the magnitude of such a task; the traditional medium of choice – a published paper or book - is simply a vestigial information schema from an age when all insights could not be woven together into a seamless unified whole.   We have the information now but we lack the unified field into which groups of knowledge workers can enlighten how it all fits together.

The scope is truly massive – with over four hundred Federal agencies and departments gathering data and information and the rate of available data increasing daily, we need a forum for insight that transcends the scaffolding handed down from the library of Alexandria.   We need a new medium where all information can be illuminated in a fractal like simulation that captures live feeds from transactional information to traffic signals.   We should be able to see ourselves as one nation, yet be able to zoom into a resolution that highlights our own unique stories and how they all together make up something greater than the parts.

Today there is no single unified effort to create a shared unified representation of our economy and the industries, companies and people that compose it.   Organizations like the Bureau of Economic Analysis and the Department of Commerce are charged with gathering data on the 'big picture.'   Other organizations are charged with understanding specific aspects of the total system; for example the Department of Homeland Security focuses on the same critical infrastructure systems financed by financial systems overseen by the Treasury and FDIC.

Why research/technology is needed to address the societal challenge.

The required transparent economy is not simply a passive representation of economic reality, but also a faithful, dynamic, virtual copy of that same reality. It serves as a repository of data for describing the past history of economic actors and the behavioral rules for simulating the future history of the actors. This combination of data and rules is the knowledge base that

enables the transparent economy to mimic the behavior of a real-world economy thereby allowing users to view what was, what is, and what if. Managing the massive amount of data collected from individual economic actors requires equally massive doses of advanced data management technology.   Visually navigating through the data requires cutting-edge data visualization techniques. Defining the data to be collected and specifying the behavioral rules of the actors require prior research on the requisite underlying economic theories and ontologies.

Inputs to accomplish the research.

From sophisticated monetary policy models, to thousands of industry and supply chain specific models, to virtual cartographies, SKUs, telephone call volumes, traffic patterns, electricity usage, every bit and byte is potential fabric for weaving together a ever more unified and total systems reflection.   We believe such a system simply cannot be owned or managed by one organization.   In fact, the focus of the input should be the facilitation of multiple ownership and exchange.   We propose that a TIP designated effort and an informal ontology articulation and experimentation would be sufficient catalyst to awaken the 'animalistic spirits' of the profit incentive to care the endeavor forward.   Like the Internet, once started, it will become impossible to stop.

Outcomes of success identified as national in scope.

A simulation of the totality of our national experience will be akin to enabling people to virtually 'present' and 'see' complexity expressed in easily understood topographies (much the same way tools like Google Earth and Microsoft's Virtual Earth enable people to 'teleport' geographically).   The result would combine economic and demographic cartographies of regional and industrial topologies plus any and all available data ranging from video feeds , highway traffic sensors, cell phone traffic and other data feeds rounding out an informational hyper-space where one's ability to see and understand events, patterns and systems is limited only by the imagination, pixel resolution and available processing power.   We describe this as a 'holographic' representation, meaning it can encompass and be oriented towards the whole without becoming disconnected from any given part.

(2) Societal Challenges Unmet by Others

The cost of lost opportunities if challenges are not met or solutions delayed.

The most obvious manifestation of the cost we are currently paying for the absence of such a system is in the current financial market crisis.   This was a failure first and foremost of our collective and individual abilities to see, understand and act rightly on a system that had become untenable. It is proof that spreadsheets, word documents, files and folders will not scale to meet our 21st century information challenges. Calls for greater transparency, and more sophisticated methodologies for representing sophisticated financial instruments are the natural solution. Since most of these instruments still have underlying assets (mortgages on

houses, credit/corporate debt, etc...) these become part of the same model and fabric.

The cost of knowing less than we could know is difficult to quantify. A proxy cost can be estimated by the gap between information technology enabled economies and those few that haven't yet crossed into the information age. The Internet has brought us to a new world, but we are left practically blind, feeling our way through pages and endless lists trying to put the meaning all together in our minds. A shared mind space where users can collectively build and share a massive visual reflection of our economy could not only eliminate massive waste, it could also channel limited resources more efficiently to best-return activities.

(3) Evidence of Commitment

The likely proposers to a competition in this area.

We, the people involved in submitting this letter, have spent years in conversations with staff ranging from the Bureau of Economic Analysis, the New York Federal Reserve, Tier one bank executives, to leading consultancy firms. Some of the national labs have been working on critical infrastructure modeling from a national security perspective as well. There is also an effort by the Federal CIO called data.gov though such organizations will probably provide open access to their data and not submit competing bids. The nature of the task requires collaboration and the magnitude means that any potential competitors could carve out aspects of the challenge and work together. We believe an NIST focus would catalyze what – anecdotally – looks to be broad interest that could be concentrated with a rally point. Such an effort should include a mixture of both government and private organizations.

Who is looking for money in this area and why.

With the support of www.swift.com and www.in-q-tel.gov we have built the basics navigation and organization interface required to navigate economic systems. Quantum4D would be among those submitting a proposal to provide this to the public. We have even built a virtual representation of global capital flows and a non-live data feed enabled rendition of the US economy spanning 10k spaces, with 70k economic entities and 800k time series. But this is just a prototype – the real system needs to support real feeds to now common 'off the shelf' knowledge structures (zip codes, NAICs, SIC etc..).

We argue that the over $5 Billion dollars spent in 2008 on financial information are all dollars spent on organizations looking to provide at least one part of the total solution we are describing. Those organizations which aim to understand the particulars of a market or industry generally group everything else outside of their focus into the domain of 'exogonous' variables simply because there is currently no human way for an individual or organization to factor in all possible forces in our economy. Through collective effort kindled by a TIP initiative the willingness to 'throw in' particular datasets or ontologies should be expected.

C. Selection Criteria: Essentials for TIP Funding

(1) Stimulates the Nation's Scientific Frontiers

Creating a simulation – or total systems reflection of the US economy – would be further stimulus to emerging techniques in information modeling. From system dynamics theory, Bayesian analysis, agent based models and a host of other new quantitative modeling techniques that have broad applications beyond the 'econosphere' (i.e. biological systems analysis, physics, and pure mathematics). If the entire US population and increasingly robust data ontology were made available to our scientist, we could understand and better manage resources by better understanding socio-economic behavioral matrices as they are affected by geospatial and regional economic considerations. Indeed, understanding ourselves as a political, social and economic whole is perhaps the aboriginal motivation for the origins of science in the time of Aristotle and his teachers Plato and Socrates.

How the Nation's capabilities will be stimulated.

GDP growth is driven by the realization of new resources and the perpetual optimization of utilization of existing resources. Discovering untapped pools of human capital, commercial facilities, infrastructure needs and having those readily available to decision makers could arguably induce a significant boost in national GDP points of several percentage points for several years going forward. From the elimination of redundancy made obvious through transparency to the more rapid identification of needs before they become problems, the ancillary and foreshadow of the potential is readily available and evident in the emergence of the Internet. Now, if you removed the inefficiency of having to mediate intelligence through archaic mediums like text and raw data, you amplify the collective intelligence and make the entire system function more efficiently and effectively.

What is the technology leverage for success or failure?

Two technologies are needed to leverage success – these are broadly defined as display interfaces and backend data management. These have been advancing rapidly and innovation in these fields does not explicitly need government attention since there are significant market drivers causing these enabling foundations to advance. As displays move beyond the desktop screen and integrate with mobile devices and large scale environmental and immersive display mediums, and as the fluidity of information becomes more liquid – less frozen in silos of balkanized data silos what will be needed is a conscious effort to foster a shared ontology or system for organizing large scale information topologies. These already exist informally but there has been no concerted effort to coordinate them.

(2) Meets a Timely Need Not Met by Others

Research will not be conducted within reasonable time period in the absence of TIP funding

The need for a national information ontology as an infrastructure to a shared total simulation

of our world will not be met by others since no one organization beyond the people and their government as a whole have the capacities or reason to focus on the details in the big picture. We are simply reasonably preoccupied by the tasks at hand managing our own local lives and responsibilities. Yet, we would all stand to benefit from an ability to 'zoom out' and see our economy as a unified whole, then drill down to our own position in the total system. The journey would surely prove educational to many and could help everyone from policy makers in DC to someone deciding between a career in Real Estate or Medicine (demographics, housing data – all this information could be made readily accessible).

There is also an artistic side to invoking ways of representing information and a national ontology unification system (nous) would need to support such morphological transformations as the presentation of information as forests or cityscapes of information. When imagination and reason conspire to conquer a domain there are infinite possibilities and beyond simply gathering today's data structures (NAICs, Oil Systems models, WUMM, etc…) the system would need to facilitate the multiple use case scenarios from sophisticated institutional use to novice individual use.

No other alternative funding sources are reasonably available to support the proposal.

Given that the broad and inclusive scope of a national virtual simulation is more expansive than the scope of any given institution, furthermore, given the experimental nature of the initial work required to enable this, the likelihood of another organization supporting such an endeavor is low.

(3) Delivers the Potential for Impacts and Transformations

How research could impact the nation in a transformational way.

The whole gamut of decision-making activities, from the lofty perches of our national leaders to the lowly shacks of destitute households, will be transformed dramatically by the equalizing effects of the new tools arising from research. Whether it involves searching for the optimum policy simulation results or for the store selling the cheapest milk, the search engine of the transparent economy will provide the same level of service to any person, at anytime, anywhere. The liberating effects of freely available information cannot be underestimated.

Unification of the ontologies in the specialized world of economics is another research byproduct that has mainstream impact. It will enable the efficient generation, integration and unification of economic knowledge, and therefore its efficient management and utilization. The disruptive chasm separating the academe from industry will finally be closed, and ideas can flow back and forth, unimpeded and productive.

How success would provide dramatic benefits to the Nation.

Human societies until very recently have been constrained to live, act, and organize via

centralized hierarchical organization structures.   As our economy has become more complex and the world more unified, the impossibility of any one individual or group to effectively manage the whole will continue to produce systematic risk potential since no adjustment can be more than a best guess of individuals operating in an incomplete information space.

Recent advances in communication and information technology over recent decades are properly viewed as setting the stage for a transformative transition to a non-authoritative, democratic and collective self-managing approach to running our lives and our world. One guidance and aim of the TIP should be to foster an intellectual mind space that is capable of nurturing and facilitating this shared resources from within a system that knows that it needs something better but can't see it until shown what it can be.

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