Discussion Paper

A Double Win for Texas:

Growing and Protecting the Texas Economy Through a Pandemic Preparedness and Infectious Disease Innovation Initiative

April 2021

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TECONOMY PARTNERS LLC

Innovating Tomorrow's Economic Landscape

Contents

Abstract

The effects of the COVID-19 pandemic have been felt across the U.S. but are particularly acute for a state such as Texas that has both a large population base as well as a significant contribution to national economic activity. The impact of infections on Texans has been felt not just in terms of harm to health and loss of life, but also economically in terms of lost jobs, lost businesses, economic hardship, and associated fiscal pressures. As this discussion paper shows, the negative impacts of COVID-19 on Texas have been severe and are ongoing. Based on high level heuristic analysis herein, TEConomy estimates that:

- The one year economic shock of the pandemic in 2020 alone likely ranged between $30 billion to $60 billion in reduced gross state product – and the likelihood is that these impacts represent a conservative, lower bound of total one year impacts. The state had almost 470,000 fewer jobs than expected in 2020 causing in excess of $26 billion in lost per capita income.
- Both economic and public health impacts from the pandemic will continue to persist for years to come, and the full impacts from this event may not be realized until decades later.

Continuing impacts of the pandemic have already been observed into 2021, with the risk of additional outbreak surges persisting even as vaccine rollouts occur. The threat to Texas, however, will not end after COVID-19 because exposure of humans to emerging pathogens and reservoirs of infectious disease will continue to be an ongoing global challenge in our highly connected world. To help the state improve its resiliency to infectious disease events like COVID-19, this paper introduces the concept of developing a Texas **pandemic preparedness and infectious diseases innovation initiative**. It inherently recognizes the threat of ongoing infectious diseases but turns the threat to the advantage of Texas by putting forth an initiative **designed to propel the state to the forefront of infectious disease R&D, commercialization of innovations** (in diagnostics, vaccines, biopharmaceutical therapeutics, and other products), **and pandemic response systems advancements**. It promises to address a large potential market, thereby generating robust economic impacts for Texas, while having the parallel benefit of enhancing public health and the economic resiliency of the state in the face of emerging pandemics.

No other health threat has the power to shut down economies – it is a unique characteristic of infectious diseases and requires a unique preparedness approach. The fact that the envisioned initiative for addressing the threat would also be designed to generate robust economic development benefits via innovation in diagnostics, vaccines, therapeutics, and other technologies, makes the concept a smart, proactive investment for Texas. To drive this initiative, Texas Senate Bill 264(87R) proposes creating an agency called the Texas Research Consortium to Cure Infectious Diseases, or TRANSCEND for short, with **net financial benefits from investment anticipated to include a significant growth in gross state product, tens of thousands of new jobs, and positive revenue returns for the State.**

I. Introduction

2020 was a year unlike any other in recent memory. The spread of COVID-19 "re-shaped daily life for much of the world's population and drove the global economy into recession."[1] As with the rest of the United States, Texas fairly quickly felt the negative impacts of the spread of COVID-19 as daily life and commerce in the state had to adjust to control disease spread and mitigate losses.

While estimates vary as to the ultimate impact of COVID-19 on Texas, and indeed the effects are still ongoing at the time of the writing of this paper, there is little doubt that the economic "shock" of the pandemic has been deep (some topline estimates of these shocks are discussed herein). Hundreds of thousands of Texans lost their jobs and the state economy shrank as international, national, and state commerce was interrupted and slowed. The economic disruption has been substantial, and the humanitarian impact worse still in terms of suffering and lives lost from COVID-19.

As with so many great challenges, there have been many examples of humanity rising to the occasion in the fight against COVID-19 to respond with intelligence, ingenuity, and cooperation. The life sciences R&D and commercialization sectors have been particularly notable contributors to the fight. As noted by TEConomy in a recent evaluation of worldwide responses to the pandemic:

> *COVID-19 has shone an extremely bright spotlight on the critical importance of life sciences research, and the commercialization of life sciences innovations, as mechanisms for effective pandemic response. The ability of industrial life sciences ecosystems to develop diagnostic tests, vaccine candidates, and antiviral agents (and to rapidly scale-up their clinical trials, manufacturing, and distribution) will ultimately make the difference in resolving the pandemic.*[2]

While life sciences have always paid attention to infectious diseases and associated threats, much of the U.S. health and life science research and commercial infrastructure has been more focused on large-scale chronic diseases – those which have a particularly significant mortality and morbidity burden (and financial cost) in our developed nation. Heart disease, cancer, diabetes, etc. have justifiably been the focus of much U.S. research and innovation activity at a national and state level. Recognizing the costs associated with cancer, for example, together with the demand for diagnostics and treatments for cancers, Texas undertook a major initiative with the Cancer Prevention and Research Institute of Texas (CPRIT), which since 2008 has provided 1,576 grants, and $2.64 billion in funding to support academic research, prevention interventions, and product development research. The impacts of CPRIT have already been impressive and are reported in a retrospective 2017 report by The Perryman Group.[3]

While the nation has faced multiple infectious disease challenges (e.g. from HIV/AIDS, SARS, and Zika), COVID-19, more than any previous epidemic in recent decades, has generated extensive economic damage and societal costs. The extent of the economic shock, and its structural ramifications within the economy, will be felt for a considerable amount of time. It is expected, as a result, that there will be mobilization of increased national and international resources towards researching and addressing pandemic disease threats – supporting extensive R&D and innovation in a range of priority areas including, for example: disease surveillance and tracking systems; rapid high sensitivity diagnostics; vaccines; immunotherapeutics; anti-viral and anti-bacterial therapeutics; decontamination technologies, and personal protective equipment.

This presents an opportunity for Texas, to position itself to leverage pandemic preparedness as a potential fast-growth economic driver. Establishing a leadership position in infectious diseases research and pandemic response innovations will not only prepare Texas to defend its people and economy in the face of future emerging diseases, but also present a distinct opportunity to build a science- and technology-based advanced industry cluster serving an expanding national and global market

[1] Simon Tripp, David Hochman, and Mitch Horowitz. (2021). "*Response and Resilience: Lessons Learned from Global Life Sciences Ecosystems in the COVID-19 Pandemic*." TEConomy Partners, LLC. for Pfizer, Inc.
[2] Ibid

[3] The Perryman Group. (2017). "*An Economic Assessment of the Cost of Cancer in Texas and the Benefits of the Cancer Prevention and Research Institute of Texas (CPRIT) and its Programs: 2017 Update.*"

(for diagnostics, vaccines, therapeutics, and protective technologies).

Such a major initiative, as presented in Texas Senate Bill 264(87R), would create an agency called the Texas Research Consortium to Cure Infectious Diseases, or TRANSCEND for short, and will likely have far ranging benefits for Texas. The negative impact of COVID-19 on the Texas economy and the people of Texas has been unprecedented. An initiative that better prepares Texas to respond to future infectious disease quickly and effectively will enhance the state's ability to mitigate the threat of such powerful negative impacts in the future. The proposed initiative would also create positive impacts by building the base of infectious disease R&D and pandemic preparedness in the state, and by accelerating technology and product development for pandemic response where a diverse range of products can be envisioned in terms of biomedical products and technologies.

Texas' positive experience with CPRIT has been significant, and it is anticipated that a pandemic preparedness and infectious diseases innovation initiative can be equally transformative. It is anticipated that an initiative could focus on three core goals:

- **Preparedness**: recruiting and retaining leading scientists and next generation trainees, and investing in their research, to create diagnostics, therapeutics, and vaccines for the future while funding infectious disease surveillance, prediction, and modeling/simulation research.
- **Innovation**: advancing public health programs and pioneering research to enable quick and effective responses to be mounted when the next outbreak occurs. Developing innovations to prevent the negative public health and economic costs associated with infectious diseases.
- **Economic Development**: generating significant volumes of high-wage jobs in R&D, diagnostics and therapeutics products manufacturing, device manufacturing, product distribution, health care, and associated industries.

As with CPRIT, it is envisioned that competitive grants could be awarded through a pandemic preparedness and infectious diseases innovation initiative to fund R&D and innovation commercialization, together with public health and statewide education initiatives. Furthermore the envisioned initiative could formulate mechanisms for allocations of funding that will enable rapid and effective response to future infectious disease crises – thereby working to substantially limit health and economic damage.

This discussion paper provides an overview of the types of negative impacts that a pandemic preparedness and infectious diseases innovation initiative can work to prevent, and the positive impacts likely to be associated with the initiative being an effective R&D and innovation engine. First, we review effects of the COVID-19 crisis and provide a series of high-level estimates for the economic and human health impacts associated with the pandemic in Texas (indicative of the type of negative effects that the initiative will be seeking to prevent). Second, TEConomy outlines a potential framework for more in-depth assessment of pandemic event impacts, based on TEConomy personnel's prior experience working on similar frameworks for national security focused biodefense impact modeling. Third, we identify and highlight the broad portfolio of positive functional impact benefits for Texas that would be anticipated through the initiative and consider the public-private and monetary-nonmonetary dimensions of these impacts. Finally, TEConomy discusses the characteristics needed in an infectious disease and pandemic response ecosystem in Texas (based on the recently completed TEConomy review of lessons learned from global life science ecosystems under COVID19). An ecosystem framework is proposed as an organizing principal for further in-depth evaluation regarding current strengths and assets to leverage, and potential gaps to address, through the envisioned pandemic preparedness and infectious diseases innovation initiative.

II. Heuristic Estimates of the COVID-19 Pandemic Impacts in Texas

There have been a wide variety of studies conducted to date on the health and economic impacts of the COVID-19 pandemic, both from the national and state perspectives. Estimates of total impact have ranged as high as $16 trillion in costs to the country[4] and are spread across a wide variety of impact categories ranging from direct mortality and morbidity from infection to indirect impacts on economic productivity, job creation, and business activity. A recent Texas A&M study found that the impact to the U.S. food and agriculture sectors alone was estimated to total $2.5 trillion,[5] highlighting the scale of the pandemic's effects across multiple industry sectors.

To help guide discussions of the pandemic's impact to the state of Texas, and begin to evaluate potential cost-benefit comparisons for future investment in pandemic preparedness, TEConomy has analyzed several data sources to produce top line, heuristic estimates of the potential economic impact to the state. These estimates are not intended to serve as a detailed, comprehensive study of impacts to the state, and represent an order of magnitude accounting of economic consequences for the state. However, the estimates presented below can help establish a baseline for discussing potential returns on investment from pandemic mitigation and prevention initiatives and infrastructure in economic terms. More detailed modeling of economic damages to the state due to the effects of COVID-19 should be developed as a part of any subsequent analysis.

To develop high level estimates for the economic damages to the state of Texas resulting from the pandemic, **TEConomy measured the health and economic effects in excess of what predicted outcomes for 2020 would have looked like in the absence of the pandemic based on historical baseline trends**. The first major impacts of the pandemic began in the first quarter of 2020 in the midst of the expansionary economic and business cycle which had continued since the recovery from the 2008 financial crisis and resulting recession, and this analysis compares the economic outcomes that occurred against the scenario in which the expansionary trend continued uninterrupted. This methodology of examining economic impacts in the context of excess consequences compared to predicted trends aligns with other major analyses of COVID-19 health and economic impacts. In particular, a widely-cited National Academy of Sciences study on national and state COVID-19 impacts uses this approach and notes that it has several benefits: first, it does not rely on potentially problematic attribution of mortality, job loss, or business disruption to COVID-19 and simply measures the aggregate deviation from the "expected" steady state in the wake of the pandemic, and second, it captures at a high level the direct and indirect effects of the pandemic on health and economic variables without the need to specifically model them.[6]

This analysis covers several perspectives on potential economic damage to the state of Texas in order to provide a range of high level estimates for consideration. First, the analysis considers the potential impact of direct employment losses in 2020 resulting from economic disruptions caused by the pandemic. Using Emsi data on Texas state employment, which leverages the BLS Quarterly Census of Employment and Wages (QCEW), Figure 1 shows the linear time trend of predicted employment based on 2010-2019 patterns versus the actual levels of 2020 employment observed in the state**. The difference between predicted and actual employment levels is 469,377 fewer jobs in Texas than expected in 2020 given trends from 2010 to 2019**. This drop in employment is consistent with sharp declines in labor force volume and corresponding increases in unemployment observed by the Bureau of Labor Statistics for the state over 2020.

To put this excess job loss in perspective, the total economic damage resulting from the drop in

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[4] Cutler DM, Summers LH. *The COVID-19 Pandemic and the $16 Trillion Virus*. JAMA*.* 2020;324(15):1495–1496. doi:10.1001/jama.2020.19759

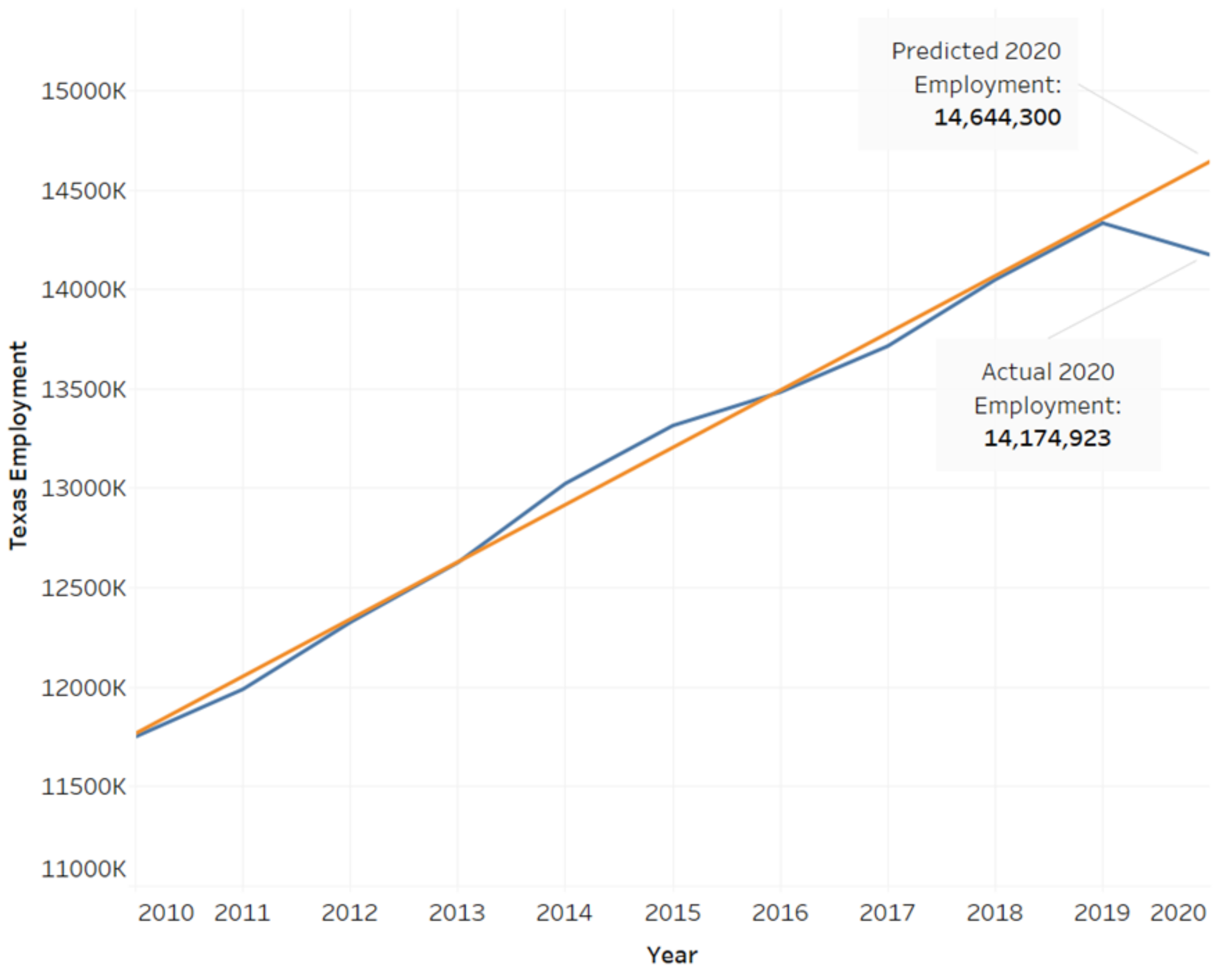
[5] "*Texas A&M-coordinated study expects COVID-19 economic impacts of $2.5 trillion loss in goods, services nationwide*." Texas A&M AgriLife, 9/2020.

[6] Initial economic damage from the COVID-19 pandemic in the United States is more widespread across ages and geographies than initial mortality impacts. Maria Polyakova, Geoffrey Kocks, Victoria Udalova, Amy Finkelstein. Proceedings of the National Academy of Sciences Nov 2020, 117 (45) 27934-27939; DOI: 10.1073/pnas.2014279117

employment relative to expected trends in the absence of the pandemic ranges from:

- **$32.6 billion dollars in lost wages**, using an average annual earnings per job for Texas of $69,457 (for 2020), or alternatively,
- **$26.0 billion in lost personal income**, using an annual per capita personal income level for Texas of 55,288 (2020 Q3 level).

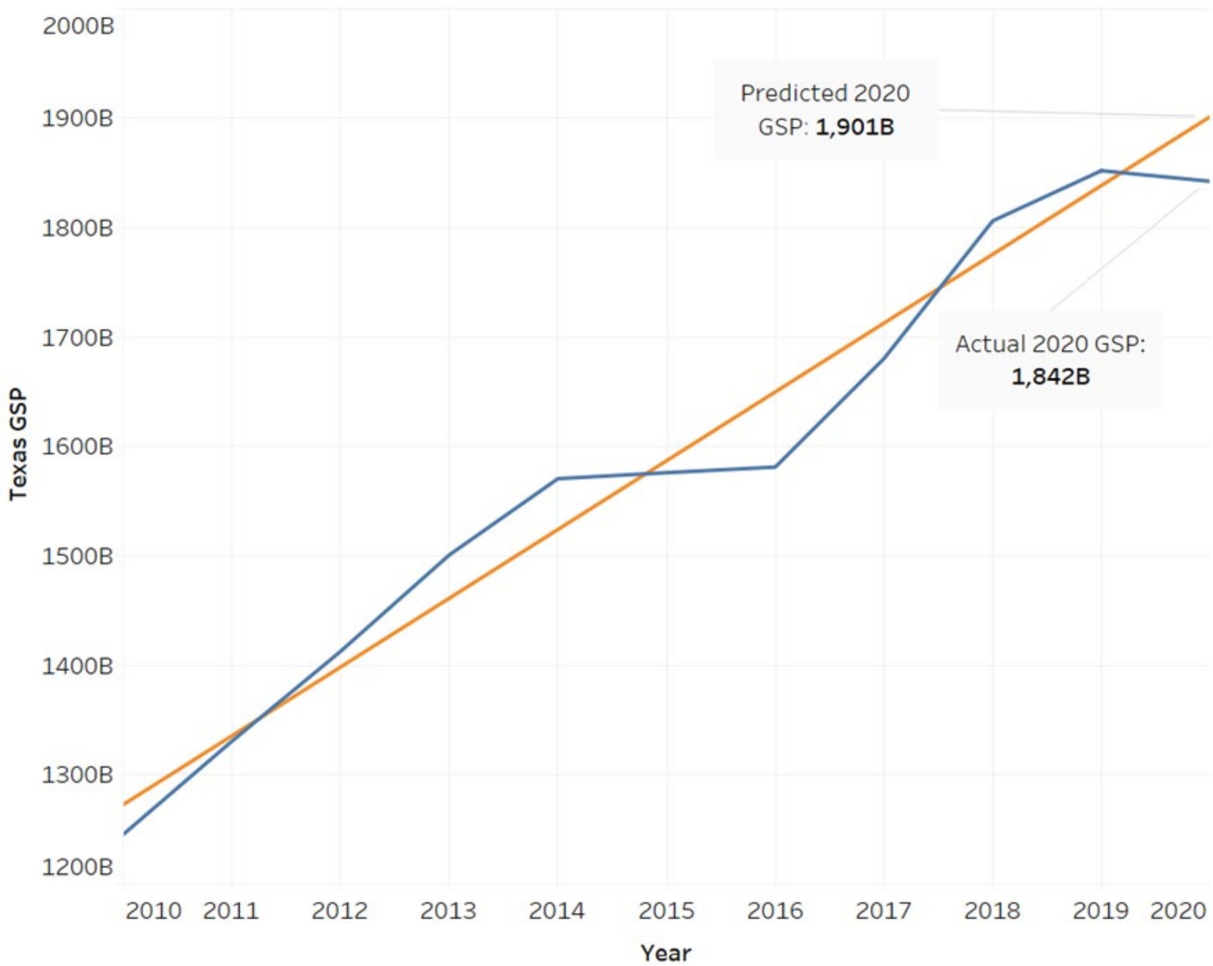
Figure 1: Time Series of Predicted and Actual State Employment Levels for Texas, 2010-2020



Source: TEConomy Partners analysis of Emsi 2021.1 Data

An additional measure of the state's economic activity is the level of Gross State Product (GSP), the dollar value of all goods and services produced by industries within the state minus the costs of required inputs. Similar to employment, Figure 2 shows the linear time trend of predicted GSP from Emsi based on 2010-2019 patterns versus the actual level of 2020 GSP observed in the state. **The difference between predicted and actual GSP levels for Texas is $59 billion lower than expected in 2020 given trends from 2010 to 2019**. While there is higher variability in the observed time trend for the state from 2010-2019 (in part due to fluctuations in energy markets which drive large shares of the state's industry base), the decrease in overall economic output attributable to COVID-19 disruptions is clearly significant and represents the first decline in state economic output since the post-2008 recession expansion period.

Figure 2: Time Series of Predicted and Actual Gross State Product (GSP) Levels for Texas, 2010-2020



Source: TEConomy Partners analysis of Emsi 2021.1 Data

A final perspective on economic consequences to the state stems from examining the direct health impacts of COVID-19 on the state's labor supply. Using a methodology similar to the modeled baselines detailed above for economic outcomes, *The Economist* has developed a data set that tracks excess deaths from 2020 to present as a part of its analysis of the ongoing impacts of the COVID-19 pandemic.[7] This data set sources information from the Centers for Disease Control on all-cause mortality, which in turn is used to develop estimates of excess mortality based on the difference between expected and actual reported deaths by week across the course of 2020. As with economic consequences, the levels of excess mortality represent a way to characterize the pandemic's impact on human health relative to baseline historical trends and allow attribution of economic damages in dollars associated with the direct mortality consequences of COVID-19.

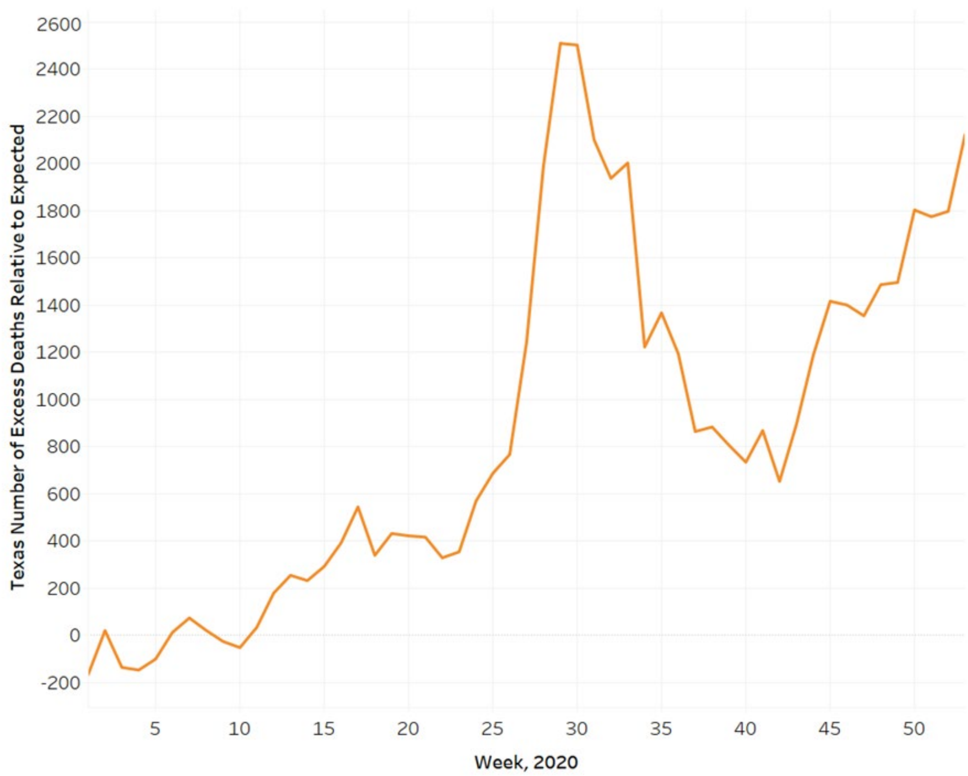
Taking all estimated excess deaths in Texas, starting from the first week that excess deaths exceeded 100 in the state (the 12th week of 2020) through the end of 2020, yields a total of 45,797 excess deaths beyond expected mortality levels for the state

[7] "Tracking covid-19 excess deaths across countries," *The Economist*. Analysis published 2/23/21, leveraging mortality data from CDC. Data and analysis publicly accessible at: https://github.com/TheEconomist/covid-19-excess-deaths-tracker

given historical baseline trends. Assigning an economic value to human life is an ongoing subject of research and debate, but many federal agencies assign a "value of statistical life" (VSL) of between $1 and $10 million per statistical life for use in cost-benefit assessment, with many current estimates closer to the $10 million upper bound.[8] These valuations of human life would produce estimates of economic loss in the tens to hundreds of billions of dollars for the state, but it is also possible to examine the direct economic context of annual loss in productivity within the state's economy in 2020 due to the loss of labor supply to mortality.

For 2020, Texas had an average annual economic output per worker of approximately $129,970 per employee based on over $1.8 trillion in total economic output and a workforce of almost 14.2 million employees. Based on total mortality figures by age for 2020, the Texas population most closely aligned with working age adults (ages 25-64) represented approximately 27.1% of all deaths during year. Applying this same proportion to the total number of 45,797 excess deaths yields approximately 12,391 excess deaths assumed to be aligned with the working age adult population in the state. **The loss of these 12,391 working age adults can then be estimated as a potential loss in economic output within the state's economy of over $1.6 billion that is not able to be easily replaced in the short term.** Note that this estimate does not include the far larger morbidity and other volunteer absenteeism effects on labor force productivity and is thus, by definition, a conservative lower bound measure for the economic impact to the state. Moreover, reduction of labor supply due to mortality represents losses to state's productivity that must be replaced over time, meaning the follow-on effects may linger for a number of years until the state can replenish the losses to working age population.

Figure 3: Time Series of Counts of Excess Deaths Relative to Expected by Week in Texas, 2020



Source: TEConomy Partners analysis of The Economist Excess Deaths Tracker Data (data originally sourced from CDC provisional excess death counts)

[8] Office of Management and Budget. 2014. "2014 Draft Report to Congress on the Benefits and Costs of Federal Regulations and Unfunded Mandates on State, Local, and Tribal Entities."

Across several potential perspectives of calculating estimates of the economic consequences of the COVID-19 pandemic for Texas, a consistent narrative emerges of total economic impacts ranging from the tens of billions of dollars in 2020 to potentially much higher impacts as the longer-term effects of the pandemic unfold. **Based on the various estimates outlined in this high level analysis, TEConomy estimates that the level of short-term impacts within Texas caused by the economic shock of the pandemic conditions in 2020 likely range from $30 billion to $60 billion dollars**. Further study is required to refine these estimates, as discussed in the next section.

III. Framework for In-Depth Quantitative Assessment of Pandemic Event Impacts

While the high-level estimates of the economic impacts to the state provide a baseline for discussing costs and benefits of increased pandemic preparedness, a more detailed analysis of the various effects on economic conditions associated with infectious disease events can be used to validate various existing estimates and provide a baseline for discussion of public policy actions. Understanding the full extent of economic losses associated with low probability-high consequence events such as pandemic outbreaks is critical to assessing risk as well as the corresponding return on investment of public policy initiatives intended to avoid negative costs to the state. Public and private investments can then address components of the risk of future infectious disease outbreaks with respect to costs avoided by either investing in mitigation of the direct economic consequences of the event or mitigating the probability that an outbreak occurs at significant scale, or both.

Table 1 outlines a potential economic impact framework for assessing the costs of pandemic events across five key categories of acute effects stemming from an infectious disease outbreak:

- **Direct health consequences**, which address the loss of life and lowered quality of life of those residents infected by a disease.
- **Public health response costs**, which encompass the excess demand that infectious disease outbreak events place on public healthcare systems and infrastructure beyond normal functions.
- **Business disruption impacts**, which outline consequences to regular business operations as a result of the spread of infectious disease.
- **Public behavior impacts**, which capture shifts in public attitudes and economic consumption patterns in response to the ongoing outbreak of an infectious disease.
- **Government spending impacts**, which detail the state and local government response to increased demand for public resources to help mitigate the direct and indirect effects of the disease outbreak.

Table 1: Economic Impact Framework for Assessing Infectious Disease Outbreak Events

Type of Pandemic Event Impacts		Economic Impacts Associated with Short Term Shock	Potential for Offsetting Positive Short Term Economic Impacts
Direct Health Consequences	Excess Mortality Due to Effects of Infection and Disease	Reduced labor supply	
	Excess Morbidity Due to Effects of Infection and Disease	Reduced labor productivity	
Public Health Response	Testing and Disease Surveillance	Costs of disease testing and surveillance efforts	Increased economic output from businesses providing testing and surveillance services
	Excess Demand on Healthcare Systems	Increased cost of operations (e.g. PPE purchases), staffing, treatment	Increased public funding support for healthcare resources
	Crowding Out of Normal Healthcare Operations	Lost revenues from preventative and elective treatments; Mortality/morbidity impacts of delayed treatment in patient populations	Increased public funding support for healthcare resources

Business Disruption	Interruption of Normal Business Operations due to Contagion Spread Reduction Measures, Prophylactic/Caretaking Absenteeism, and Other Disease Mitigation Policies	Reduction in economic output from affected businesses (and resulting downstream supply chain/price effects)	Potential for increased efficiencies/economic output due to shift to virtual/remote business operations
	Additional Cleaning & Remediation Expenses to Maintain Business Operations	Costs of cleaning, disinfection, sanitation, and other supplies	Reduction in costs to maintain physical site locations due to remote employees
	Excess Business Closure Rates	Lost economic output from affected businesses	New business formation in areas providing goods and services aligned with pandemic environment
Public Behavior	Reduced Spending in Key Business Sectors Due to Pandemic Conditions, e.g. Travel, Tourism	Reduction in economic output from affected industry sectors	Shifts in spending patterns to other goods and services, e.g. other entertainment products, home upgrades
	Public Avoidance of Businesses and Activities with High Risk of Contagion Exposure, e.g. Event Venues, Retail Stores	Reduction in economic output from affected businesses	Shifts in spending patterns to online and virtual industries, e.g. online shopping and delivery, digital content
Government Spending	Excess Demand for Social Welfare Programs (e.g. state unemployment benefits, welfare, Medicaid)	Increased government expenditures	Potential supplemental support from Federal government transfers

Source: TEConomy Partners.

Using this framework, future modeling of the various acute consequences from a disease outbreak event will yield economic impacts across various Texas industry sectors which can be passed through detailed quantitative models of the state's economy to understand direct impacts on the various affected industries, indirect impacts on the supply chain of those industries, resulting changes in household spending patterns, and implications on taxes and other federal, state, and local government revenues and expenditures. Such analysis is recommended to provide refined impact estimates likely to be associated with investment in a pandemic preparedness and infectious diseases innovation initiative.

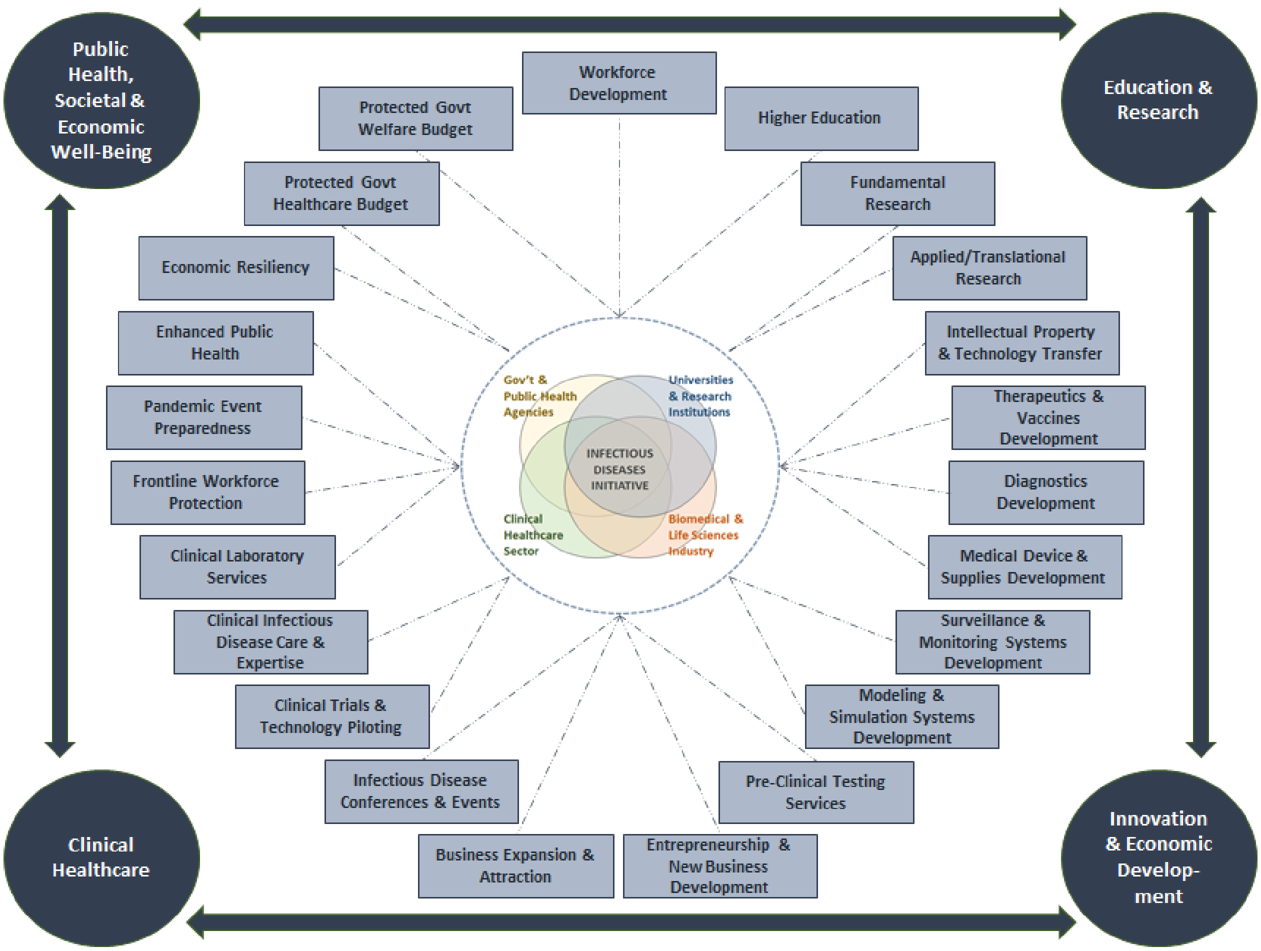
IV. Functional and Potential Positive Economic Impacts Associated with the Envisioned Pandemic Preparedness and Infectious Diseases Innovation Initiative

In addition to avoiding or mitigating the cost impacts of potential pandemic events, investment in public initiatives designed to boost pandemic preparedness also generate a number of positive functional impacts. Major life science and health initiatives, such as the one described herein, present multi-faceted pathways to the generation of wide-ranging functional impact benefits across both economic and social dimensions. TEConomy has worked on many advanced economic and functional impact evaluation projects in science and technology sectors within the US economy (see sidebar), and the outcomes of past initiatives suggest the following functional impacts are a likely outcome of efforts involved in the scope of the envisioned initiative (Figure 4).

Some Examples of TEConomy Team Impact Reports in Health and Life Sciences

- *The Human Genome Project*
- *Genetic/genomic clinical laboratory testing*
- *Medical device industry*
- *Pharmaceutical industry*
- *Biotechnology industry*
- *Patents and NIH funded innovations*
- *Academic medical centers*
- *Research universities*
- *Hospitals and health systems*
- *Specialty research institutes.*

Figure 4: Functional Impact Domains Anticipated for a Pandemic Preparedness and Infectious Diseases Innovation Initiative



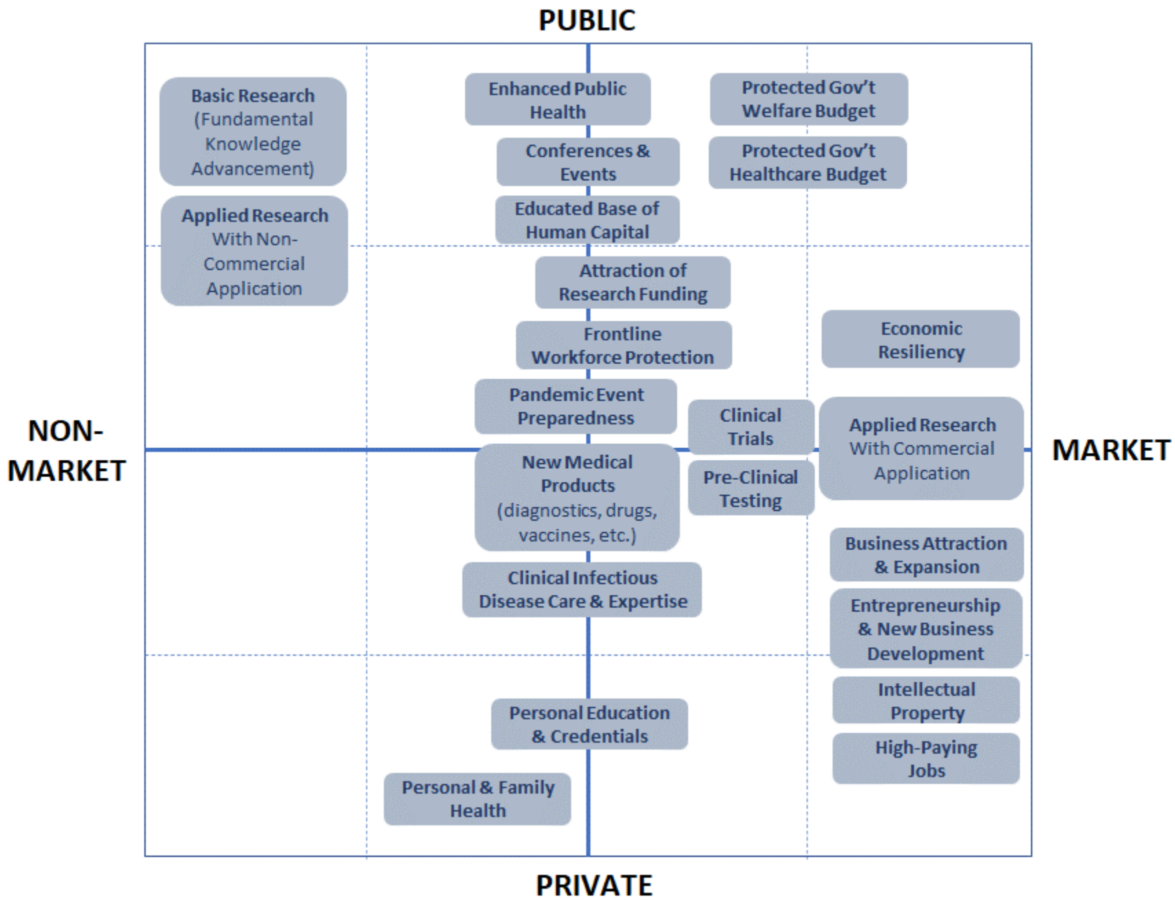
Source: TEConomy Partners. Based on, and adapted from, original work in: Simon Tripp, Ryan Helwig, and Dylan Yetter. (2017) "*The Importance of Research Universities.*" Produced for BioCrossroads.

At the heart of this representation are four key stakeholder groups that would comprise the core of the envisioned initiative: 1) universities and research institutions; 2) biomedical/life science industry; 3) the clinical healthcare sector, and 4) government and associated public health agencies. Twenty-three individual functional impacts associated with the anticipated operation of the initiative radiate from the core, ultimately supporting four primary impact pillars:

- **Education and Research.** Here five principal categories of functional impact are anticipated, comprising workforce development (meeting the initial and ongoing education and skills training of the required workforce across the ecosystem), and specific higher education programs at the undergraduate, graduate, and professional education levels. Growth in both fundamental and applied research, and associated impacts is anticipated together with resulting intellectual property generation and technology transfer. These positive impacts also have spillover effects in the next domain.
- **Innovation and Economic Development.** Innovation and economic development are anticipated to result through the development of a range of potential product and technology platforms, including therapeutics and vaccines development, diagnostics development, the development and production of medical devices and medical supplies, development of disease surveillance systems, and modeling and simulation systems. Each of these technology spaces would be anticipated to have a line-of-sight to large scale global markets. The development of these platform technologies will be associated with multiple economic development benefits in terms of building demand for product development and testing services, and the development and growth of new (entrepreneurial businesses), growth of existing infectious disease-related life science companies in Texas, and attraction of new business operations to the state. The development of the envisioned initiative and its associated ecosystem also has the potential to attract conferences and events to Texas (generating business tourism impacts).
- **Clinical Healthcare.** In healthcare, positive impacts are likely to be diverse. Texas-based health systems and medical practices may derive revenue through leadership and participation in clinical trials (which brings the added benefit of giving Texans early access to novel emerging therapeutics), while the robust translation of research into advanced clinical practice will enhance clinical infectious disease diagnostics and clinical treatment. The anticipated growth, post-COVID, in telemedicine (both domestically and internationally) will also allow Texas-based clinicians to leverage their infectious disease and pandemic response expertise in providing remote clinical consultations, further increasing clinical revenues for Texas. The growth of an advanced infectious disease clinical diagnostics laboratory services base would also provide a pathway to enhanced revenues.
- **Public Health, Societal, and Economic Well-being.** As envisioned, the initiative would also, by design, generate robust positive impacts for Texas through optimizing pandemic event preparedness and significantly enhancing and protecting overall public health. This, of course, generates significant benefits in terms of the health of individual Texans (and by extension the productivity of the workforce), but also has strong economic impacts associated with it in terms of economic resiliency (protection of Texas from infectious disease economic shock events) and associated government revenue and expenditure challenges (helping to protect Texas government budgets from excess demand for unemployment benefits, welfare supports, and government paid health expenditures).

Figure 5 further illustrates how the wide-range of functional impact benefits anticipated as a result of the initiative could generate diverse benefits for society and government (the public dimension) and for individual Texans (the private dimension). Positive effects are anticipated across both market (monetary) dimensions (boosting the economy and individual incomes), as well as non-market (nonmonetary) dimensions in terms of improving overall knowledge, well-being, and statewide quality of life.

Figure 5: Functional Impacts of the Initiative Generate Impacts on Public and Private, and Market and Non-Market Dimensions. (Impact placement is subjective and the size of blocks is not relative to impact level).



Source: TEConomy Partners. Based on, and adapted from, original work in: Simon Tripp, Ryan Helwig, and Dylan Yetter. (2017) "*The Importance of Research Universities.*" Produced for BioCrossroads.

Assigning distinct economic benefits to each component of the functional impacts described above will require detailed analysis to characterize each type of impact's potential short- and long-term effects on the Texas economy. The potential positive effects on the state's public health and research industries as well as the increases to economic output that will be realized through an enhanced innovation ecosystem and attraction of new flows of revenue into the state economy need to be estimated and are likely to result in lasting gains in Texas' competitive position in the biomedical sector. In the absence of a detailed study outlining the gains from each dimension of functional impacts, several heuristics on the benefits from investment in biomedical research can provide a sense for the order of magnitude for economic effects within Texas that may be derived from the initiative.

The National Institutes of Health (NIH) cite several studies in documenting the widely acknowledged economic impact of their public investment in biomedical research and innovation, including:

- An FY 2016 study[9] that estimates that for every $1M in NIH awards to Texas, 15.68 state jobs were created. Applying this measure to a potential $3B investment (similar in scale to

[9] NIH's Role In Sustaining The U.S. Economy: 2018 Update Authored by Dr. Everett Ehrlich" Dr. Everett Ehrlich, United for Medical Research, 2018.

CPRIT) yields **an extrapolated increase of over 47,000 additional jobs** (or the equivalent increase in the level of in-state economic activity) created over the course of the initiative's funding.

- Another study of the impact of public funding on private pharmaceutical R&D investment finds that "*a $1.00 increase in public basic research stimulates an additional $8.38 of industry R&D investment after 8 years*" and that "*a $1.00 increase in public clinical research stimulates an additional $2.35 of industry R&D investment after 3 years.*"[10] Using this estimate, an initial investment of $3 billion in the envisioned initiative (similar to CPRIT) **could potentially spur follow-on private R&D investment in the state ranging from $7 billion to $25 billion.**

These estimates of positive gain to the state's economic activity likely do not capture the full breadth of functional impacts that would be realized (they do not include, for example, the cost savings from improved health to state residents), and also do not account for the longer-term economic gains to the state from attraction of new businesses and talent as a result of improvements to the state's competitive position as a result of focused public investment in a pandemic preparedness and infectious diseases innovation initiative's activities.

Texas benefits from having a specific example to look to in terms of impacts generated through the similar initiative, CPRIT. Analysis by the Perryman Group estimates that high levels of effects are being generated via CPRIT. The analysis for 2017 concludes that "the current total annual impact of all CPRIT operations, prevention/screening and research programs Including initial outlays and multiplier effects) includes $705.5 million in output (real gross product) in 2017 as well as 10,139 jobs. **When all secondary benefits are considered, these values rise to $10.9 billion in output and 98,430 jobs**."[11] The Perryman Group further concludes that "annual tax receipts associated with CPRIT grants and programs (including downstream effects) total $513.4 million in 2017; local public entities receive $239.8 million."[12] Over the 10 year funding commitment to CPRIT it is noted that government tax receipts will be well in excess of the total commitment of State resources.

Based on initial examination of R&D funding multipliers in life sciences (evident in the NIH studies) and the robust impact findings from the CPRIT impact study, it is reasonable to anticipate a robust return to state investment in an infectious diseases initiative in terms of expansion of the state economy, together with tens of thousands of jobs supported. Furthermore, it would be anticipated that just in terms of increased tax revenues the initiative would be likely to provide back to the state treasury more than the state puts in. It is likely to prove a win for the state, a win for the economy, and a win for Texas families.

[10] Andrew A. Toole. (2007) "Does Public Scientific Research Complement Private Investment in Research and Development in the Pharmaceutical Industry?" Journal of Law and Economics, vol. 50

[11] The Perryman Group. (2017). "*An Economic Assessment of the Cost of Cancer in Texas and the Benefits of the Cancer Prevention and Research Institute of Texas (CPRIT) and its Programs: 2017 Update.*"

[12] Ibid.

V. Framework for Strategic Design of a High Impact Pandemic preparedness and Infectious Diseases Innovation Initiative

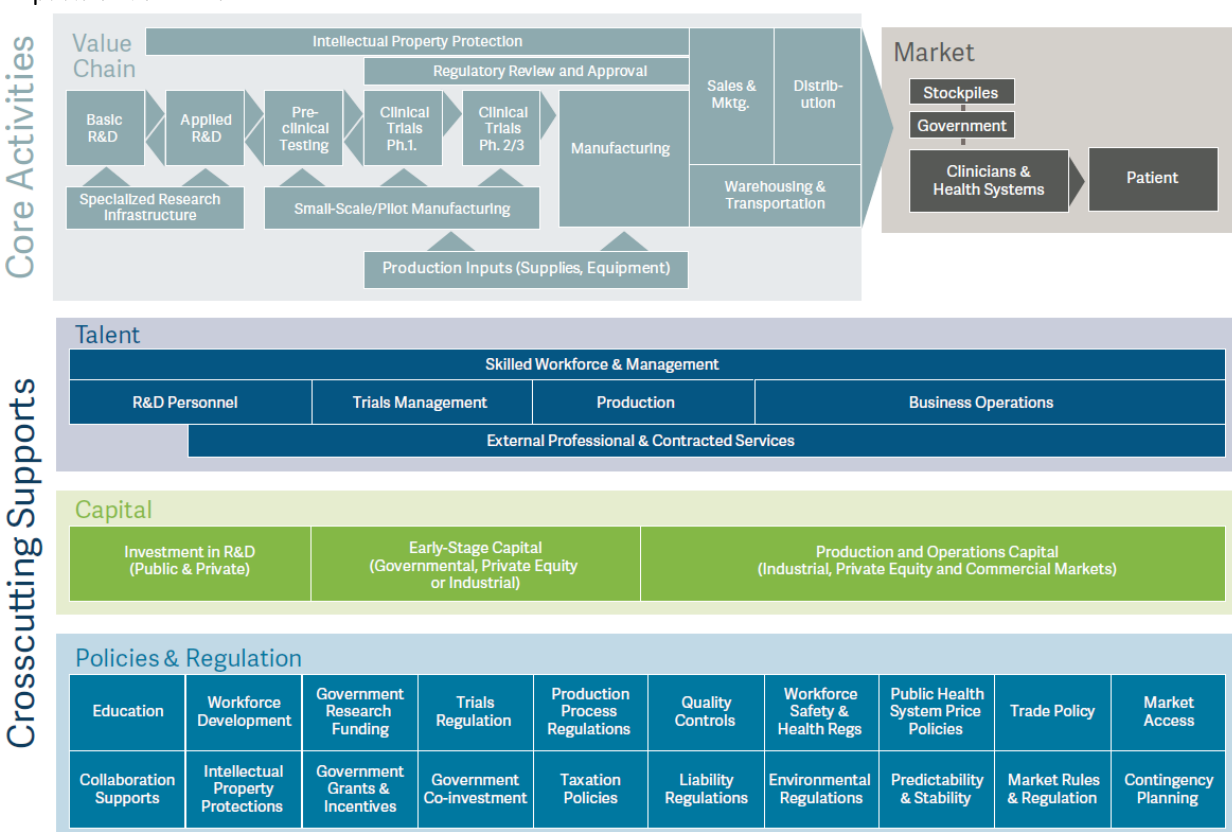
In terms of both costs avoided as well as business and innovation impacts, the envisioned initiative is anticipated to provide significant and wide-ranging economic and functional impact benefits. It should be noted, however, that these impacts will depend on the readiness and completeness of the overall science and technology ecosystem that is required to support life science sector advancement.

As noted in TEConomy's recent report for Pfizer:

> *Life sciences advancements result from the presence and operations of a complex ecosystem, comprising intellectual assets, specialized infrastructure, a skilled workforce, complex production technologies, and sophisticated supply chains. These ecosystems comprise private industrial, academic, nonprofit, and governmental actors and are supported by a range of public- and private-sector capital resources. Those ecosystems that innovate and produce products for human clinical application operate, by necessity, under strict regulations regarding efficacy and safety, and public policy plays a significant role in governing the operation of the ecosystems and their markets. Understanding the structure of these ecosystems, or their operational "framework," is a foundational requirement.*

The development and ongoing viability of innovation-based advanced industries very much depends on having a complete and well-tuned innovation and technology-based economic development (TBED) ecosystem. For an infectious diseases and pandemic response program, the holistic ecosystem is shown on Figure 6.

Figure 6: Ecosystem elements that will be engaged in, or influence, an infectious diseases innovation initiative and its outputs. Based on TEConomy framework developed for Pfizer, Inc. on global life science ecosystem impacts of COVID-19.



The potential success of the initiative will be significantly enhanced by early evaluation of the completeness of this ecosystem and identification of key assets and any critical gaps or areas of weakness that need to be addressed. TBED ecosystem evaluation is a specialized skill, using a set of proven quantitative and qualitative techniques:

- **Research and innovation strengths and core competencies** can be assessed through machine-learning based analysis of grants, publications, and patents, and through reference to scientometrics data.
- **Emerging innovation and commercial development** can be assessed through SBIR/STTR award data, risk capital funding data (e.g. via PitchBook data analytics), and commercial databases of company formation and growth.
- **Longitudinal growth and sectors of strength** can be measured through reference to relevant industry code statistics and macro-economic data.
- **Education and talent capacity** and core competencies can be evaluated through higher education output statistics, occupational and skills data, and recent job posting data analytics.
- **Policies and regulations**, and other associated ecosystem elements, may be evaluated through mixed-method quantitative and qualitative approaches.

Planning for a pandemic preparedness and infectious diseases innovation initiative will benefit from performance of a detailed prospective economic and functional impact study to more precisely profile the anticipated returns that may be expected for the Texas economy and society through funding the initiative. **Moreover, the initiative will need to have a strategic action plan developed that will identify key institutions and assets, profile R&D core competencies to build upon and their line-of-sight to significant market opportunities, evaluate the completeness of the current ecosystem, and lay-out a series of strategies and specific associated actions designed to fully realize the power and promise of the concept for Texas.**

VI. Conclusion

As shown in the analysis of the state's economic trajectory in 2020 relative to previous years, the COVID-19 pandemic hit Texas hard. The impact of infections on Texans has been felt not just in terms of harm to health and loss of life, but also economically in terms of lost jobs, lost businesses, economic hardship, and associated fiscal pressures. As this discussion paper shows, the impacts of COVID-19 on Texas have been severe and are ongoing. Based on high level heuristic analysis herein, TEConomy estimates that:

- The economic shock of the pandemic in 2020 alone likely ranged between $30 billion to $60 billion in reduced gross state product, which represents a conservative minimum threshold for economic impacts which will continue to be felt by the state's population for years to come.
- The state had almost 470,000 fewer jobs than expected in 2020, causing in excess of $26 billion in lost per capita income, representing lost wealth for the state's residents that has altered the trajectory of the state's economic growth.

Continuing impacts of the pandemic have already been observed into 2021, with the risk of additional outbreak surges persisting even as mass vaccine rollouts occur. The threat to Texas, however, will not end after COVID because exposure of humans to emerging pathogens and reservoirs of infectious disease will continue to be an ongoing global challenge in our highly connected world. With the presence of rapid global transportation and shipping networks, it is extremely challenging to contain all outbreaks at their source – a fact evidenced by recent human and livestock infectious disease events (COVID-19, SARS, Zika, Avian Influenza, Porcine Respiratory Disease Complex, etc.). Zoonotic spread, climate change pressures, the close contact of dense human populations, and even deliberately bioengineered pathogens (released for the purpose of terrorism), each threaten our health, safety, and economic futures by increasing the risk of further pandemic outbreak events.

The concept for a pandemic preparedness and infectious diseases innovation initiative, outlined herein, recognizes this growing threat but also views it as an opportunity for a proactive initiative by Texas in putting forth an initiative designed to propel the state to the forefront of advanced infectious disease R&D, product development, and pandemic response systems. It promises to address a large potential market, thereby generating robust potential economic impacts for Texas, while having the parallel benefit of enhancing public health and the economic resiliency of the state in the face of emerging pandemics. The net financial benefits from investment in the envisioned initiative are anticipated to include a significant growth in gross state product, tens of thousands of new jobs, and positive revenue returns for the State.

This discussion paper highlights and characterizes many of the economic and functional impact benefits that may be anticipated through an initiative as it is preliminarily envisioned in Texas Senate Bill 264(87R), the Texas Research Consortium to Cure Infectious Diseases, or TRANSCEND for short. Further in-depth study is recommended to provide robust metrics for anticipated impacts, putting refined bounds around anticipated returns for Texas. It is further recommended that a strategic feasibility/action plan be developed based on proven quantitative and quantitative analytic methods for the design of advanced life science and associated advanced economic development initiatives. This should include an in-depth assessment of existing Texas core competencies in key fields, assessment of the current industry and institutional base in infectious diseases and associated products, and a detailed assessment of the completeness of the life science ecosystem required for supporting optimized sectoral development.

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