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Should Communities Get into the Power Marketing Business?

Kevin Novan

Traditionally, Californians have been unable to choose an electricity provider. Instead, each region has been served by a single, regulated utility. This model is changing. Local governments are now beginning to compete with regulated utilities to supply electricity. This article reviews the potential benefits and risks posed by this new form of retail choice.

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by Amanda R. Lindsay, Michael R. Springborn, and Rebecca S. Epanchin-Niell

California is divided into a patchwork of electric utility service areas. Within each service area, a single utility has traditionally been responsible for supplying electricity. This includes producing and purchasing electricity, maintaining the regional distribution grid, and metering and billing. While many of the local monopolies are Publically Owned Utilities, the majority of California's electricity—approximately 75%—is procured and distributed by for-profit Investor Owned Utilities (IOUs) Pacific Gas & Electric (PG&E), Southern California Edison (SCE), and San Diego Gas & Electric (SDG&E).

Until recently, consumers were obligated to purchase electricity from the utility serving their region. Beginning in 2010, however, customers in Marin County were presented with an option. They could continue purchasing electricity from PG&E or they could switch and buy from an alternative source—their local government.

The program implemented in Marin is a Community Choice Aggregation (CCA) program. CCA programs enable city and county governments to purchase electricity on behalf of the households and businesses in their jurisdiction, effectively competing with IOUs to supply electricity.

Since the adoption of the Marin CCA, three more CCA programs have been implemented in California: in Sonoma, Lancaster, and San Francisco. Efforts are also underway to introduce CCA programs in over 20 different jurisdictions throughout the state. Figure 1 (page 2) displays the development of CCA programs across the state. If all of these programs are adopted, over half of the state's population will soon have the option to purchase electricity from an IOU or their local government.

The recent surge in support for California CCA programs has been driven by three main motives. Consumers want some combination of (1) cheaper electricity, (2) cleaner electricity, and (3) more locally produced electricity. This article explores the potential for CCAs to deliver on each of these three goals.

IOU Retail Rates

To understand how CCA programs will affect retail electricity rates, it is important to first review how electricity prices are currently set. IOUs charge rates that are determined by the California Public Utility Commission (CPUC). The CPUC sets the rates to ensure that the IOUs recover their costs and earn a modest return on their investments. In particular, utilities earn a positive rate of return on expenditures made on utility-owned assets (e.g., power plants, distribution equipment). In contrast, the costs of generating and purchasing electricity are directly passed on to consumers with zero mark-up.

During 2015, PG&E's required revenue was $13.7 billion, SCE's was $12.2 billion, and SDG&E's was $3.6 billion. Table 1 provides a breakdown of the major components of the IOUs' revenue requirements. The cost of generating electricity—which

Figure 1. Adoption of Community Choice Programs

Source: Clean Power Exchange (CPX): http://clean-powerexchange.org/california-community-choice/

includes both utility-produced electricity as well as purchased electricity—accounted for 48% of the IOUs' required revenue. Transmission and distribution costs accounted for 44% of the required revenue. The remaining 8% covered a range of miscellaneous costs (e.g., energy efficiency programs, nuclear decommissioning).

To collect the required revenue, IOU customers pay two broad categories of charges: generation and non-generation charges. The generation charges exactly offset the utility's cost of generating and purchasing electricity. Under the IOUs' standard, residential rate structures, households pay a constant per kWh generation charge.

The non-generation charges cover the delivery expenses (transmission and distribution) and miscellaneous costs. The CPUC requires that the non-generation rates increase with consumption—a practice referred to as tiered pricing. Households are assigned a baseline level of consumption that varies by climate zone, season, and rate class. Each kWh consumed up to the baseline level is charged at a low per kWh non-generation rate. Electricity consumed beyond the baseline level is charged at progressively higher rates.

CCA Electricity Prices

So what changes if a local government establishes a CCA program? To begin with, the CCA becomes the default electricity provider. Individual households and businesses within their jurisdiction purchase electricity from the CCA unless they opt-out and remain with their IOU.

Even if a customer switches to a CCA program, the IOU continues to deliver their electricity through its transmission and distribution network. The IOU is also still responsible for metering and billing. The only difference is that the CCA, as opposed to the IOU, will be responsible for purchasing or generating the electricity demanded by the CCA customers.

Households that switch to their local CCA program will still receive a single, consolidated bill delivered by their IOU. The IOU will still collect the same tiered non-generation charges set by the CPUC.

There will, however, be two important changes to CCA customers' bills. First, the generation charge will be determined by the local government, not the CPUC. Second, CCA customers will see a new charge: the Power Charge Indifference Adjustment (PCIA). The PCIA is intended to cover the additional costs the IOUs incurred procuring electricity prior to CCA customers switching providers. The PCIA is intended to ensure that departing CCA customers do not impose a burden on the remaining IOU customers.

Table 2 compares the average monthly electricity bills a typical household would face with PG&E versus the Marin CCA program. The bills are calculated assuming the household consumes 463 kWh per month. If the household remains with PG&E, they would pay 9.7 cents per kWh in generation charges and an average of 10,7 cents per kWh in non-generation charges. Combined, this would result in an average monthly bill of $94.27.

If the household joins the Marin CCA program, they will have the option to enroll in the standard plan ("Light Green") or pay a premium and purchase a greater share of renewable electricity. Under the standard Light Green plan, the household would pay 8.2 cents per kWh in generation charges, which is 15% less than the generation rate charged by PG&E. The household would continue to pay the same non-generation charges to PG&E. They would also now pay an additional 2.4 cents per kWh to PG&E, which includes the PCIA. Combined, the household joining the CCA would see their average monthly bill increase slightly to $98.44.

This rate comparison raises a couple of important questions. First, how is the CCA able to charge a lower generation rate? For one, the cost of generating electricity and, in particular, renewable electricity, has fallen in recent years. As a result, electricity contracts signed more recently have been for lower costs. This in fact highlights the rationale behind the PCIA. The IOU has already contracted for energy to serve customers at a higher average cost. If these customers depart for a CCA, then the IOU will have to sell these contracts off at a potential loss.

More generally, CCA advocates argue that CCA programs will offer lower generation rates because they do not have distorted incentives like the IOUs. Specifically, CCA proponents note that, because the profits earned by regulated IOUs are largely independent of the costs incurred producing and purchasing electricity, they will have weak incentives to minimize the cost of providing electricity.

In contrast, CCA proponents claim that the objective of the local governments overseeing CCA programs is to maximize the benefits of their constituents—in particular, by keeping prices as low as possible. While there is certainly some truth to these arguments, it remains to be seen whether local governments will make prudent decisions when it comes to contracting for electricity.

The rate comparison presented in Table 2 also highlights the importance of the PCIA. Without the PCIA, the Marin household consuming 463 kWh a month would save approximately $7/month by joining the CCA program. There is a very active debate surrounding how these PCIA charges should be set and how they should adjust over time. How this debate plays out will play an important role in determining whether CCA programs will be able to compete with the IOUs on the basis of electricity prices alone.

Table 1. 2015 IOU Revenue Requirements in $1,000's

	PG&E	SCE	SDG&E
Purchased Power	$4,514,153	$4,412,244	$1,008,008
Utility-Owned Generation	$2,185,558	$1,513,067	$399,351
Distribution	$4,399,854	$4,350,777	$1,138,103
Transmission	$1,610,878	$910,155	$423,318
Demand Side Management/ Public Programs	$646,788	$545,126	$162,987
Bonds and Fees	$673,170	$485,956	$131,756
Total 2015 Revenue Requirement	$13,730,664	$12,198,048	$3,578,637

Source: California Public Utility Commission (CPUC) utility cost report, www.cpuc.ca.gov/uploadedFiles/CPUC_Website/Content/Utilities_and_Industries/Energy/Reports_and_White_Papers/AB67_Leg_Report_3-28.pdf.

Cleaner Energy

While customers clearly prefer cheaper electricity, perhaps the strongest factor driving the spread of CCA programs is the desire for cleaner electricity. In fact, of the four operational CCA programs in California, three of them have the word "clean" directly in the title: Marin Clean Energy, Sonoma Clean Power, and CleanPowerSF.

California's Renewable Portfolio Standard has mandated that the IOUs procure 33% of their electricity from renewable energy sources by 2020. The CCA programs are looking to accelerate renewable adoption. For example, the Marin Clean Energy CCA program offers customers three different plans (displayed in Table 2). Customers choosing the standard "Light Green" plan will have 52% of their total electricity consumption purchased from non-hydro, renewable energy sources. Alternatively, customers could elect to pay a premium and join the "Deep Green" plan, which ensures that 100% of their consumption is purchased from renewable sources.

There are a couple of ways CCA programs can purchase renewable electricity. One option is to directly sign contracts to purchase output from renewable producers. Alternatively, the CCA could buy unbundled Renewable Energy Certificates (RECs). Each REC guarantees that a MWh of renewable electricity has been produced. By purchasing a REC, the CCA can claim the environmental attributes of that MWh of renewable output without paying for the energy itself. Regardless, as customers continue to join CCA programs with higher renewable shares, there will be an increase in the overall share of production coming from clean, renewable sources.

Table 2. PG&E vs. MCE 2016 Rate Comparison

	PG&E	Marin Clean Energy CCA		
	Standard Rate (E-1)	Light Green	Deep Green	Local Sol
Renewable Share	30%	52%	100%	100% (local)
Generation ($/kWh)	$0.097	$0.082	$0.092	$0.142
PG&E Delivery ($/kWh)	$0.107	$0.107	$0.107	$0.107
PCIA/FF ($/kWh)	-	$0.024	$0.024	$0.024
Avg. Monthly Bill (463 kWh/month)	$94.27	$98.44	$103.07	$126.22

Source: Marin Clean Energy Rate Comparison, https://www.mcecleanenergy.org/rates/

While customers clearly prefer cheaper electricity, perhaps the strongest factor driving the spread of CCA programs is the desire for cleaner electricity.

It is important to note, however, that the IOUs also now offer customers the option to purchase more renewable electricity. For example, PG&E's Solar Choice program provides customers with the option to purchase 50%, or even 100%, solar energy. While these IOU-offered programs may simply be a response to the threat of competition from CCA programs, this nonetheless highlights that CCAs are not the only option for customers to go green.

Local Renewables?

CCAs, however, are not just emphasizing any renewable electricity. Instead, there is clear push for local renewable energy. For example, the Marin Clean Energy CCA program offers the "Local Solar" plan, which offsets customers consumption with 100% locally produced solar production. Similarly, the CleanPowerSF program offers San Francisco residents a "SuperGreen" rate plan which will "localize energy" by investing in new renewable energy facilities in the San Francisco region.

Pushing for more locally produced renewable energy is, in many ways, directly at odds with the first two motives for adopting CCA programs—providing cheaper and cleaner electricity. To understand why this is, it is important to note that generating a MWh of renewable electricity in, say, San Francisco, is effectively the same as producing a MWh of renewable electricity in, say, the Central Valley of California. Outside of periods with heavy congestion on the grid, renewable electricity produced locally will essentially be a perfect substitute for renewable electricity produced elsewhere in the regional grid.

Therefore, if CCA programs have the dual objectives of providing cheap and clean electricity, then every effort should be made to procure the cheapest renewable electricity possible. Unless the CCA program is located in a region that has cheap land and excellent renewable potential—neither of which would describe San Francisco or Marin for example—then a bias towards purchasing locally produced renewable energy will likely lead to more expensive renewable output.

It is also important to note that there is nothing inherently greener about locally produced electricity. In fact, there are reasons to believe just the opposite—locally produced electricity may be less green. For one, the regions within California with the highest renewable potential (i.e., best solar and wind resources) are not located near the population centers along the coast. Therefore, to produce local renewable electricity, a greater amount of renewable capacity will need to be installed. Given that there are real environmental costs involved in the construction of solar panels and wind turbines, it may in fact be greener to locate the renewable capacity in locations with more wind or solar potential.

Moreover, each MWh of renewable electricity is not equally green. California, as a whole, has a relatively clean mix of electricity generation—the state is heavily dependent on efficient natural gas generators. As a result, locally produced renewable electricity will likely be offsetting production from relatively clean generation—and therefore reducing low amounts of pollution. In contrast, if CCA programs were to buy unbundled RECs from renewable producers in regions with more coal-fired generators, then the renewable energy supported by the CCA customers would potentially be offsetting much more pollution.

Conclusion

CCA programs are rapidly gaining momentum in California. While these programs have the potential to provide cheaper, cleaner electricity to their customers, they are not without their risks. What will happen if CCA prices rise, or utility prices fall, and customers switch back to IOUs? Who will bear the burden as the local governments are forced to sell off their contracts at a loss? As communities throughout California move forward with CCA programs, it will be important for the local governments and the residents to consider these issues carefully.

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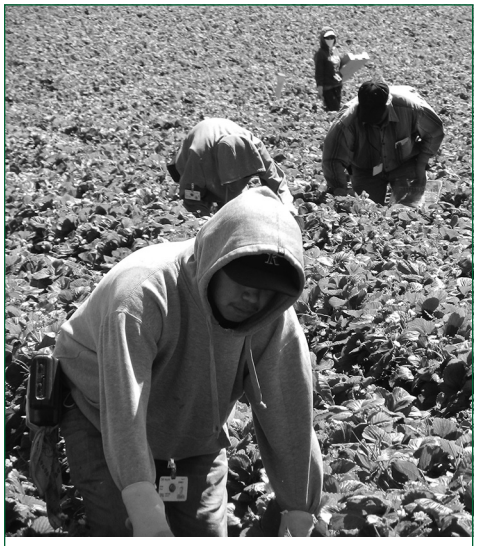
Where Did All the Migrant Farm Workers Go?

Maoyong Fan and Jeffrey M. Perloff

The share of agricultural workers who migrate within the United States has fallen by about 60% since the late 1990s. This reduction in the number of migrant farmworkers increases the risk that fruits and vegetables will not be harvested before they spoil. On average over this period, one-third of the drop in the migration rate was due to changes in the demographic makeup of the workforce, while two-thirds was due to government and institutional changes in the market. However, in recent years, demographic changes were responsible for nearly half of the overall change.



Migrant farmworkers plant and pick most of the fruits and vegetables that we eat.

Migrant farmworkers plant and pick most of the fruits and vegetables that we eat. Seasonal crop farmers, who employ workers only a few weeks of the year, rely on workers who migrate within the United States from one job to another. Because finding migrants to pick their crops before they spoil is becoming increasingly difficult, seasonal farmers are struggling.

Trend in Migration

From 1989 through 1998, more than half of all seasonal crop farmworkers migrated at least 75 miles within the United States (see Figure 1). Since then, the share of workers who migrate has dropped by more than in half, hitting 17% in 2012.

The migration rates fell in all areas of the country and for most demographic groups. Figure 2 on page 6 shows that migration rates fell for undocumented and documented workers (such as citizens, legal permanent residents, and people with other work authorization). On average over the entire period, a larger share of undocumented workers migrated than did documented workers. The migration rates fell for both groups since the late 1990s, but the rates for documented workers dipped in the early 1990s too.

Why Do Fewer Workers Migrate?

What explains this pronounced drop in migrants? The two main explanations are:

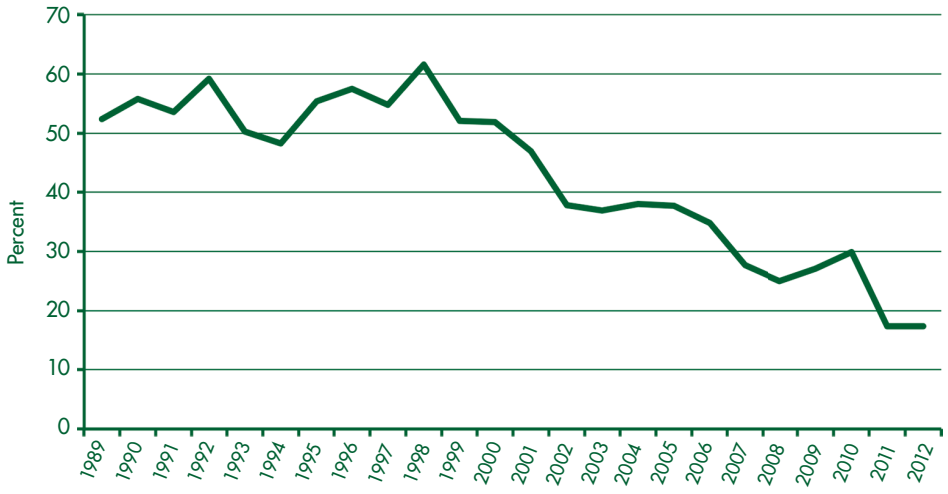
(1) Governmental and economic changes in the United States and Mexico made immigration less attractive.

(2) Demographic changes made farm workers less willing to migrate.

Governmental and economic changes reduced the number of undocumented immigrants from Mexico. After 9/11, new laws and greater enforcement increased the difficulty for undocumented workers (who are predominantly young and single) to cross the border.

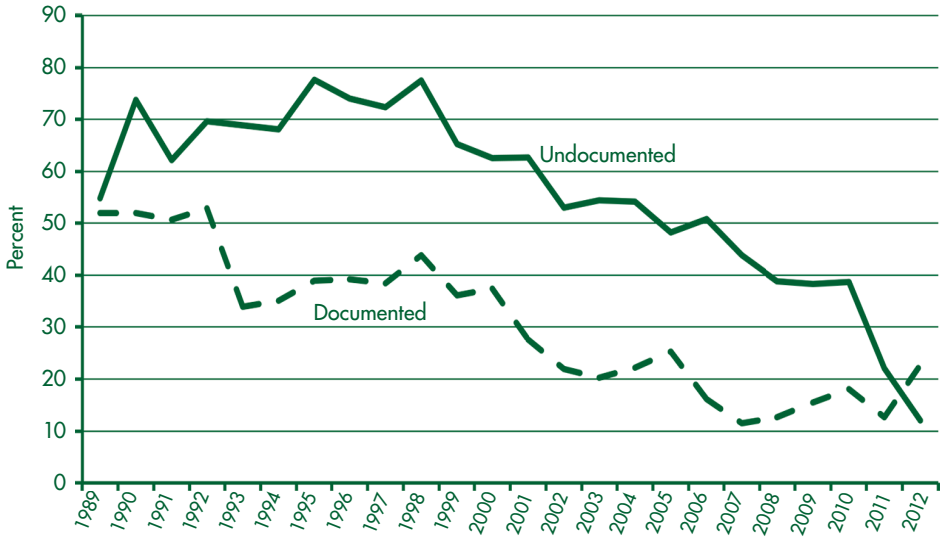
These laws include the Illegal Immigration Reform and Immigrant Responsibility Act of 1996, the Homeland Security Act of 2002, the USA Patriot Act of 2002, the Enhanced Border Security and Visa Entry Reform Act of 2002, the Intelligence Reform and

Figure 1. Percentage of Farmworkers Who Are Migrants



Source: National Agricultural Workers Survey and authors' calculations.

Figure 2. Migration Rates of Undocumented and Documented Workers



Source: National Agricultural Workers Survey and authors' calculations.

Terrorism Prevention Act of 2004, the REAL ID Act of 2005, and the Secure Fence Act of 2006. Some undocumented workers who were already in the United States became more fearful of moving for work because of new federal, state and local laws, and increased resources for local immigration enforcement to apprehend them.

In addition, Mexicans are less likely to want work in U.S. agriculture than in the past due to a falling birth rate, an improving economy, and increased social welfare programs. The 1997 anti-poverty *Programa de Educación, Salud y Alimentación* (later renamed *Oportunidades*) in Mexico increased welfare in Mexico through education, health and conditional cash transfer initiatives, which decreased the incentive for workers to cross the border. *Oportunidades* also increased agricultural production in Mexico.

On average over many years, migrants have always had different characteristics than non-migrants (see Table 1). Migrants are more likely to be undocumented, male, young, Hispanic, without a family or a home in the United States, and less likely to speak English. For example, since 1999, undocumented workers are 55% of U.S. migrant workers, but only 40% of non-migrants. Females are 15% of migrants, but 27% of non-migrants. Only one-fifth of migrants speak English, compared to two-fifths of non-migrants.

In the 2000s, in large part due to the governmental and economic changes, the composition of the hired agricultural work force has changed. Among other changes, these workers are now older, wealthier, more likely to be female, and more likely to live with their families in a U.S. home. Because of these and other demographic changes, a smaller share of workers is willing to migrate than in the past.

Table 1. Characteristics of Migrants and Non-Migrants

	Migrants	Non-Migrants
Age	32.78	35.54
Years of Education	6.38	7.66
Income, Last Year ($ thousands)	11.26	16.87
Years of Farm Experience	9.00	11.70
Female	14%	28%
Hispanic	96%	76%
Undocumented Worker	49%	34%
English Speaker	19%	40%
Married	60%	62%
Spouse in Household	25%	54%
Children in Household	22%	48%
Skilled Worker	19%	25%
Employed by a Farm Labor Contractor	25%	16%
Number of Observations	12,509	24,566

Source: National Agricultural Workers Survey and authors' calculations.

Statistical Analysis

To analyze the cause of the reduced migration rate, we conducted a statistical analysis with Susan Gabbard and Anita Alves Pena (using data from 1989 through 2009).

We found that migration rates differ substantially with worker's marital status, gender, and other characteristics. All other characteristics the same, a female is 15 percentage points less likely to migrate than a male, which is a large difference given that the sample average probability of migrating is 53% in 1998. Hispanics are 15 percentage points more likely to migrate than are non-Hispanics. Skilled workers are seven percentage points less likely to migrate than unskilled workers.

Married workers who do not live with their spouse in the United States are 19 percentage points more likely to migrate (the coefficient on "married"). However, married workers who live with their spouse in the United States are 10 percentage points less likely to migrate (the sum of the "married" and the "spouse in household" coefficients). Similarly, workers are 11 percentage points less likely to migrate

if they live with their children. Presumably, these family-oriented workers see themselves as having a higher opportunity cost of migrating. In contrast, married workers who are not living with their families are more likely to migrate—perhaps so that they can send more money home to their families in Mexico or other countries of origin.

Using those estimates, we assess the drop in the migration rate from two effects. On average over the entire period, one-third of the reduction in migration rates was due to changes in the demographic makeup of the work force. However, the share of the drop due to change in the demographic composition increased in recent years, hitting 45% in 2009. The agricultural workforce became older, more experienced in farm work, less likely to be employed by a farm labor contractor, and less likely to be Hispanic. Workers also were more likely to be married and living with immediate family members such as a spouse and children in the United States, and more likely to have a home or a car in the United States.

The remaining two-thirds of the drop in the migration rate was the result of fundamental changes in the market due to governmental, institutional, and economic changes.

Implications

Farmers have responded to the reduction of migrants in several ways. They have changed cropping patterns, worked harder to retain workers, made jobs more attractive to female workers, adopted labor-saving technologies, and increasingly turned to guest worker programs. During this time, the number of agricultural guest workers more than doubled from 20,192 in 1998, to 44,847 in 2009, and almost doubled again to 85,248 in 2012.

Because migrants play a crucial role in many labor-intensive, seasonal, agricultural crops, the dramatic decrease in migration rates significantly reduced the ability of the agricultural labor market to respond to seasonal shifts in demand during the year. If the current downward trend of migration continues and no alternative supply (such as from a revised H-2A program or earned legalization program) becomes available, farmers will probably experience greater difficulty finding workers during planting and harvesting seasons. Already farmers in a variety of crops are turning to labor-saving mechanized solutions to deal with this problem.

Our results also directly address a major concern that granting legal status to undocumented agricultural workers will reduce their willingness to migrate. We find that legal permanent residents were more likely to migrate than were undocumented workers from 1999 through 2009. Apparently, stricter border enforcement during this period made undocumented workers less willing to migrate within the United States because they feared such a migration would raise the odds of being caught.

Nonetheless, one-time legalization programs—such as the 1986 Immigration Reform and Control Act's Seasonal Agricultural Workers (SAWs) program—will not allow the United States to close its Mexican border and at the same time avoid a farm labor problem. Because agricultural work is physically demanding, it is difficult to remain in agriculture over one's working life. Moreover, as agricultural workers put down roots in the United States, living here with their families and amassing assets, they become less willing to migrate. The experience of seasonal agricultural workers who gained documentation under IRCA shows that, while they continued to migrate for years after they obtained legal status, eventually, they began to migrate less and leave the farm labor force. A seasonal worker who was 22 in 1986 would be 45 in 2009. By 2009, the farm labor force had few seasonal workers (and few farmworkers over age 45). Thus, to maintain a large and flexible agricultural worker force, a steady stream of new, young workers is required—whether it be from a porous border, temporary work permits, or a perpetual program of earned legalization through farm work.

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For additional information, the author recommends:

Fan, Maoyong, Susan Gabbard, Anita Alves Pena, and Jeffrey M. Perloff, "Why Do Fewer Agricultural Workers Migrate Now?" *American Journal of Agricultural Economics*, 97(3)(2015): 665–679.

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The Emergence of University–Private Firm Research and Development Agreements

Gordon Rausser

Due to declining governmental funding for basic science, public-private research partnerships have played an increasingly important role in supporting innovative university research and development. This article presents an assessment of the changing research and development landscape and the role of such partnerships to empower universities in promoting economic growth.

A major driver of U.S. economic development since the Second World War has been productivity growth. The university research system has played an essential role in fostering productivity growth by consistently generating outputs with public good characteristics that have been reproducible and thus have not lent themselves to private market development and appropriation. Despite the success of this system, the scientific research establishment has come under increasing scrutiny as federal and state research funding (in real dollars) has been on a downward trend since the 1980s.

Specifically, the scientific research establishment has experienced a declining share of the federal budget. Scientific research and development (R&D) received nearly 12% of the federal budget in the mid-1960s, but this share has fallen below 4% in recent years (Figure 1). This decline in federal public research funding has coincided with a slowdown in productivity growth, which has been largely flat since the 2008 Financial Crisis. State and local government research funding has declined along with federal funding.

As the public sector contributions to university research budgets have declined, the need to seek out alternative sources of funding has become increasingly imperative. On a national scale, overall R&D funding from the private sector has steadily grown over the last 50 years, and now accounts for over 70% (Figure 2). In essence, the federal government and private enterprise have essentially switched roles in terms of the execution of R&D funding.

In most universities, researchers have been encouraged to replace federal funding with external research grants, many of which are sourced from private commercial interests. As a consequence, many researchers' marginal research time and the generation of ideas are focused increasingly on specific private interests. This has created an opportunity for private firms to leverage their R&D funds to redirect a larger share of universities' research efforts, gaining increasing influence over a particular university's research agenda.

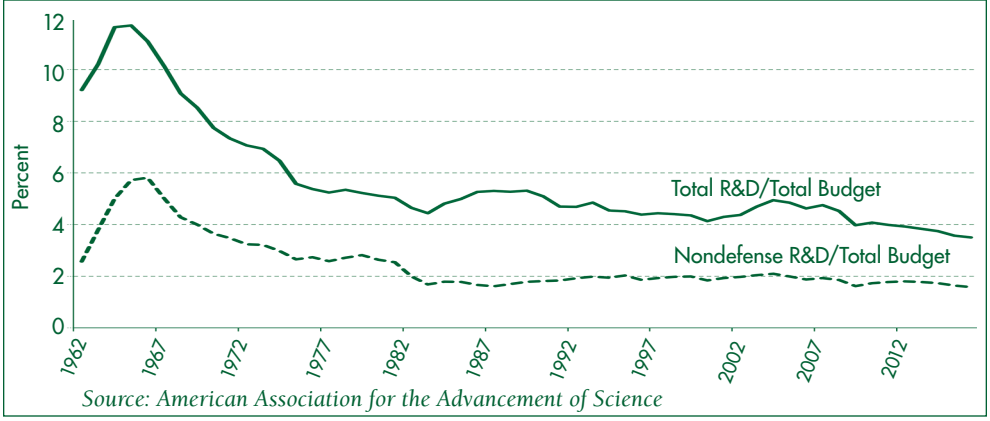
The passage of the Bayh–Dole Act in 1980 dramatically altered the university incentive landscape by structurally changing intellectual property (IP) rights and royalty distributions. Under the Act, IP rights are assigned to the universities where the research takes place, even if the research is federally funded, and it requires that universities share any license revenues with the inventors. This allocation of the royalty stream gives university researchers incentives to select areas of research that are likely to result in commercially valuable innovations.

The Bayh-Dole legislation, when combined with a critically important Supreme Court ruling (Diamond vs Chakrabarty, which allows researchers to patent genetically modified organisms), helped revolutionize the biotechnology field. Over the last few decades, thousands of biotechnology companies have been founded and have spent billions of dollars of private R&D funds. Research conducted in universities has been crucial to the success of the biotechnology industry; many new companies have been started by professors and most employ research professors as consultants.

This court ruling and the assignment of property rights to universities for discoveries funded by the federal government have also led to the rapid emergence of technology transfer offices (TTOs) at research universities. At the time of the Bayh-Dole Act in 1980, there were only 27 TTOs at universities; one decade later, in 1990, such offices had quadrupled.

What these institutional changes have also meant is that universities have actively pursued monetization of their patents. For example, over the years, the University of Wisconsin, a land-grant university, has generated more

Figure 1. Public Sector Research and Development Funding



Source: American Association for the Advancement of Science

than $1.5 billion, which only ranks 10th among U.S. universities. The University of California system, Northwestern University, Columbia University, New York University, and Princeton University all generated more than $100 million in 2011 from patent licensing.

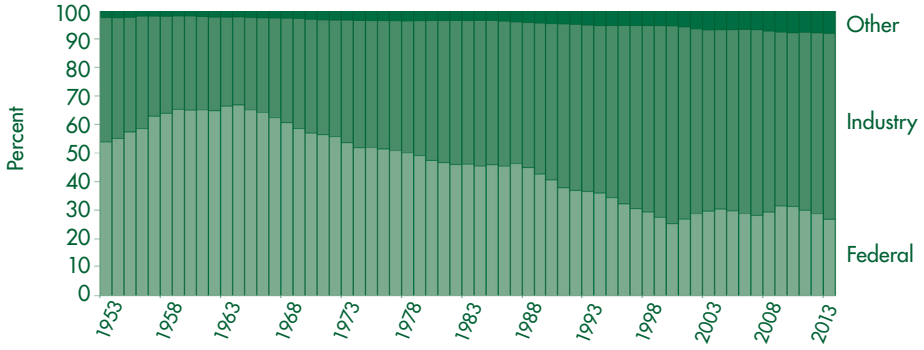
The changing public research landscape exists not only for universities but also for public-sector research conducted at governmental agencies. For example, the President's Council of Advisors on Science and Technology recommended that the U.S. Department of Agriculture research portfolio be rebalanced by the creation of innovation institutes funded through public–private partnerships (PPPs). The justification, in part, for this recommendation was to overcome "congressional constraints" on research funding budgets sourced by the federal government.

Because of the dramatic decline in public sector support for basic science at universities and the changing incentive landscape, the relationships between the private sector and universities have expanded, assuming many different shapes and forms. Some of these relationships are formal, others are informal. For formal relationships, the types of partnerships have included single or multiple sponsored research partnerships, spinoffs or startups, strategic partnerships, open collaborative research, consortia, research units/centers, technology licensing, IP sharing, material transfer agreements, and clinical research and trials.

Regardless of the type of university–industry partnership, three characteristics or dimensions of these partnerships, referred to as PPRPs, are key to understanding research partnerships: size, stage, and assignment of control rights. The size of a research partnership is indicated by such factors as the number of partners involved, the amount of financial resources and other assets exchanged and committed to the research relationship, and the length of the commitment.

The stage of research defines a second key dimension: Partnership agreements fall on different segments of the continuum ranging from early-stage, basic research to late-stage, targeted research focused on the commercialization of innovations.

Figure 2. Trends in Research Funding



Source: American Association for the Advancement of Science

The third dimension may be defined by the consistency between the assignment of control rights with the core values and culture of each research partner. For example, within a specific partnership agreement, the public partner's control rights may locate them somewhere on a continuum representing the tradeoff between academic freedom versus outreach—engaging with the business community to pursue commercial value as defined by the private partner. In fact, this dimension also reflects the tradeoff between basic research representing the long-run culture and core values of most research universities engaged in expanding the frontiers of basic knowledge, and the very focused, applied research traditionally valued by the private partner.

The available evidence shows that PPRPs flourish in an environment in which the paradigm of the research process formally recognizes the non-linearities and the chaotic nature of R&D processes. This framework formally recognizes that there is feedback between both basic and applied research. The often meandering path of innovation occurs through a circuitous route that cannot be codified and many would argue is impossible to measure. This framework, or paradigm, goes so far as to argue that applied research drives basic science as much as, if not more than, basic science drives applied research.

There can be no question that basic science and applied research are closely tied. As Louis Pasteur emphasized, long ago, "There is no such thing as a special category of science called applied science; there is science and its application, which are related to one another as the fruit is related to the tree that has borne it."

In fact, this vision is very much aligned with the original land-grant university legislation and the subsequent Smith-Lever Act, introducing Cooperative Extension. In the original conceptualization, researchers at the university would make discoveries; those discoveries would be transmitted and adopted through the advice and education service offered by Cooperative Extension. Moreover, major problems in the field would be observed by Cooperative Extension and taken back to the basic science investigations that were conducted by university researchers.

The non-linear, chaotic paradigm of scientific research is in sharp contrast to what has been referred to as the "linear decomposition paradigm of scientific research." During World War II, and following the conclusion of that crisis, the U.S. government drew a clear distinction between basic science research and applied science research. During the war, it funded basic science and was instrumental in developing radar,

vehicles, medical treatments, and perhaps most famously, the atomic bomb.

Vannevar Bush, who was head of the Office of Scientific Research and Development, convinced the government to continue funding basic science at universities. He compellingly argued that, just as governmental support of basic science was crucial to military success during the war, government support of university research was similarly critical to promoting economic growth in peacetime.

In Bush's view, basic scientific research is scientific capital. Once basic science discoveries take place, they assume the form of a "public good." Such goods are non-rival and non-excludable. In other words, they are offered to society and all private firms to then take this basic knowledge and attempt to modify and apply it to the research challenges that they face that allow for commercialization.

The most challenging PPRPs are the formal contractual strategic relationships between private firms and universities. Partnerships are complicated by the uncontrollable, unforeseeable nature of scientific research. The partnership's contract must directly address unanticipated events.

Unfortunately, there is no such thing as a complete contract. The contract must contain a set of implementable actions to be taken when unanticipated events occur in the research partnership. The contract must establish the governance structure, which requires the assignment of "control rights." In negotiating such contracts, the bargaining space between the parties must be clearly articulated.

Once the bargaining space is set, the negotiations of the contract emerge with both front-end rights established as well as back-end rights clearly specified with regard to public access to any research discovery, assignment of intellectual property rights that come in the form of codified knowledge (namely patents), and licensing rights. There are several stages in the implementation of the contract, and the attributes and characteristics of each stage of the contract are briefly described in Table 1.

The potential benefits from PPRPs are easily articulated. Complementarities between scientific and practical

Table 1. Research Partnership Structure

Partnership Attributes	Control Rights
Stage 1: Setting the Bargaining Space	
Public partner objectives	
Partner selection process (many vs. single offers)	
Private partner objectives	
Type and size of partners	What are the binding policies of the respective institutions (i.e. what are they willing to accept)?
Type of relationship	What is the intersection?
Proximity of private partner(s) to campus	Is there a Pareto frontier?
Primary location of research	
Repeat relationship	
Limitation on funding percentage	
Stage 2: Negotiating the Contract	
Front-End	
Complementary assets	Right to use proprietary data Background rights
Governance structure: Oversight committee	Control of governing committee Right to expand Right to extend Right to terminate (no cause) Right to terminate projects
Governance structure: Research focus	Right to define research range Right to choose research orientation
Back-End	
Public access to research discovery	Right to control publication delay Right to suppress due to proprietary information No proprietary information
IP rights: Patents	Filing responsibility Ownership Partial ownership Control of patent litigation Right to know-how transfer Ownership of core technology Right to blocking patent
IP rights: Licenses	Initial option (right-to-negotiate vs. right-of-first-refusal) Right to exclusive/non-exclusive license (right to blocking license) Percentage (access option) Third-party option Right to sub-license
Stages 3 and 4: Reviewing and Renewing the Agreement	
Reviewing partnership	Right to transparency
Renewing relationship	Implied right to renew

knowledge have the capacity to generate rapid and far-reaching innovation. Each partner is seeking attributes and assets in prospective partners that complement its own abilities and resources.

Industry is interested in combining its knowledge of markets with information on new research and innovation in order to identify those developments that are likely to lead to commercial applications. This motivation may be obvious, but industry is also interested in other, less obvious assets such as access to academic expertise, networks, and first-hand information about up-and-coming scientists (current graduate students).

And while universities are very clearly interested in financial capital, they are also seeking intellectual capital, cutting-edge research technologies, and proprietary research tools (e.g., databases). Access to these research assets enhances a university's ability to provide a first-rate education to its graduate students and to serve the regional community's economic development goals.

Although the potential benefits of research partnerships are clear, the potential risks to both parties can be substantial. These risks can pose serious obstacles to the successful formation of PPRPs. In addition to the uncertainty inherent in any research process, the differences between university educational objectives and corporate goals are a primary source of risk in these relationships.

With private financing comes the concern that the traditional orientation of the academic research agenda toward basic, public goods research will be directed toward more applied, appropriable research that serves the objectives of the private partner, and that this conflict of interest, in turn, may result in a loss of academic integrity. Certain partnership mechanisms, such as conflict of interest agreements and publication delays that often accompany collaborations with private partners, are seen to create barriers to the traditionally free and open research culture of public universities.

Planning horizons between university and industry partners also tend to differ; university researchers focus on long-term research while companies often seek quick turnaround projects. The difference in university and industry turnaround time can make negotiating and managing research agreements a challenge. In addition, the cultures and values of research partners may simply clash, creating insurmountable blocks to a continuing relationship. University integrity may be questioned if the pressure to secure future research financing and to form future relationships negatively influences behavior under a current collaboration.

Issues concerning IP are especially contentious. Hold-up and background rights are of primary concern to an industry partner interested in commercializing the products of a research partnership. Researchers at universities and other public institutions often use proprietary research tools in their research without obtaining rights. They are blocked, however, from using these tools for commercial purposes.

This is the basis for the collective research model: Generally, one researcher in an institution may freely access another researcher's patented research tool for academic study. Industry partners and researchers doing private research are often excluded from this type of arrangement. Thus, a private institution looking to partner with a particular researcher, for example, may experience hold-up at the commercialization stage because the public research partner did not obtain formal rights to all research inputs (i.e., background rights).

Further, if numerous university researchers and graduate students are involved in a research project, industry risks loss of privacy and protection for proprietary information. In response to this risk, private partners may restrict researchers with confidentiality agreements. Private partners frequently indicate that long-term strategic partnerships provide a more successful mechanism than one-time specific research ventures for reconciling these issues.

Contractual relationships between universities or other public sector entities and private firms to engage in creative research raise a series of critical questions. Does the profit-driven sponsor shift the university's or public sector's mission away from more basic research? Does the industry's desire to exploit IP rights interfere with communication within and between universities to an extent harmful to open science and the pursuit of public good research? Quite naturally, conflicts are an inevitable consequence of the fundamental clash between public systems that encourage openness in science and private sector or industrial systems that focus on financial rewards based on secrecy.

In the final analysis, this all boils down to one core question: Can a university or public sector partnership with industry or private firms be socially beneficial or, more precisely, Pareto improving? In our recent book, we have demonstrated that a collective choice framework for the design and implementation of PPRPs, in the face of conflict between private self-interest versus the public interest, can lead to Pareto optimal cooperative outcomes.

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For additional information, the author recommends:

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