



Winter 2013

WARWICK ECONOMICS

# Bulletin



Special Issue:  
Brainpower

WARWICK ECONOMICS

Bulletin

Winter 2013

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THE UNIVERSITY OF  
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WARWICK ECONOMICS  
**Bulletin**

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# POLLUTING POTENTIAL

Air pollution affects students' performance on high-stakes tests and long-term educational and career prospects, new research shows

By Victor Lavy

**H**igh-stakes exams are the norm in many developed nations, and the results often help to determine whether secondary students seek a university degree, what calibre of university admits them, and what kinds of careers they pursue.

Yet my recent research with colleagues suggests that performance in these exams can be affected by forces that are random, transitory and have nothing to do with student quality. One such factor is the air pollution level at the test sites.

Our research, believed to be one of the first tests of how air pollution may affect cognition, reveals long-term consequences for educational attainment, labour market outcomes, and earnings.

Students' exposure to higher levels of pollution on the dates of their tests negatively affected their performances at those times. This appears to be the result of a temporary variation in performance, rather than a permanent reduction in intellectual ability. But because the tests play such a crucial role in their lives – helping to determine whether and where they go to university, what career choices they have, and their professional options and earnings – the effects of this random factor linger on for more than a decade, and possibly for the rest of their lives.

My recent work, with Avraham Ebenstein and Sefi Roth, examines the effects of fine particulate matter and carbon monoxide, two of the most dangerous forms of air pollution, on the results achieved by Israeli high school students on secondary school exit exams.

In our work, we look at the effects of pollution on results in the Bagrut, a matriculation certificate used in Israel that is a prerequisite for university admission and is an economically important educational milestone. Though the Bagrut is exclusive to Israel, many countries and some American states have similar high school matriculation exams. These include the French Baccalaureate, the German Certificate of Maturity (Reifezeugnis), and the Italian Diploma di Maturità. In many respects, the Israeli system is not so different from the system used in the UK (with reliance on a combination of AS- and A-level exams and GCSEs) and the US, with a reliance on SAT and ACT scores as critical in university admissions. For the Bagrut, Israeli students take a series of national exams in core and elective subjects following 10<sup>th</sup> and 11<sup>th</sup> grades, and then they take another large set of exams following 12<sup>th</sup> grade. The Bagrut includes seven mandatory subjects and one elective subject. The exams are given bi-annually during the two exam seasons. The Bagrut is a pre-requisite for university entrance. Failure to obtain certification will have a significant effect on higher educational

attainment. Access to university majors is also determined by Bagrut performance. As a result, it is a gatekeeper in Israel for many lucrative professions.

Our work examines how outcomes on the exam were affected by levels of fine particulate matter and carbon monoxide exposure on the day of the exam at the test sites, as measured by the Air Quality Index. Fine particulate matter is a complex mixture of solid and liquid microscopic droplets found in the air that consists of various components including acids, metals, dust particles, organic chemicals and allergens. These fine particles can travel through small passageways, suggesting that high levels of pollution may affect test takers even indoors. In Israel, the main sources of particulate matter are sand storms, coal-burning power plants, and certain industrial processes.

Ambient air pollution has significant known consequences for human health and life expectancy. Short-term acute exposure decreases circulatory performance and leads to increased illness and hospitalization rates. Research has documented a link between carbon monoxide and higher incidents of respiratory and heart-related emergency room visits

Though evidence documenting a link between cognition and ambient air pollution is extremely limited, our work documented a connection.

The effect of pollution is through exposure during several exams (eight to 10 on average) which are held at different dates in high schools. Our work

## The Researchers

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**Avraham Ebenstein** is assistant professor at the Hebrew University of Jerusalem.

**Sefi Roth** is a phd student at Royal Holloway, University of London.

## Publication details

This article is based on *Air Pollution, Cognitive Performance, and the Long-term Impact of Transitory Shocks on Human Capital and Income*, a working paper available at: [http://www2.warwick.ac.uk/fac/soc/economics/staff/academic/lavy/text\\_and\\_tables\\_air\\_pollution\\_draft\\_20\\_09\\_12.pdf](http://www2.warwick.ac.uk/fac/soc/economics/staff/academic/lavy/text_and_tables_air_pollution_draft_20_09_12.pdf)

Completely random variation in scores can affect wages and careers 10 years after a student completes high school.





estimated the effect of exposure during an exam on the test score on that exam. Then we estimated the effect on long-term outcomes (post-secondary schooling and earnings as adults).

We found that a 10-unit increase in the ambient concentration of fine particulate matter as measured by the Air Quality Index reduced Bagrut exams test scores by 0.46 points, and the same increase in ambient concentration of carbon monoxide reduced scores by 0.85 points. (The score in each exam ranges from 0 to 100 and the mean is around 70.) Alternatively, relative to a day with average air quality, one standard deviation increase in the fine particulate matter is associated with a .65 decrease in scores, and the same increase in carbon monoxide is associated with a 0.54 point decrease in scores.

Our results are largely driven by poor performance of test takers on very polluted days. The results suggest that modest pollution levels have only a marginal impact, but that very polluted days can have much larger effects.

The results also show that the impact of pollution is highest for certain sub-populations with high rates of asthma, or other pre-existing conditions that make individuals vulnerable to air pollution. For those with higher rates of asthma and respiratory illness, the effects of fine particulate matter are larger, suggesting the physiological impairment is a potential underlying mechanism. In contrast, the effects of carbon monoxide are largely consistent among Israeli subpopulations, suggesting that neurological impairment may be a mechanism.

We estimate that an additional 10 units of fine particulate matter is associated with 0.03 per cent decline in Bagrut certification, 0.03 per cent decline in probability of enrolment at university, a 0.15 decline in years of education at university and a 2 per cent decline in monthly income a decade later.

Our evidence shows that pollution exposure is only related to temporary variation in performance, rather than a permanent diminution of intellectual ability. We find that a student's average pollution

exposure at Bagrut exams dates during the period (May-July) in 11<sup>th</sup> grade has no correlation with his or her average Bagrut scores on exams taken in May-July of 12<sup>th</sup> grade, suggesting that the effects we estimate are capturing the consequences of short-term random effects, rather than reflecting actual quality gaps between students.

We believe our findings hold significant policy relevance and in several arenas.

Insofar as there are permanent wage consequences from completely random shocks to student performance, our results highlight the danger in assigning too much weight to a student's performance on a single, high-stakes exam, rather than an overall academic record. If completely random variation in scores can still matter 10 years after a student completes high school, this suggests that placing too much weight on high-stakes exams like the Bagrut may not be consistent with meritocratic principles.

In addition, our results provide new and compelling evidence that cognition is affected by air pollution exposure. Our work suggests that the gain from improving air quality may be underestimated by the current, narrow focus on health impacts. Insofar as air pollution may lead to reduced cognitive performance, the consequences of pollution may be relevant for a variety of everyday activities that require mental acuity.

Our results underscore the need for pollution-regulating policies to take mental and physical human health into account. These results may also highlight a way in which individuals in highly polluted areas, such as those living in cheaper, industrial areas of cities, could have economic disadvantage exacerbated by pollution.

While our data is too recent to know whether the affected students will "catch up" later with their peers who had lower pollution exposure, our results suggest that having excessive pollution during one's Bagrut administration has a non-trivial effect on education and wages that are long lasting.

Our results highlight the danger in emphasising performance on a single exam rather than an overall academic record

# IMPORTING INNOVATION

High-skilled immigration benefits scientific progress, new research shows

By Fabian Waldinger

The political debate often ignores potential benefits from attracting high-skilled immigrants. This stems in part from the difficulty inherent in measuring potential benefits from high-skilled immigration. These benefits (and potential costs) may only occur years after immigrants have arrived in the country. Furthermore, immigrants like to settle in booming areas. As a result, comparing the economic outcomes in areas with more immigration to outcomes in areas with less immigration does not provide an accurate measure of the true effect immigrants have on the local economy.

My recent research with colleagues, Petra Moser and Alessandra Voena, investigates and measures the true, long-run effects of high-skilled immigration by analysing decades-old data from the World War II period. Our work examines the effects of high-skilled chemists who were expelled from Nazi Germany and moved to the United States. Our research looks at the impact this group of immigrants had on patents granted in the United States over several decades, and, as such, it provides the first systematic, empirical analysis of the effects of German Jewish émigrés on US innovation.

Starting in 1933, the Nazi government dismissed all university researchers of Jewish origin. As a result, some of the best chemists in the world were forced to migrate to other countries. Many of them chose to settle in the United States. Our study analyses how the arrival of these high-skilled immigrants affected patenting of US inventors over a long period of time.

Historical accounts suggest that Jewish émigrés from Nazi Germany revolutionised US science. By 1944, more than 133,000 German Jewish émigrés found refuge in the United States. In physics, émigrés such as Leo Szilard, Eugene Wigner, Edward Teller, John von Neumann, and Hans Bethe formed the core of the Manhattan project that developed the atomic bomb. In chemistry, the work of émigrés created "hardly less than a revolution... their work on the structures of proteins and amino acids, on metabolic pathways and genetics, almost immediately propelled the United States to world leadership in the chemistry of life," as Howard Sachar, author of *A History of Jews in America* put it. At the same time, however, other accounts suggest that the émigrés' contributions were reduced by the administrative hurdles and anti-Semitism they faced at the time.

To measure the impact of one specific group of immigrants in the period – the chemists – we collected a new, inventor-level data set of changes in US patenting. Our analysis of the data shows that these high-skilled chemists substantially increased patenting by US inventors for about 20-30 years after their arrival. This increase was driven, not by an increase in patenting by US chemists who had previously worked in these fields, but an inflow of other chemists into the émigrés' research specialties. The émigrés attracted a new group of domestic US inventors to their fields.

Because immigrants often choose to settle in booming areas, a simple comparison of locations with and without immigrants could overstate any

## The Researchers

**Fabian Waldinger** is an associate professor in the University of Warwick Department of Economics and a research associate with its Centre for Competitive Advantage in the Global Economy (CAGE).

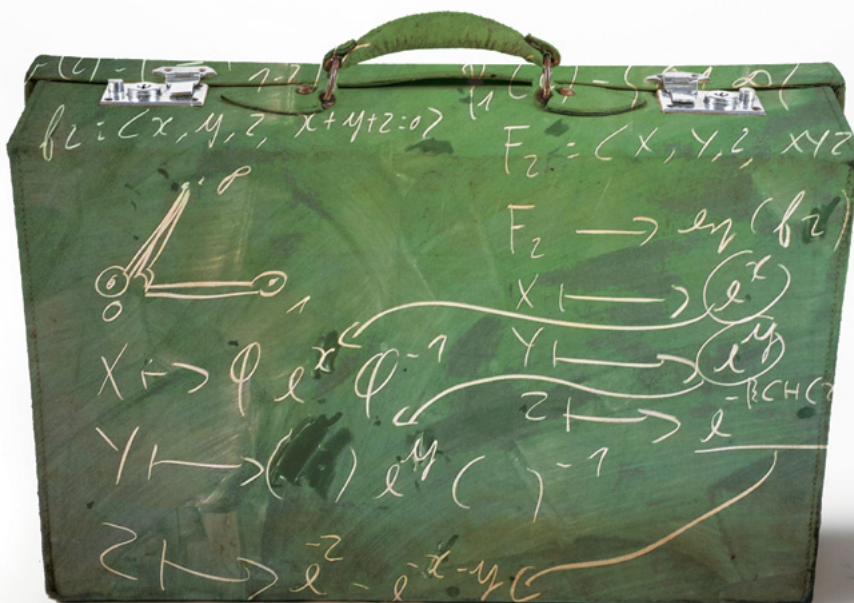
**Petra Moser** is an assistant professor in Stanford University's Department of Economics.

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## Publication details

This article summarizes the paper *German Jewish Émigrés and US Invention*. The full academic paper may be found at: <http://www2.warwick.ac.uk/fac/soc/economics/staff/academic/waldinger/research/tacit130805all.pdf>

[continued overleaf](#)



High-skilled chemists who immigrated to the United States in the World War II era substantially increased patenting by US inventors for 20-30 years after their arrival.



# THE WISDOM OF THE CROWD

Crowd-sourced technologies reveal the tensions between information providers and consumers

By Ilan Kremer and Motty Perry

A company named Waze Mobile has developed a GPS navigation software, a social mobile application that provides free, turn-by-turn navigation based on the live conditions of the road, based on real-time traffic conditions, as reported by users. The greater the number of drivers who use this software, the more beneficial it is to its customers.

Waze is but one example of the proliferation of technologies that purvey "the wisdom of the crowd." Technologies such as these collect, maintain and disseminate information provided by users to establish reputations and recommendations for practically everything – high schools, restaurants, doctors, travel destinations, and even religious gurus.

Our recent research looks at this phenomenon through the lens of mathematical models to provide understanding about the optimal strategy for sharing and using such information. Our work underscores the difficulty in managing such crowd-sourced technologies, which must find a way to balance the tension inherent in a system in which agents are both providers of and consumers of information. Companies must carefully manage this conflict of interest, and, deciding just how much information to reveal is a surprisingly tricky matter, we find.

Waze provides an apt case in point. When a customer logs in to Waze with a smartphone, he continuously sends information to Waze about his speed and location. This information and information sent by others enable Waze to recommend to this driver and others an optimal route to their destinations. But in order to provide good recommendations, Waze must have drivers on every possible route. Indeed, as Waze's own president and co-founder has admitted, Waze sometimes recommends a particular route to a driver even though – and indeed, exactly because – the service does not have information about that route. The information transmitted by this "test"

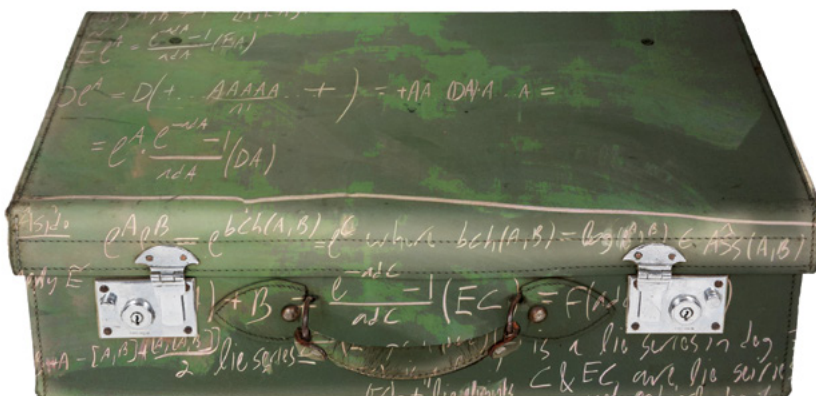
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positive effects from immigration. To avoid these problems, we compared the changes in patenting by US inventors in research fields that benefited from the migration of a German-Jewish chemist to changes taking place in research fields that were dominated by German chemists who did not migrate to the United States.

Of course, the United States may have attracted only those chemists who were working in fields that were growing particularly quickly. To address this concern, the study also compared changes in patenting by US inventors in the pre-dismissal research fields of émigrés. Because these migrants were not planning to migrate and only did so after they were dismissed from their university positions in Nazi Germany, their pre-dismissal work was not geared toward research fields that were booming in the United States.

Our findings provide empirical evidence for historical accounts suggesting that immigration sparked a US revolution in science and immigration, and they show that high-skilled migrants can have large positive effects on innovation. The positive effects of the migrants stemmed largely from their ability to attract new researchers into their areas of specialties. Native researchers who had already worked in these same fields, however, did not become more innovative. As a result, our work may suggest one reason why some native, high-skilled workers may not necessarily support the inflow of high-skilled migrants – even though this kind of migration can have very large positive effects on innovation as a whole.

Immigration sparked a revolution in US science and innovation.



## The Researchers

Ilan Kremer and Motty Perry are economics professors at the University of Warwick Department of Economics. Yishay Monsour is a computer science professor at Tel Aviv University.

Finding a way to balance the tension inherent in a system in which agents are both providers and consumers of information is surprisingly difficult.

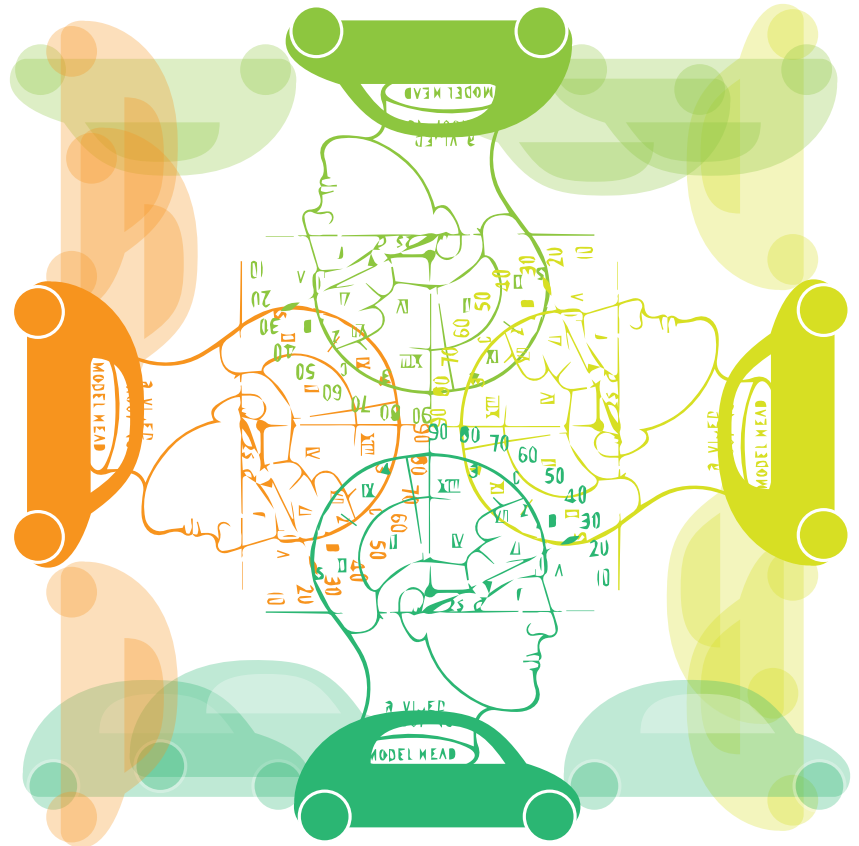
driver is then used to better serve future drivers. But, in order not to deter drivers from using the system, Waze must be very careful about how often it "sacrifices" drivers by subjecting them to an exploratory drive intended to improve the experiences of others, rather than to provide them with the quickest trip. Thus, the tension: All users benefit from the experiences of the explorers, but no user wants to be thrust into the role of explorer.

The wisdom of the crowd is far from perfect – as anyone who has acted on crowd-source recommendation that went awry has experienced first-hand. This is largely because of one of the important characteristics of these new reputational markets, namely, the feedback effect, wherein users are consumers of as well as generators of information. A policy that ignores this effect and simply provides the most accurate, current recommendations, will lead in the long run to insufficient exploration of available information – think of the alternative routes in the case of Waze – and, hence, a suboptimal outcome.

Clearly, a policy not to reveal any information would not be helpful in any way. However, a policy of full transparency is not ideal either.

This applies for a wide array of situations, not all of them stemming from new technological innovations. Consider, for instance, the controversy over healthcare report cards to evaluate medical providers that are being discussed in the UK and the US and elsewhere. These systems propose giving the public disclosure about patient health outcomes for individual physicians or certain hospitals. Supporters argue that the system gives providers powerful incentives to improve quality together with providing patients with important information. Sceptics counter that report cards may encourage providers to "game" the system by avoiding sick patients, seeking healthy patients, or both. Finding the way to balance these incentives, and to make the information beneficial is difficult. The performance record of physicians or medical centres just embarking on certain procedures will be difficult to evaluate – because well-established people and places will have many cases to cite and those new to the procedure will have so few to evaluate that the record will not be statistically significant. At the same time, society has an interest in seeing that newcomers learn these procedures, rather than sending all patients to one "best" provider. Sometimes too much transparency comes at a cost that does not result in the best outcome.

Indeed the difference between the "best" and "second best" may be negligible. Consider, for instance, the situation with TripAdvisor, the dominant online source in the hospitality industry,



with more than 75 million reviews generated by some 40 million visitors per month. TripAdvisor's Popularity Index is a company secret, yet it is apparent that its exact strategy differs from just a simple aggregation. The closer a property is to a Number One ranking in its given market, the more numerous its direct online bookings. For example, a property ranked Number One generates 11 per cent more bookings per month than one ranked Number Two. The difference is particularly striking given that in most cases the difference between similarly ranked hotels is minor. TripAdvisor's revenue is generated through advertising, and as a result, the company's main concern is the volume of visitors to its site.

These are just a few of many fascinating examples of the rapid growth in the number of rankings and league tables published in recent years, and they may well be the face of things to come – affecting the reputations of many, perhaps even university professors. Our work suggests that managers of these websites are facing a difficult tension conflict between gathering information from users and making good recommendations to the same users.

## Publication details

This article is based on *Implementing the Wisdom of the Crowd*, a working paper, available at [http://www2.warwick.ac.uk/fac/soc/economics/research/workingpapers/2013/twerp\\_1024\\_perry.pdf](http://www2.warwick.ac.uk/fac/soc/economics/research/workingpapers/2013/twerp_1024_perry.pdf)

Recommendations for the best travel destinations, driving routes, or even one's guru come from crowd-sourced technologies and sites

# POVERTY'S BRAIN DRAIN

Being poor saps mental resources

By Anandi Mani

**P**oor people often behave in ways that can further perpetuate their poverty – by being less productive workers, less attentive parents, or worse managers of their time and money, for example. A long-standing debate about poverty stems from the question of why this is the case. Are people poor because of inherent traits and tendencies to make bad decisions? Or, are they poor because poverty itself somehow leads them to make these bad decisions?

My recent research with colleagues provides a fresh perspective on poverty and the underlying debate. Our recent work is the first to establish that poverty directly causes lower intellectual capability. This link is not just a correlation. Our findings suggest that being poor saps the very mental energy needed to take on the tasks that might lead them out of poverty – such as education, job training and time management.

Our research revealed the effect of pressing financial concerns upon low-income individuals' performance on common cognitive tests. In the experiments, financial worries reduced the results on IQ tests by an average of 13 points, equivalent to the drop from the loss of a full night's sleep, or from chronic alcoholism.

Our findings stem from two very different experiments – one with shoppers in a New Jersey shopping mall and the other with sugarcane farmers in Tamil Nadu, India.

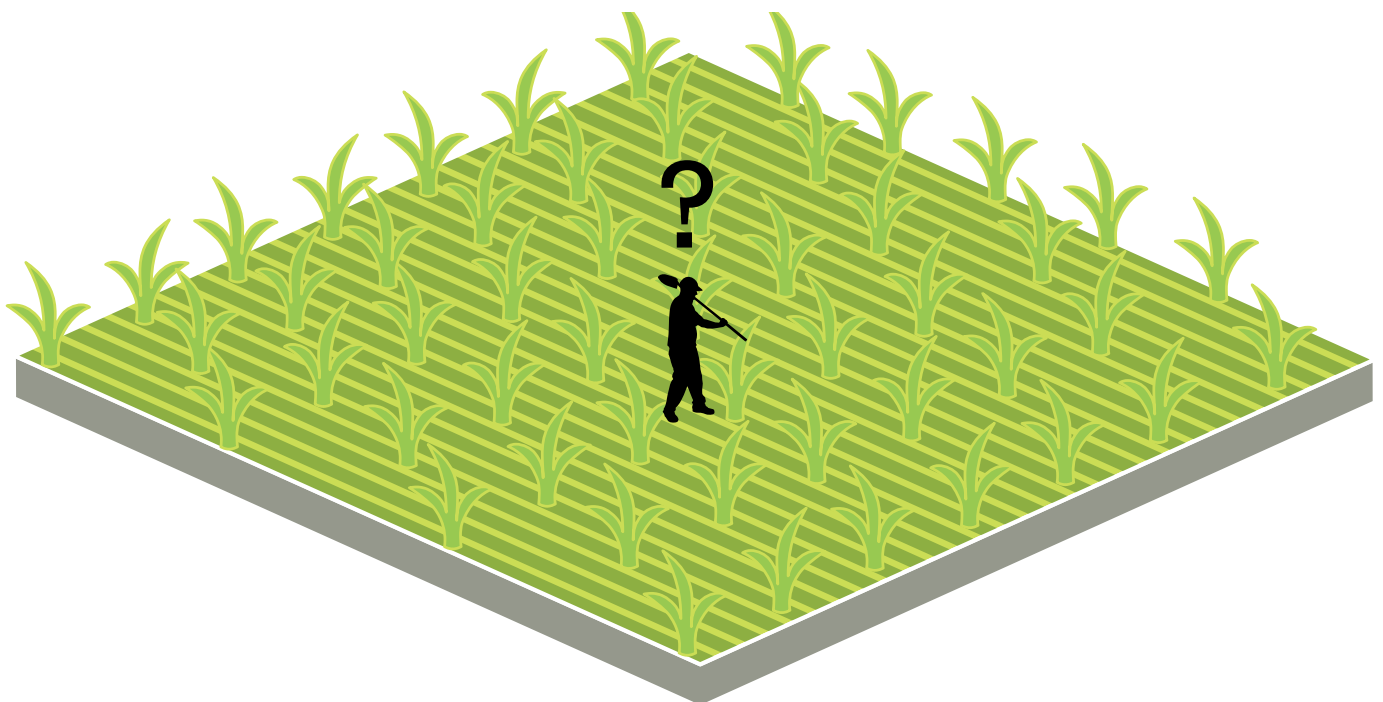
In the experiment in the mall, we asked people of varying income levels to consider a hypothetical financial decision, such as how to pay for a car repair, to see how it affected their performance on unrelated spatial and reasoning tasks. Both rich and poor individuals did equally well if the repairs were inexpensive, but the performance of the poor alone dropped significantly when the repairs were expensive.

In the experiment in Tamil Nadu, we gave farmers similar IQ tests both before the harvest, when they are very short on money, and again a few weeks after harvest, when they have money. The same farmers performed much better on similar IQ tasks after harvest than before, when they report lower ability to cope with ordinary bills. Their performance is not explained by lack of nutrition, greater physical effort due to harvest, or biological stress factors, or getting better at the IQ task.

Taken together these findings provide new insights into the effects of financial concerns.

The poor must manage sporadic income, juggle

One insight is to appreciate that people who are materially poor are also short on mental attention resources, directly because of poverty.





expenses, and make difficult trade-offs. Even when not actually making a financial decision, these preoccupations can be present and distracting. The human cognitive system has limited capacity. Of course, people of all income levels face stress, for instance if they are short of time. Deadlines can capture our attention, and we may have less mental bandwidth for other important, but non-urgent tasks, such as parenting. But people with more financial resources may be able to "buy more time" with money, or cut back on their commitments -- which is a luxury that the poor do not have.

These insights are important for the creation of effective policies aimed at the poor. Policymakers should focus on reducing the "cognitive" taxes on

the poor, just as they avoid imposing monetary taxes upon them. Simple interventions – such as automatic defaults for enrolment in savings programmes, simpler forms for programme eligibility, and text reminders for important tasks – may be helpful for the poor. Agricultural extension services that provide farmers with information about new seeds, pesticides and agricultural practices – should be carefully timed to coincide with the greater cognitive capacity that is evident after harvests. In addition, a financial product that releases a steady stream of income throughout the year may be better for farmers than receiving one lump sum return and facing a lot of financial anxiety before the harvest.

**The Researchers**

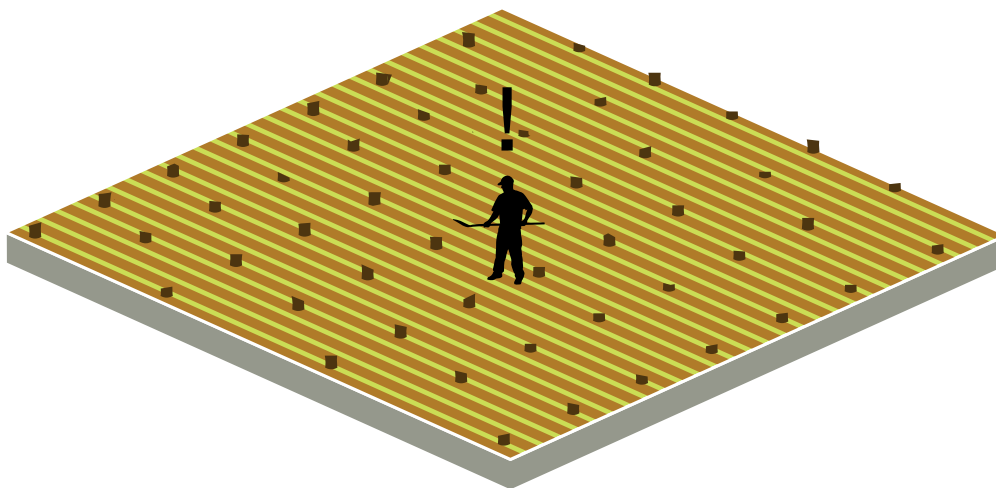
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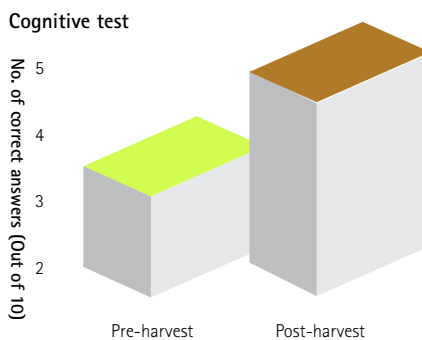
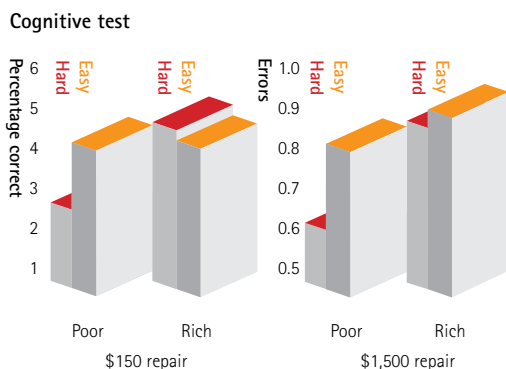
**Jiaying Zhao** is an assistant professor of psychology at the University of British Columbia.

Our findings offer a new explanation for many behaviours of the poor.



**Figure 1**  
The poor and rich performed equally well on IQ tests under "easy" conditions – that is, after they were asked a question about car repairs of \$150 (roughly £100). But the poor performed significantly worse than the rich under "hard" conditions – after they were asked a question about car repairs of \$1,500 (roughly £1,000). The question about the more expensive car repairs was intended to trigger thoughts about financial concerns.

**Figure 2**  
The same sugar cane farmers performed significantly worse on cognitive tests taken before the harvest than after the harvest.



**Publication details**

This article is based on "Poverty Impedes Cognitive Function" published in Science magazine. The full article is available at: [http://www2.warwick.ac.uk/fac/soc/economics/staff/academic/mani/mani\\_science\\_976.full.pdf](http://www2.warwick.ac.uk/fac/soc/economics/staff/academic/mani/mani_science_976.full.pdf)

# WARWICK ECONOMICS AND INDIA'S BRAINPOWER

## The Final Word

By Siobhan Benita and Abhinay Muthoo

**F**or the past three years, the University of Warwick has sent student volunteers to a small village in Haryana, India, to teach English and improve pedagogy at the Laksh School. The Department of Economics is proud to support the university in this initiative, not just because it offers an unforgettable experience for participating students but also because it fits with our core belief in the power of education. Receiving an education and learning how to develop and apply one's brain power can provide a life-changing route out of poverty, particularly in a country such as India, with its huge social and public policy challenges.

As the university starts the recruitment process for Laksh 2014, our department is contemplating how we can interact with India not just through volunteering but in other academic and policy aspects as well. Our recent conversations with Indian officials and policy experts reveal clear frustration that India has not yet been able to establish a stronger and more competitive presence on the world stage. The reasons for this are complex but include a failure on India's part to train and retain its brightest people. The country needs improved leadership – superior brain power if you like – across all sectors. There is scope for Warwick Economics to engage with this agenda in several ways.

Within the department, we already have academics (some of them of Indian origin themselves) who undertake quality research that is relevant to India's development. With regard to public policy, we recently established the Warwick Policy Lab to help apply academic research to real world policy issues. We knew from the outset that this endeavour should have international reach. Through the Policy Lab, we can focus additional academic work in very specific and applied areas.

We are not alone in this pursuit. The University of Delhi, for example, has recently established a Cluster Innovation Centre to encourage and fund interdisciplinary research projects with clear and significant impact components. Some of the centre's early projects have produced extraordinary results, including the production of a rickshaw that transforms into a nighttime shelter for its owner. In fact, so many students and academics have been inspired to submit project applications to the innovation centre that it is looking to partner with like-minded organisations such as the Policy Lab in order to increase the capacity, talent and resources devoted to the projects. We are inspired by the work this centre is doing. The projects use quality, multi-disciplinary research in a highly applied way, and they are making real and positive differences to people's lives. This approach exactly aligns with

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Fostering academic and policy-oriented partnerships will promote opportunities for study and work within India.



To establish a stronger and more competitive presence on the world stage, India must expand educational opportunities.

our Policy Lab mission, and we hope to find several areas in which we can collaborate productively with the innovation centre.

We also are exploring areas in which we can forge productive academic partnerships across India's higher education sector more widely. Whilst India is strong in science and technology, it is still relatively weak in social sciences. The appetite is growing amongst young students to take economics at degree level, but the discipline is still plagued by a lack of general understanding about its value and a lingering perception that it is somehow secondary to subjects such as medicine or engineering. As a result of this and other factors, many of the brightest Indian students who do study economics choose to go abroad and then pursue successful careers outside India.

To help prevent this brain drain, we want to work with academic partners in India to develop courses that can be taught to Indian students in their homeland, to give them knowledge and skills which can be applied at the most senior levels in the public and private sectors within the country itself. In February next year, for example, several members of the faculty will travel to Delhi to teach economics at a special Winter School that we have jointly organised with the Indian Statistical Institute. And we also have plans – which will benefit our own alumni as well as others – to raise understanding amongst Indian employers

of the value of a degree in economics from a UK institution like Warwick. This is crucial if our best Indian students are to secure top positions when they return home after graduation.

Warwick is also well placed to help Indian higher education organisations with new teaching methods like MOOCs (Massive Open Online Courses). In a country with so many citizens, where the sheer number of people needing education is daunting, using the Internet to reach the masses has huge potential. Warwick has already been involved in the production of a MOOC and is well placed, both in terms of content and technology solutions, to help organisations in India develop their own online teaching ideas.

With a population of over 1.2 billion and a modern history intertwined with our own in the UK, India is a country of many challenges but also immense potential and promise. The brain power contained within that population must be nurtured to flourish. Better nutrition and improved public health will play an important part in this process but so will education and learning. It is both sensible and exciting for us to be involved in India's development.


Whether we are academics or practitioners, we will all be affected by its fortunes over the coming years.

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