Broken Instruments

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Abstract

Repeated use of the same instrumental variable by a literature can "collectively invalidate" an instrument. This paper examines two ways in which this can happen. First, when the same instrumental variable is used to instrument multiple distinct covariates, it is more likely to violate the exclusion restriction. Second, when a variable is documented to affect many outcomes that are likely to be highly or even mildly persistent, using lagged values of that variable as an instrument is likely to violate the exclusion condition. This paper produces a dataset of approximately 960 instrumental variables papers from 1995-2019 in highly-ranked economics general interest and field journals. We find six commonly-used instruments whose literatures, taken together, suggest they are likely to fail the strict exogeneity condition: (i) elevation and bodies of water (ii) sibling structure (iii) ethnicity/ethnolinguistic fractionalization (iv) religion (v) weather and (vi) immigrant enclaves. Taken together, these instruments have been used in 86 "top five" publications and 317 well-ranked field or general interest journals, with 189 total uses cataloged from 2011 onwards. We conduct Monte Carlo exercises and suggest methods to determine whether or not an IV regression's point estimates are likely to be correct.

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I Introduction

A strength of empirical economic research is its focus on causality and mechanisms that underlie economic phenomena. A crucial tool in determining causality has been instrumental variables regression, typically used to isolate a source of variation that identifies a single causal channel. Unfortunately, finding a good instrument is difficult, and consequently, a strong instrument for an important phenomenon accepted by the literature often becomes pervasive.

In general, a strong instrument with the capacity to be used for many purposes is more likely to be invalid. In Morck and Yeung (2011)'s words, "...each successful use of an instrument creates an additional latent variable problem for all other uses of that instrument."[1] To better understand this phenomenon, we document the use of instrumental variables in well-regarded economics journals from 1995-2019. An analysis of these instruments uncovered two primary concerns.

We create a database of approximately 960 instrumental variables papers from well-regarded journals, and identify six strains of literature in which the exclusion restriction should attract particular attention. First, "elevation and bodies of water," used to isolate exogenous components of housing supply, segregation, governance structure, dam location, and infrastructure cost, and broadband provision among other variables. Second, "sibling structure," used to isolate exogenous components of family size and fertility, father presence, parental wages, child schooling, age at grandparenthood, welfare receipt and geographical mobility, among other uses. Third, ethnicity/ethnolinguistic fractionalization, which is used to instrument for rule of law, corruption, democracy, income and investment, social trust, institutions, creditor protections, and welfare-state generosity. Fourth, religion, which is used to instrument for land regulation, social trust, national uncertainty aversion, the free press, private school share, bank regulation, and work ethic. Fifth, weather, which is used to instrument for agricultural and fishing productivity, economic growth, energy prices, commodity prices, pollution, population, migration, water quality, political changes, and managerial moods.

Our sixth instrument, past immigration, while only instrumenting for a single covariate (current immigrant share or flow) affects dozens of outcomes such as education, housing supply, political equilibria, and firm capital investment, which are likely to be highly persistent, particularly when taken jointly, leading to a violation of the exclusion restriction. Second, we find instruments that are potentially subject to contamination caused by the persistence of outcome variables. For example, in the case of preexisting

[1] Bazzi and Clemens (2013) also enunciate this issue, suggesting that literatures may "collectively invalidate" the use of an instrument.

immigrant enclaves as an instrument for flow immigration, the persistence of latent variables affected by past immigration is likely to increase nonlinearly as the number of outcomes affected by immigration increases, violating the exclusion condition.

Figure 1 depicts the uses of these six instruments in all surveyed journals individually and jointly over time. While the use of one of these instruments is mostly limited to between two and five papers a year, the cumulative use of these instruments in economics journals reaches 317 papers by 2019.[2] Moreover, the total use of these instruments has been relatively steady since 2006 at approximately 13 papers per year and has not significantly declined for any of them over time. If anything, the data show the use of these IVs is at best leveling off after increasing precipitously from 2002-2013.[3]

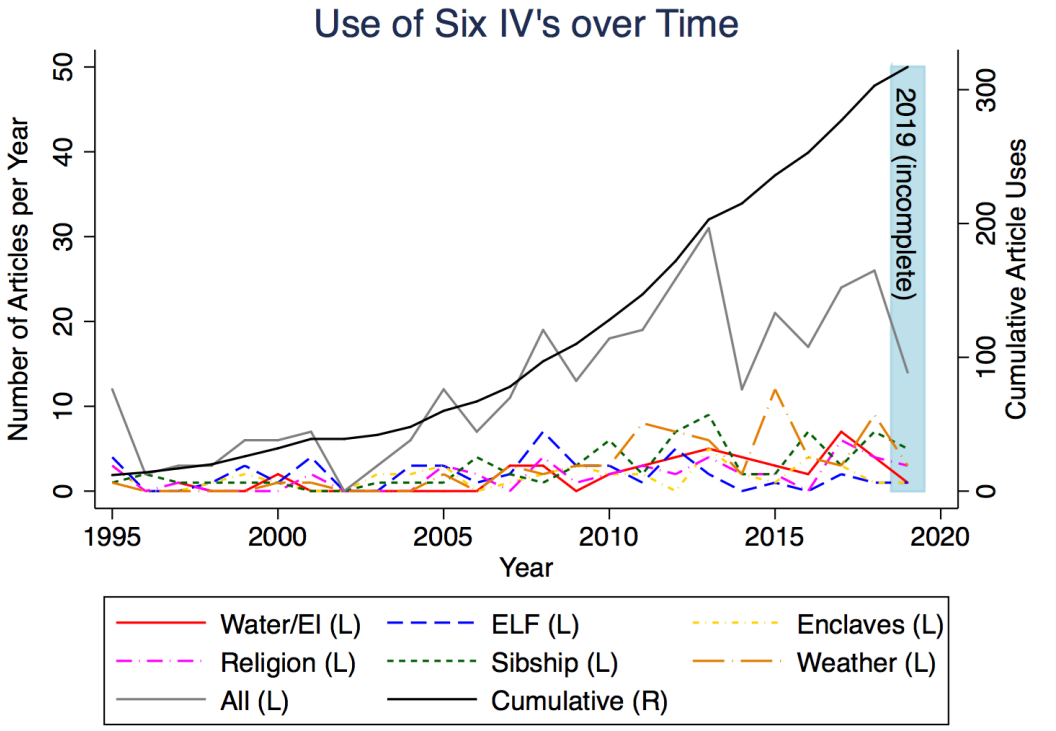

Figure 1: This figure depicts the use of six instruments in well-ranked economics journals from 1995-2019: (i) elevation and bodies of water (ii) sibling structure (sibship) (iii) ethnicity/ethnic fractionalization (ELF) (iv) religion (v) weather and (vi) immigrant enclaves. Individual yearly uses for each variable and their sum are given by the left axis (L). Cumulative uses of all instruments are given by the right axis (R).

To offer evidence of our claim and a potential positive lesson from this paper, we provide Monte Carlo

[2]We include available categorized articles from 2019, though these are not complete.

[3]We are aware of a long literature on instrumental variables preexisting 1990. However, it is only in the 1990's that mechanical statements of simultaneous equations with excluded variables makes way for clear treatment and committed defense of instrument exogeneity in the papers we surveyed.

evidence on various versions of the IV estimator. We find controlling for endogenous covariates of other papers as exogenous, while not necessarily providing an unbiased estimator, improves the MSE of an IV estimator in practice. More importantly, we find that when IV estimates do not significantly change even when including other endogenous covariates as exogenous, the original IV estimator is likely to provide accurate point estimates.

Our paper touches on several other papers criticizing some of these same instruments. Bazzi and Clemens (2013) discusses the issue of collective invalidation of instruments in the context of growth regressions and to our knowledge is the first to mathematically set down the idea of a literature's collective invalidation. Sarsons (2015) discusses why rainfall likely does not affect conflict solely through income shocks, and may be a bad instrument for conflict. We complement her work by noting more than fifteen other uses of the instrument for more than thirty other outcomes. Dell, Jones, and Olken (2014) review the literature on weather shocks, but avoid the concerns we raise focusing on the effect of weather on variables, rather than narrow causal chains that weather as an instrument is claimed to uncover. Jaeger, Ruist, and Stuhler (2018) argue that because general equilibrium adjustments take time, and because immigration shocks are correlated over time, short- and long-run effects of immigration may be misstated. Our contribution is to argue the many documented outcomes increases the potential persistence of the system: if outcomes influence one another even weakly over time, persistence of a shock grows nonlinearly with the number of outcomes. Heath et al. (2019) make an argument related to this paper's focus: the repeated use of natural experiments increases the likelihood of false discoveries. Heath et al. (2019) examine two in particular: the Regulation SHO pilot and business combination laws, which we do not touch on in this paper. Finally, Young (2019) notes that a number of top instrumental variables papers rely on outliers. Our Monte Carlo evidence finds outliers are increasingly likely in small sample multiple-paper IV situations.

Section 2 discusses a framework for thinking about multiple-paper exogeneity violations. There exists no clear panacea when dealing with multiple regressions. While including another paper's regressors is sometimes enough to guarantee consistent estimates, it could also cause inconsistent estimates. Section 3 discusses our data collection and criteria for journal inclusion. Section 4 discusses in detail each of the six potentially problematic instruments. Second 5 produces Monte Carlo evidence on IV estimator performance in a multiple-paper setting. Section 6 concludes.

II Framework

In this section, we outline four potential pitfalls stemming from repeated use of the same instrument or use lagged values of a variable as an instrument for a covariate that affects many outcomes. The first is the obvious “direct" violation of exogeneity described by Morck and Yeung (2011). When two separate papers use the same variable Z as an instrument for both X_1 and X_2's relationship with outcomes Y_1 and Y_2 respectively, we must be concerned with whether X_1 affects Y_2 or X_2 affects Y_1, a standard violation of exogeneity. It is possible that controlling for X_2 or Y_2 induces a violation of the exclusion restriction where none would have occurred in the absence of controls. The third occurs when covariates are used as proxies for a broader concept (e.g. using education as a proxy for human capital), as the significance of other outcomes from other papers may contradict the causal story. The last occurs when a variable affects many outcomes that are potentially persistent. Even if the persistence of each individual outcome variable is relatively weak, the variables can generate substantial persistence jointly. This strong joint persistence can induce significant serial correlation, invalidating the instrument.

Figure 2 demonstrates the first two “direct" and “indirect" violations using directed acyclic graphs (DAGs). The lefthand DAG (“Possibility 1") shows two papers, Paper 1 and Paper 2. Paper 1 is interested in the relationship between X_1 and Y_1. Paper 2 is interested in the relationship between X_2 and Y_2. These relationships are confounded by unobserved variables ξ and ν, respectively, and require an instrumental variable Z, which is the same for both papers. The implicitly-assumed DAG for Paper 1 is circled and given by the solid red lines, while the implicitly-assumed DAG for Paper 2 is circled and given by dashed blue lines. While both papers establish the solid red and dashed blue lines as important, their joint publication gives rise to concerns depicted in the dotted bidirectional black lines (among others).

In Possibility 1, X_2 may affect X_1 or Y_1, and Y_2 may affect Y_1. This might be the case, for instance, if a city’s elevation gradient and the presence of bodies of water affected both local changes in housing prices during a national housing market downturn, which affects local change in employment (Paper 1) as well as segregation and local school choice, which affects local educational outcomes (Paper 2). Consistent with Figure 2, it is likely that segregation and local school choice might affect both the change in housing prices and cyclical changes in local employment and that educational outcomes may also cause cyclical changes in employment. The importance of Paper 2 raises concerns about Paper 1’s causal channel and identification. Fortunately, in this situation, because Paper 2’s outcomes are known, controlling for X_2 and Y_2 is enough to properly identify the affect of X_1 on Y_1 in Paper 1.[4] A paper analyzing the effect of

[4]It is easy to see that the effect of X_1 on Y_1 will be consistently estimated by instrument X_1 with Z and controlling for X_2 and

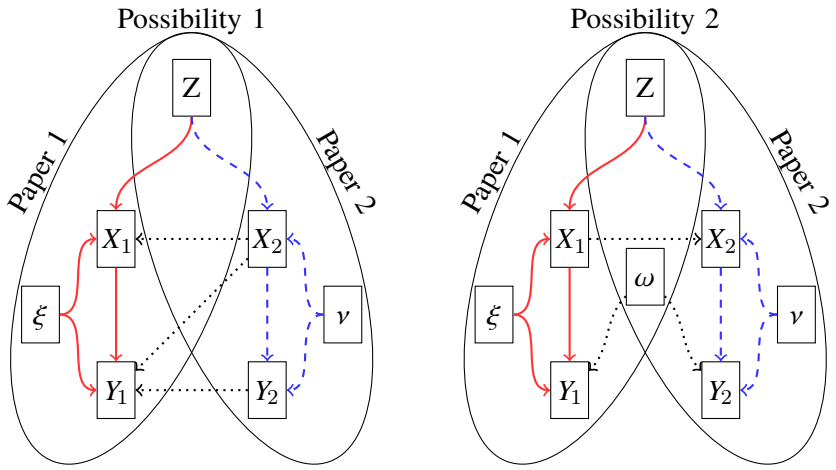

Figure 2: This figure uses a DAG to depict two different possibilities when the same instrument is used in two different papers. In each example, the implicit DAG for the two papers are circled and labelled. In both examples, the first paper's DAG is depicted using a solid red line, and estimates X_1's relationship to Y_1 using Z as an instrument, removing the confounder ξ. Similarly, the second paper's DAG is depicted using a dashed blue line, and estimates X_2's relationship to Y_2 using Z as an instrument, removing the confounder ν. The difference between the two examples is the dashed black lines, which are unmodelled in either paper. As discussed in the text, for Paper 1 to accurately estimate for X_1's effect on Y_1, in the first example, it must control for both X_2 and Y_2. However, in the second example, it must *not* control for both X_2 and Y_2, as this would induce a violation of strict exogeneity, even though no such violation is present in either of the two papers separately.

housing prices at the business cycle need only to control for segregation measures in this case.

The same cannot be said in Possibility 2. Note in Possibility 2, the two outcomes are completely causally unrelated as regards Z and X's and are only affected by the same variable ω. In Possibility 2, Paper 1's *not* controlling for X_2 and Y_2 is sufficient for identification.[5] However, controlling for X_2 and Y_2, induces spurious correlation where there was none via residual regression and Berkson's paradox between X_1 and Y_1. In this way, in Possibility 2, Paper 1's estimates of the effect of X_1 and Y_1 are contaminated even though there is no casual chain. This might be the case if, for instance, if XXX. Consider the case in which sibling composition instruments for family size, which affects both child mortality (as an adult) and child geographic mobility. It is possible these two causal chains are largely unrelated and each paper may independently use the instrument correctly. However, if a child's IQ affects both their adult mortality and

Y_2, because it satisfies both criteria of Pearl (2009): controlling for X_2 and Y_2 closes all backdoor paths, and we are conditioning on no descendants.

[5]This can be seen from the fact that ω is a confounder, but only has the opportunity to bias X_1's estimates via the inclusion of X_2 and Y_2.

their adult geographic mobility, controlling for child geographic mobility induces a correlation via IQ, violating the exclusion restriction.

While repeated use of an instrument for multiple combination of endogenous variables and outcomes is cause for concern, Figure 2 makes it clear there is no panacea. In the first case, controlling for the relevant endogenous covariates and outcomes is enough to produce a valid estimator, while in the second, controlling for the same endogenous covariates and outcomes is enough to invalidate an otherwise valid estimator by inducing spurious correlations.

The third problem deals with the causal scrum that occurs when each new outcome is found to be significant. First, as the number of outcomes proliferates, the likelihood that some seemingly innocuous control is in fact a mediator through an unthought-of channel increases, and controlling for it would invalidate the estimate of the total effect of X_1 on Y_1. Second, it raises the possibility that significance on Y_2 suggests the "proxy" story behind the relationship between X_1 and Y_1 is incorrect.[6] In this case, every additional outcome opens up an additional potential causal channel to exogeneity violation. The idea behind this concern is depicted with a concrete example in Figure 3. Brückner and Ciccone (2011) use rainfall to instrument for transitory negative income shocks, which are positively related to democratic regime change. The paper argues this is consistent with the theory in Acemoglu and Robinson (2001), that democratic improvements may occur during recessions, when income is low and so the opportunity cost of unrest is low. However, rainfall's affect on income is also found to affect risk preferences, population size, school attendance, and urbanization, which may muddle estimates of the causal effect of lower income. For instance, the Folk theorem in game theory suggests agent discount rates are highly relevant in what repeated-game equilibria may be supported. If rainfall affects discount rates through income, it calls into question the idea payoffs alone are affected by rainfall. While the presence of multiple outcomes does not necessarily invalidate papers that use proxy variables, it does call into question whether the proxy is a pure proxy or is contaminated by causal channels not advocated for in these papers.

Figure 4 depicts the fourth and final way in which multiple uses of an instrument may induce exogeneity violations. As in Card (2001), suppose we wish to estimate the affect of immigrants on local education or local land values. However, identification is threatened by the tendency of immigrants to immigrate to places where wages are high, housing prices are low, and education is high quality per unit cost. This produces confounders that threaten identification, depicted as dotted arrows connecting ΔX_t with Y_t^1 and Y_t^2. To obtain accurate estimates, it is thus necessary to find an instrument for current immigration flows

[6]This point is also made in Heath et al. (2019), which studies two natural experiments: state business combination laws and Regulation SHO pilot that have been used for more than 120 academic papers.

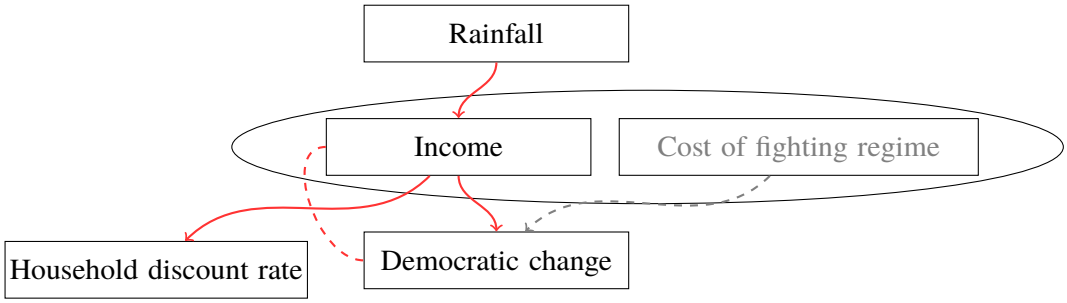

Figure 3: This figure shows an example of how proxy variables are often used. In the first paper, income is used as a proxy for the cost of fighting a regime, which leads to democratic change. However, another paper establishing that income also affects discount rates raises concerns regarding the assumed "proxy relationship" between income and democratic change.

that does not affect local education or local land values.

A traditional solution to this particular problem is to use past immigration as an instrument for current immigration. Bartel (1989) finds immigrants tend to immigrate to places where there are already many immigrants. He argues this is due to "supply side" factors such as culture, linguistic familiarity, or "weak ties" that may be unrelated to "demand side" factors, such as city-level productivity. This reasoning implies current immigrant levels determine a city's exposure to national immigration trends. Thus, if immigration from Mexico increases by 10%, it is plausible that cities with preexisting Mexican immigrant populations will absorb proportionally more of that immigration flow than states with no preexisting population, producing a valid instrument that increases immigration for reasons other than productivity.

However, the proposed relationship between current immigration flows and past immigration flows is subject to criticism. If we believe that ΔX_t affects Y_t^1 and Y_t^2, it is also the case that ΔX_{t-1} affected Y_{t-1}^1 and Y_{t-1}^2. This yields three important avenues by which X_{t-1} may affect Y_t^1 and Y_t^2 other than through ΔX_t. First, it is likely that Y_{t-1}^1 (and similarly Y_{t-1}^2) affects either or both Y_t^1 and Y_t^2.[7] Since X_{t-1} affects Y_{t-1}^1, this establishes another channel through which past immigration can affect outcomes. In the given example, it is quite likely that past education and land values are durable goods. Both are connected to human or structural capital and both have low depreciation rates. Consequently, lagged values of immigration affect current levels of education and capital via persistence of these variables, not simply through immigration today, posing a problem for identification.

Second, it is plausible past change in immigration ΔX_{t-1} not only affects Y_{t-1}^1 and Y_{t-1}^2, but also the level of immigration directly. For instance, the immigrant stock (X_{t-1}, rather than ΔX_{t-1}) likely directly

[7] A similar argument is made in Jaeger, Ruist, and Stuhler (2018). Our contribution is to document the sheer weight of papers finding potential long-run affects

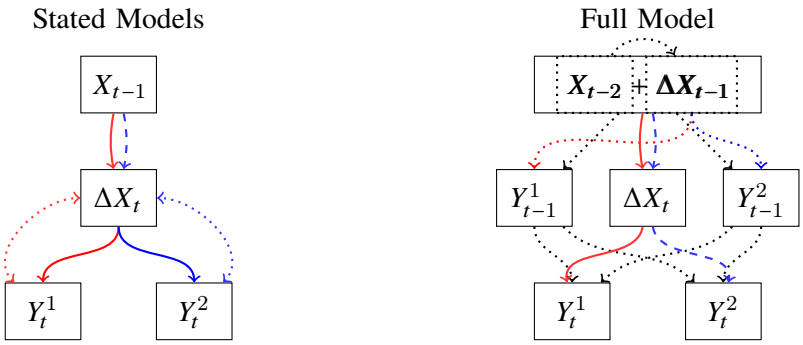

Figure 4: This figure generates a DAG for the "immigrant enclaves" and similar instruments. In the stated model, previous immigration (X_{t-1}) influences immigration flows ΔX_t. In its most "Bartik"-style form, common form, local immigration levels determine exposure to national changes in immigration, which then affect a variety of outcomes, such as education and land values (Y_t^1 and Y_t^2). The "full model" recognizes that if each of the levels of Y_t^1 and Y_t^2 is affected by ΔX_t, then Y_{t-1}^1, and Y_{t-1}^2, and other (unmodelled) covariates are certain to be affected by ΔX_{t-1}, and potentially even X_{t-2}. For instance, we might expect past education and past wages both to affect current education and current wages. These unmodelled effects, that threaten identification and whose likelihood is revealed by multiple outcomes being established, are depicted as black dotted lines. For convenience, the explicit error terms have been omitted from the diagram.

affects land values and education levels, rather than simply through immigrant flows (see, for instance, our discussion of the many long-run affects of ethnolinguistic fractionalization in this paper). Third, while the stock of past immigrants X_{t-2} may affect Y_{t-1}^1 and Y_{t-1}^2, and therefore other variables, it is also guaranteed to indirectly affect them through its affect on ΔX_{t-1}. This is a standard problem with dynamic instruments. The past immigrant stock X_{t-1} is the sum of the past immigrant X_{t-2} and ΔX_{t-1}. However, by assumption, X_{t-2} affects ΔX_{t-1}.

How important is this problem of multiple outcomes? Consider the following vector autoregression for k outcomes, in which all other past outcomes lagged one period weakly affect every other past outcome:

$$
\begin{aligned}
Y_1 &= \sum_{i=1}^{k} \beta_{1i} Y_{i,t-1} + \epsilon_{1,t} \\
Y_2 &= \sum_{i=1}^{k} \beta_{2i} Y_{i,t-1} + \epsilon_{2,t} \\
&\vdots \qquad\qquad \vdots \\
Y_k &= \sum_{i=1}^{k} \beta_{ki} Y_{i,t-1} + \epsilon_{k,t}
\end{aligned}
$$

or, organizing this into a standard VAR matrix:

$$Y = \beta X + \epsilon$$

Consider the case in which β's diagonals are significantly greater than zero (own autocorrelation is significant at one-year lags), but less than one in absolute value. Even if the off-diagonals are only slightly greater than zero, the persistence of a shock increases geometrically as a function of the number of outcomes k and the size of the off-diagonal relations $\beta_{k,j}$, $k \neq j$. Consider the case in which Y_1 (for instance, immigration) is shocked, via $\epsilon_{1,t}$. A number of studies have shown that immigration effects future immigration (via $\beta_{1,1}$), but also native public/private educational decisions (Y_2), maternal labor supply (Y_3), wages (Y_4), voting behavior (Y_5), prices of service goods (Y_6), native health (Y_7), supply of nurses (Y_8), native task intensities (Y_9) and so on. These each plausibly affect one another over time. For instance, we would expect educational decisions, maternal labor supply, and child-rearing choices to potentially affect long-run prices of service goods and/or wages. Indeed, in the case of education and child-rearing decisions, we may expect a delayed response not captured by the 1-period VAR above.

What is the effect of adding more outcomes? Table 1 depicts the results of increasing k, the magnitude of the off-diagonals $\beta_{k,j}$, $j \neq k$, and the diagonal element $\beta_{k,k}$. Table 1 displays two important facts. The relationship between $Y_{1,t+20}$ and $Y_{k\neq 1,t+20}$ is strongly convex in k and $\beta_{k,j}$ when $k > 1$ and when $\beta_{k,j} > 0$.[8] Indeed, for reasonable levels of autocorrelation, such as that caused by $\beta_{k,k} = 0.95$, when $\beta_{k,j} = 0$ and $k = 8$, there is no affect on other variables, and a unit shock to $Y_{1,t-20}$ increases $Y_{1,t}$ by "only" 0.36, and $Y_{2,t}$ by zero. However, if the off diagonal elements are only 0.02, which would appear feasible when discussing relationships like education, wages, labor supply, and prices, the effect of a unit shock to $Y_{1,t-20}$ on $Y_{1,t}$ and $Y_{2,t}$ are 0.91 and 0.87 dramatically higher in both cases. Indeed, adding a ninth variable causes the effect on all variables to be increasing over time, meaning cities diverge in the relevant economic covariates in the long run.[9]

III Data

Our data collection process contained two parts. First, from 1995-2019, all uses of articles with the phrase "instrumental variable" in the American Economic Review, the Journal of Political Economy, the

[8]The geometric relationship between k and $\beta_{k,j}$ can also be shown succinctly the fact that the maximum eigenvalue of β increases linearly as a function of $\beta_{k,j}$ and k.

[9]For a related discussion, see Jaeger, Ruist, and Stuhler (2018).

Table 1: Effects on $Y_{x,t+20}$ from a shock to $\epsilon_{1,t}$

Effects on $Y_{1,t+20}$ from a shock to $\epsilon_{1,t}$						
	$\beta_{k,k} = 0.8$			$\beta_{k,k} = 0.95$		
k	$\beta_{k,j} = 0$	$\beta_{k,j} = 0.02$	$\beta_{k,j} = 0.04$	$\beta_{k,j} = 0$	$\beta_{k,j} = 0.02$	$\beta_{k,j} = 0.04$
1	0.012	0.012	0.012	0.36	0.36	0.36
2	0.012	0.013	0.017	0.36	0.39	0.49
3	0.012	0.015	0.029	0.36	0.43	0.70
4	0.012	0.017	0.050	0.36	0.48	1.08
5	0.012	0.021	0.092	0.36	0.55	1.73
6	0.012	0.026	0.17	0.36	0.64	2.85
7	0.012	0.033	0.32	0.36	0.75	4.76
8	0.012	0.042	0.59	0.36	0.91	7.99
9	0.012	0.055	1.08	0.36	1.10	13.37
10	0.012	0.073	1.95	0.36	1.36	22.29
Effect on $Y_{j\neq 1,t+20}$ from a shock to $\epsilon_{1,t}$						
	$\beta_{k,k} = 0.8$			$\beta_{k,k} = 0.95$		
k	$\beta_{k,j} = 0$	$\beta_{k,j} = 0.02$	$\beta_{k,j} = 0.04$	$\beta_{k,j} = 0$	$\beta_{k,j} = 0.02$	$\beta_{k,j} = 0.04$
1	0	0	0	0	0	0
2	0	0.006	0.013	0	0.16	0.33
3	0	0.008	0.024	0	0.20	0.55
4	0	0.011	0.046	0	0.25	0.93
5	0	0.014	0.088	0	0.31	1.58
6	0	0.019	0.17	0	0.40	2.70
7	0	0.026	0.31	0	0.52	4.61
8	0	0.035	0.58	0	0.67	7.83
9	0	0.048	1.07	0	0.87	13.22
10	0	0.066	1.95	0	1.13	22.14

Table 1: This table displays the effect on $Y_{1,t+20}$ after introducing a unit shock to $\epsilon_{1,t}$ twenty periods earlier, depending on the own autocorrelative term ($\beta_{k,k}$, the off-diagonal autocorrelative term ($\beta_{k,j}$) and the number of linked outcomes (k). The top panel displays effects on Y_1, while the bottom panel displays effects on $Y_{j\neq 1}$.

Quarterly Journal of Economics, Econometrica, and the Review of Economic Studies were catalogued. This resulted in approximately 684 papers with more than one thousand paper-instrument-outcomes due to either multiple instrumented-covariates or multiple outcomes being examined. Many of these papers included common instruments, such as (1) dynamic panel instruments outlined in Arellano and Bond (1991) or Blundell and Bond (1998) (2) competing product characteristics or counts as in Berry, Levinsohn, and Pakes (1995) (3) Bartik (1991) instruments, with the exception of “immigrant enclaves", and (4) Frankel and Romer (1999) “gravity" based instruments. This paper does not discuss any of these extremely common instruments.

We then examined this list and found the six potentially concerning instruments discussed above.

Following this, we searched for uses of these instruments on economic journal-hosting websites, Elsievers, Online Wiley, JSTOR, and some journal-specific websites. If an article cited use of an instrument or a related instrument, we pursued that lead, yielding some journals not in our original search criteria but relevant to and cited in the literature. Our target journal was typically in the top sixty journals in RePeC's journal rankings. This garnered additional papers relevant to these six instruments. Importantly, the text below cannot possibly touch on all the uses of these instruments, and consequently we attempt to discuss only the most highly relevant papers, though we include other papers in our tables.

IV Six Instruments

We discuss each of the six instrumental variables separately.

Elevation and bodies of water

Changes in elevation and the presence of bodies of water (including rivers and streams) are used as an instrument 21 times in "top five" papers, and 23 times in top field or general interest journals. They are used, either implicitly or explicitly, to instrument for approximately fifteen outcomes: (1) change in housing prices (2) change in housing stock (3) city density (4) farming (including income) outcomes (5) enterprise (6) segregation (7) school governance structure (8) number of county governments (9) presence of dams (10) cost of highways (11) broadband provision (12) share of developed land (13) access to international markets (14) access to domestic market center and (15) presence of piped water. These fifteen instrumented covariates are then used to estimate more than thirty-five unique outcomes, from household health, longevity, and fertility, to firm earnings, worker wages, household education decisions, and investment outcomes, to air quality, industrial composition, trade openness, and educational efficiency.

Perhaps the most important recent paper in this literature is Saiz (2010), which produces city-specific estimates of the elasticity of housing supply. Because housing prices and quantities are determined by supply and demand, and because residents in more inelastic cities are more able to increase prices through more regulation, the paper must instrument for both the demand-side of housing and for regulation, which is coincident with the elasticity itself. To deal with these issues, the paper first produces novel measures of developable land by calculating the amount of MSA area either lost to internal bodies of water (including rivers, lakes, wetlands, and other water features), lost to oceans and the Great Lakes, or lost because the soil gradient is 15% or more. To instrument for both demand, Saiz (2010) uses the interaction of

land unavailability with a shift-share industrial composition instrument, immigration shocks, and average January hours of sun, along with their levels. In analyzing the simultaneous role of regulation, the paper instruments for local housing regulation using the share of local expenditure spent on protective inspections and the nontraditional Christian share in 1970. With instrumented regulation and quantities, Saiz (2010) is able to estimate housing supply elasticities. Importantly for this paper, Saiz (2010) uses immigration shocks, average city weather 1941-1970, and elevation and bodies of water together as instruments. While this paper flags these instruments as concerning, Saiz reports that the results are similar if each instrument, including additional instruments of climate or immigration, is used *separately* as well. This implicit overidentification-style test may help alleviate some concerns about using these instruments.

Saiz's measure has been influential: the paper has more than 1200 citations in Google Scholar as of Fall 2019. A number of top journal articles have been based around using the housing supply elasticity measures of Saiz (2010) along with the change in national housing prices, in a Bartik-like framework. Mian and Sufi (2009) and Glaeser, Gyourko, and Saiz (2008) both establish strong relationships between Saiz's measure and housing price changes, but do not use it as an instrument. However, Mian and Sufi (2011), Mian, Rao, and Sufi (2013), and Mian and Sufi (2014) use Saiz's elasticities combined with national housing prices to measure the exposure of MSA's to exogenous housing price declines. This is used to instrument the actual housing price decline, which then affects debt growth, employment growth, and the change in consumption for each paper respectively. It is also used as an instrument for the same variable to understand the affect of housing downturn exposure on the purchase of automobiles (Berger and Vavra, 2015), corporate investment (Chaney, Sraer, and Thesmar, 2012), and industrial composition (Beaudry, Green, and Sand, 2012). This multiple use of the same instrument on the same covariate for different outcomes may not ordinarily be concerning.[10] However, religion has been used to establish housing supply elasticity, and local religiosity (instrumented for with area ancestry) may causally affect education, marriage and divorce rates, and welfare disability receipt (Gruber, 2005). Religion is also related to social trust, bank regulation, beliefs about redistribution, and private school presence (Zak and Knack, 2001; Barth et al., 2013; Guiso, Sapienza, and Zingales, 2006; West and Woessmann, 2010). It is plausible the latent variables affecting education, marriage, social trust, beliefs about redistribution, and actual welfare receipt affect business cycle dynamics, corporate investment, and household portfolio choice.

[10]Saiz's values for land elasticity, not used in conjunction with national housing prices, has also been found to be linked to the long-run income and population convergence patterns of cities (Ganong and Shoag, 2017), suggesting that high-income cities with relatively less elastic housing may have experienced atypically low income convergence compared to historical norms.

Elevation and the presence of water around a city are also important factors in dam construction (Duflo and Pande, 2007). Duflo and Pande use river gradients as an instrument for dam construction in India, finding that "...A gentle river gradient (1.5-3 percent) increases the number of dams, while a steep gradient reduces it. However, a very steep river gradient (more than 6 percent) increases dam construction." Dams are not unimportant: as the authors report, 19% of the world's electricity supply, and 30% of irrigated land is generated via dam. Lipscomb, Mobarak, and Barilam (2013) find the presence of dams (instrumented using river gradient) to be causally related to local longevity, income, education, infant mortality, poverty rates, urbanization, illiteracy, human capital measures, and years of school. Taken together, these papers suggest many economic variables may be affected by rivers, bodies of water, and gradient changes other than via the elasticity of housing supply.[11] Finally, dams are found to mitigate the affects of weather shocks (discussed in another section) on agricultural production (Sarsons, 2015).

Rivers and bodies of water instrument not only housing availability and dam presence, but also segregation (Cutler and Glaeser, 1997), school competition (Hoxby, 2000),[12] and the number of county governments (Alesina, Baqir, and Hoxby, 2004; Hatfield and Kosec, 2013, 2019). While these are separate endogenous covariates, they are linked to rivers because rivers "divide MSAs into natural subunits." Instrumented-for segregation is found to differentially affect a number of important economic outcomes, such as education, income, and single motherhood, all by race (Cutler and Glaeser, 1997). Indeed, the fact that bodies of water are linked to differential labor market outcomes by race suggests that other outcomes, such as consumer spending over the business cycle, may differ in these cities for reasons other than housing prices. Instrumented-for school governance structure is found to improve student achievement and school efficiency. Smaller governments are found to compete less on regulation, and as a consequence affects economic development (Hatfield and Kosec, 2013) and air quality and industrial composition in the form of employment in polluting industries (Hatfield and Kosec, 2019).

Finally, while not used as an instrument per se, Felkner and Townsend (2011) find that "growth in enterprise is more likely in areas of lower, flatter elevation and in areas closer to rivers and waterways." They additionally find being near these naturally enterprise-friendly areas spurs enterprise in surrounding areas, suggesting a strong spatially autocorrelated role for both elevation and rivers. Additionally, the

[11] It is also worth noting that because dams are important sources of electricity, and their power generation is subject to weather conditions, weather interacted with dams (discussed below) has been used as an instrument for electricity production as well (Allcott, Collard-Wexler, and O'Connell, 2016), leading to potentially differential affects of weather and climate for these cities. The authors also note that this may lead to different industrial composition in the long run.

[12] Hoxby (2000)'s definition of streams included inlets, lakes, ponds, marshes and swamps if they are "roughly curvilinear in form."

presence of rivers have been used as a source of potential traffic congestion in Winston and Langer (2006).

Figure 5 below summarizes a subset of papers dealing with elevation and water graphically. Blue are the instruments or measurements created from the presence of elevation changes and bodies of water. In pink are the instrumented-for endogenous covariates. In red are outcomes. As can been seen, slopes and bodies of water have the potential to affect an incredible variety of covariates in independent ways. Because most of these covariates of interest are important, such as a city's segregation, or educational efficiency, housing elasticity, or presence of a dam, they are likely to affect other economic outcomes of interest, which should make researchers wary when using this instrument.

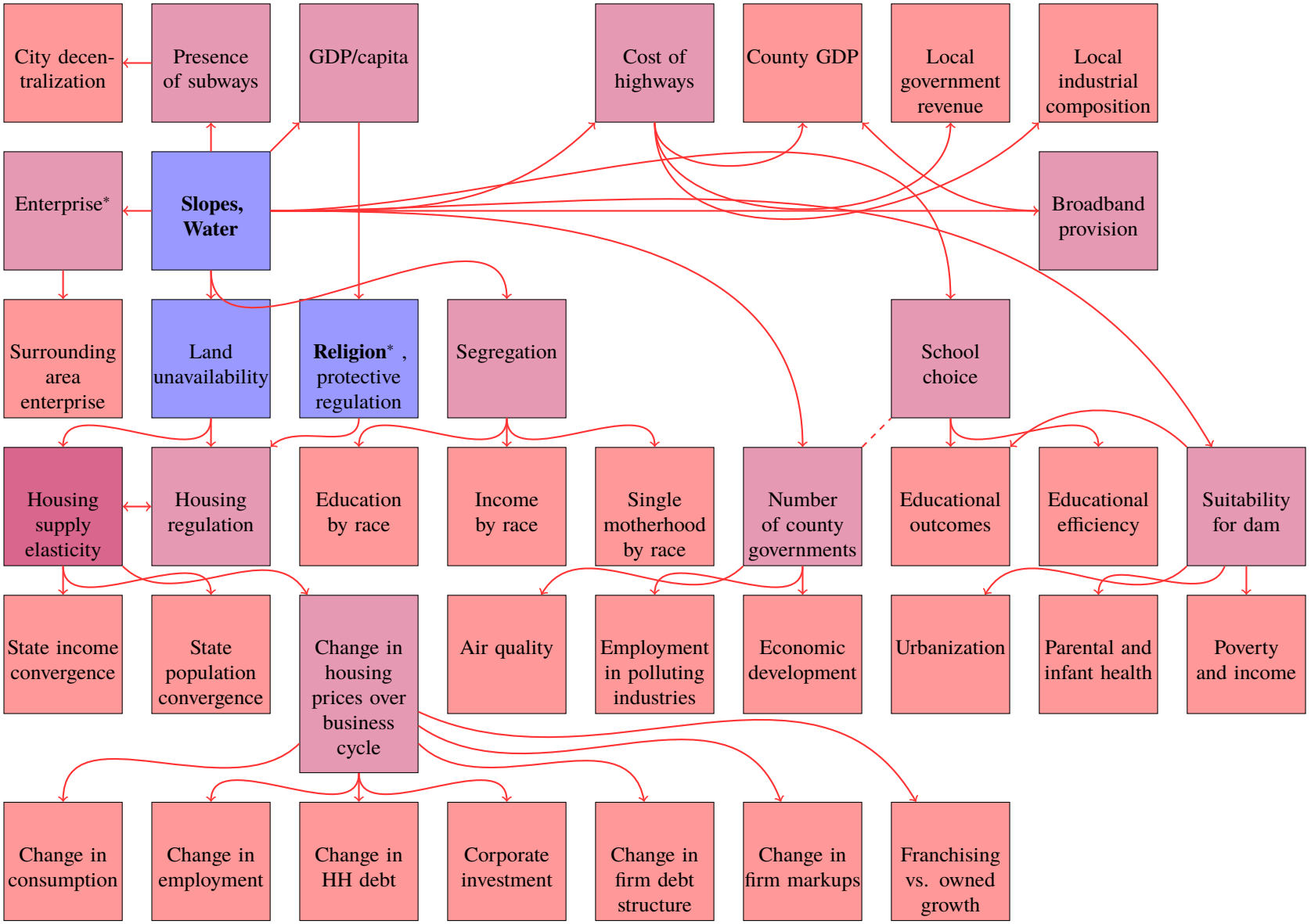

Figure 5: This figure summarizes selected research using elevation and bodies of water as an instrument. Blue are the instruments or measurements created from the presence of elevation changes and bodies of water. In pink are the instrumented-for endogenous covariates. In red are outcomes. Enterprise* is not directly treated as an instrument. A more complete list of 55 paper-instrument-outcomes can be found in Appendix Table XXX. Some variables, such as “city decentralization" and “urbanization" or “economic development" "GDP/capita" and “poverty and income" are listed in multiple places for legibility.

Sibling structure

Perhaps because it is available in many datasets, the age/gender composition of an individual's siblings is a popular instrument, and is used 12 times in "top 5" papers and 36 times well-ranked other journals. In one early paper, gender mix is used as an instrument for women's education, which affects earnings (Butcher and Case, 1994). However, Angrist and Evans (1998) argue households desire a mixed sibling sex composition, as households whose first two children are girls are empirically more likely to have a third child. Thus, they use sibling gender mix to instrument for family size, which affects maternal labor supply. Gender mix as an instrument for family size is also used to study child private school attendance and academic performance (Conley and Glauber, 2006), parental marital status and non-traditional family living, income, health insurance, and blood pressure and obesity (Cáceres-Delpiano and Simonsen, 2012), as well as child BMI and illness (Palloni, 2017).

However, the gender and age mix of children is also used as an instrument for welfare generosity. According to housing and urban development rules, children of opposite sex who are not very young cannot be required to share a bedroom. Thus, a household with two girls is less likely to receive generous housing benefits. Consequently, child gender mix is also used as an instrument for children living in a public housing project, which affects the neighborhood they live in, their school quality, and whether or not children repeat a grade (Currie and Yelowitz, 2000).

While households are more likely to have a third child if they initially have two girls (as opposed to mixed gender or two boys), they are also more likely to get divorced if their first child is a girl. Lundberg and Rose (2003) show a link between first-born child sex and female marital status, finding first-born sons are more likely to cause a mother to transition into marriage. Bedard and Deschenes (2005) use first child sex as an instrument for marital dissolution, which affects female earnings (differentially by income category). Ananat and Michaels (2008) also find that having a female first-born child increases marital dissolution, finding it causes dispersion in earnings, increasing both very high and very low income households. Dahl and Moretti (2008) find households with a firstborn son are more likely to remain intact, which they argue is due to the desire of fathers for sons. Instrumenting for absentee fathers with the firstborn child's gender, they estimate an effect on family income of $128/year (intent to treat), or $18,000/year for the households whose father leaves due to child gender. These papers suggest child gender composition and order strongly influence family dissolution in addition to family size, and may affect many of the same variables of interest through a distinct causal channel.

Because women become mothers at an earlier age than men become fathers, first-born child sex is also

used as an instrument for the age at which a parent becomes a grandparent. (Rupert and Zanella, 2018) find that a woman whose first child was a girl becomes a grandmother 2.5 years earlier than if her first child was a boy. The instrumented effect of being a grandparent is to reduce the total annual hours of women aged less than 80 who have children above the age of 14 an economically meaningful amount: by 32% (from 1600 hours per year). Dynamic optimization suggests a mother with knowledge of this is likely to change her education, marriage, and labor force decisions earlier in life for reasons other than simple family size, offering a third causal channel.

The age and gender mix of siblings is also used as an instrument for sibling contribution for parental care, which affects a child's own contribution to parental care (Antman, 2012), parental nursing home use (Houtven and Norton, 2004), child depressive symptoms (Coe and Van Houtven, 2009), and child employment and hours worked (Bolin, Lindgren, and Lundborg, 2008). It is also used as an instrument for migration, which affects earnings Abramitzky, Boustan, and Eriksson (2012) and parental outcomes Antman (2010).

Number of siblings itself is used as an instrument for a variety of outcomes. For instance, Levin and Plug (1999); Taber (2001); Korpi and Tåhlin (2009) use it as an instrument for schooling, which affects wages. The same method is also used (with other instruments) to show the affect of schooling on smokers quitting smoking (Sander, 1995). Ziliak and Kniesner (1999) allow the number of children to affect labor supply (but not other parameters) in their model, though do not formally use it as an instrument.

Closely related are studies that use twins as an instrument. Typically twins are also used to instrument for family size, and instrumented family size affects whether or not a mother is ever married, her labor force participation, earnings, family earnings, welfare receipt, and poverty status (Bronars and Grogger, 1994; Angrist and Evans, 1998)[13]. Twins as an instrument for family size also affect divorce rates (Jacobsen, Pearce, and Rosenbloom, 2001), child personality (Fletcher and Kim, 2019), whether or not a child is living without a father (Dahl and Moretti, 2008), child IQ (Black, Devereux, and Salvanes, 2010), child schooling (Åslund and Grönqvist, 2010), children's own family size (Kolk, 2015), and children's geographic distance from their mother (Holmlund, Rainer, and Siedler, 2013).

One potential flaw of using twins as an instrument for family size is that it not only affects the age composition of siblings, which as described affects a number of outcomes via a different channel than family size, but also the gender composition. There appears to be an excess of same-sex non-identical twin pairs even beyond that which would be predicted by already-unbalanced non-twin live birth ratios

[13]Bronars and Grogger (1994) only report IV estimates in text, not tables, but produce tables in which IV estimates may be backed out.

(James (1971)). Moreover, approximately 75% of twin births were delivered via Cesarean section which appears to be related to long-run child cognitive development, potentially via Cesarean-related after affects such as disturbed gut bacteria (Polidano, Zhu, and Bornstein, 2017). It is also probable short-run child development affected by cesarean-section or twin births affects a multitude of parental choices and child outcomes: for instance, Dahl and Moretti (2008) find evidence that fathers are more likely to leave children with health problems. Finally, by compressing birth events, twin births, also affect mother's age at potential sibling's birth, which has itself been used as an instrument for the presence of a younger sibling, and thereby probability of marriage by an older sibling (Vogl, 2013), maternal employment and thereby child adverse health events (Morrill, 2011), and a child's desired number of children (Rasul, 2008). This suggests twin births may have affects on child and parental outcomes not simply via family size per se, but also through age composition, gender composition, and Cesarean section births.

Figure 6 depicts a subset of the highly interlinked set of regressions that use gender/age composition or twins as instruments.

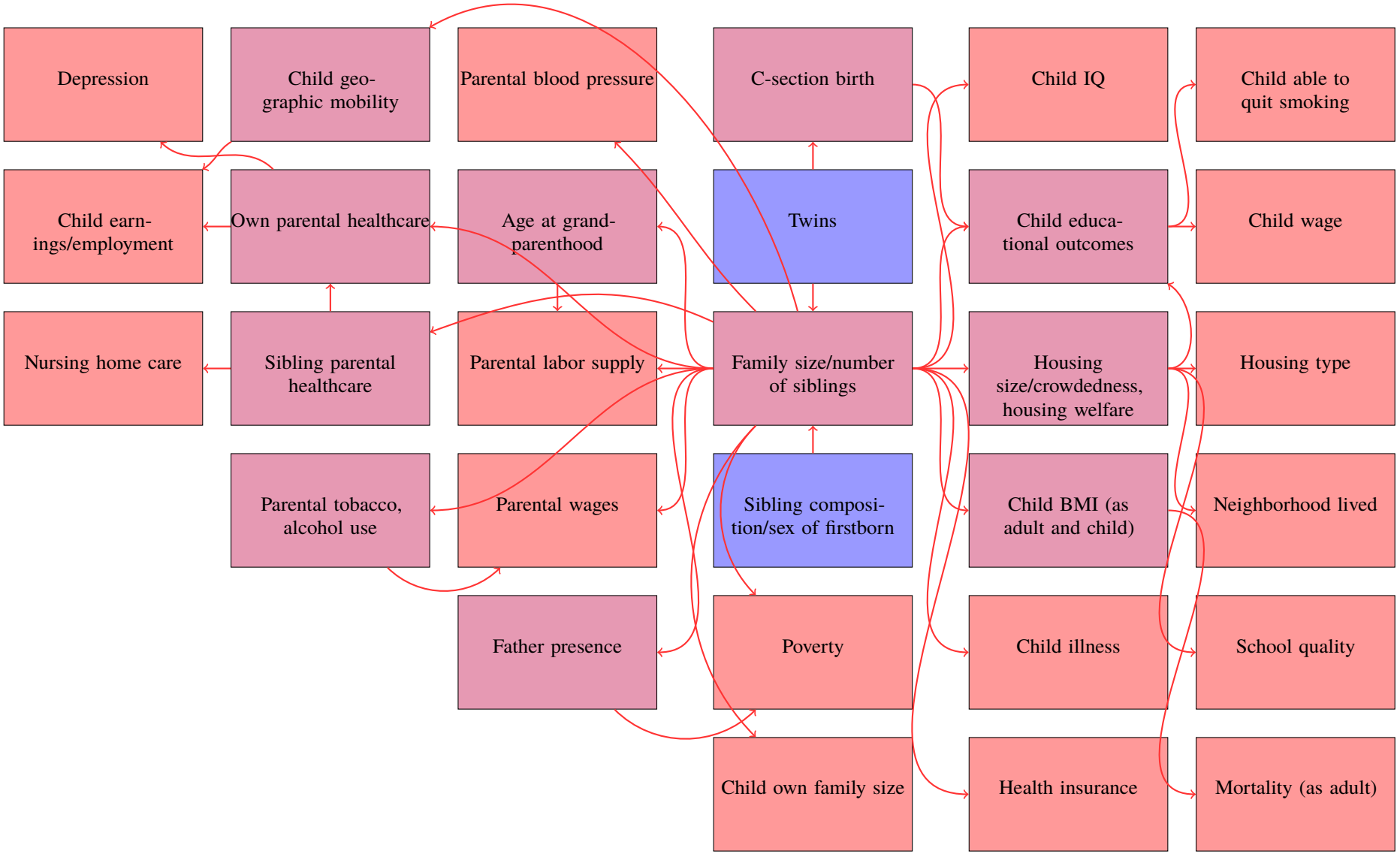

Figure 6: This figure summarizes selected research using sibling structure. The main instruments are in blue, the endogenous covariates are in purple, and the outcomes are in pink. Some papers use family size and sibling structure directly to instrument for other covariates of interest, so it is also linked to endogenous covariates.

While information on siblings is present in many datasets, it is used for such a large variety of outcomes that its use as an instrument must be limited. Many of these uses, such as the likelihood siblings will be present to take care of an elderly parent, child geographic mobility, and parent's age at grand-parenthood are likely to affect decision-making such as education earlier in the lifecycle via household planning. Worse, while a household member may know which sibling is likely to live near parents when older and provide care, that information is far less likely to be available to researchers.

Ethnolinguistic fractionalization and language

Ethnolinguistic fractionalization (ELF) and similar concepts, including ethnic fractionalization, linguistic fractionalization, ethnolinguistic polarization, or fraction speaking a European language[14], are frequently used to examine the affect of "institutions" or "governance" on relevant economic outcomes, most importantly growth. However, governance is a broad concept, and these ethno-linguistic measures are used to discuss multiple distinct but interrelated concepts. Usefully, Kaufmann, Kraay, and Zoido-Lobatón (1999) breaks governance into three fundamental aspects of governance: (1) the rule of law, (2) bureaucratic efficiency/effectiveness, and (3) graft/bribery. As noted in Hall and Jones (1999), a useful economic definition might quantitatively map these to the wedge between private costs and returns, or private returns and social returns. However, in practice these indices are taken as given, assuming the difference in a wedge from increasing in a corruption index from a one to a two, and then from a two to a three are the same, though they might not be.[15] There are therefore three immediate problems with how ELF and related concepts are commonly used. First, different papers focus on very different governance concepts, second, the indicies are not necessarily well-scaled, and third, it is used to instrument for a variety of endogenous covariates, even beyond governance.

With regards to the first issue, one of the first papers to examine ethnolinguistic fractionalization, Mauro (1995), uses ELF to instrument, in different regressions, for both corruption's effect on investment and growth and then for bureaucratic efficiency's effect on investment and growth. Notably, bureaucratic efficiency includes judiciary efficiency, red tape, and corruption. However these three concepts are not the

[14]While fraction speaking English or another European language is potentially different in concept, the correlation between speaking a European language and ethnolinguistic fractionalization is -0.29 (taken from Hall and Jones (1999) and Bazzi and Clemens (2013) data). ELF and related concepts are used 4 times in "top 5" papers and 37 times in other, well-regarded journals. In a regression of fraction speaking a European language on ethnolinguistic fractionalization, for every 1% more fractionalized a society becomes, it is -0.4% less likely to speak a European language.

[15]We could find no evidence that the governance indicies commonly used are well-scaled. This scaling problem has the potential to flip regression results, as it does for test scores in Bond and Lang (2013) and happiness rankings in Bond and Lang (2019) .

same: for instance, using Mauro's data, we calculate that even after extracting the portion of "red tape" that covaries with "corruption," there is still a strongly positive correlation between red tape and ELF. While such regressions might plausibly suggest institutions affected by ELF matter, which institutions is unclear. Indeed, after controlling for investment in separate regressions, Mauro (1995) notes corruption's statistical importance on growth vanishes, while bureaucratic efficiency's does not. This suggests ELF acts through corruption to reduce investment, but also through other channels related to bureaucratic efficiency (including investment itself).

As an instrument for corruption alone, ELF has been used by Michaelides et al. (2015) and Michaelides, Milidonis, and Nishiotis (2019) to instrument for a country's Transparency International's "Corruptions Perceptions Index," which we denote as TI Score. While the TI score is generated from a range of 13 different sources, the questions primarily appear to focus on the inappropriate use of public funds for private gains and bribery.[16]They find higher corruption is linked to information leakages before government debt downgrades and high volatility of asset prices and exchange rates.

[16]Most of the sources are surveys, one of which is Mauro (1995)'s own source Business International.

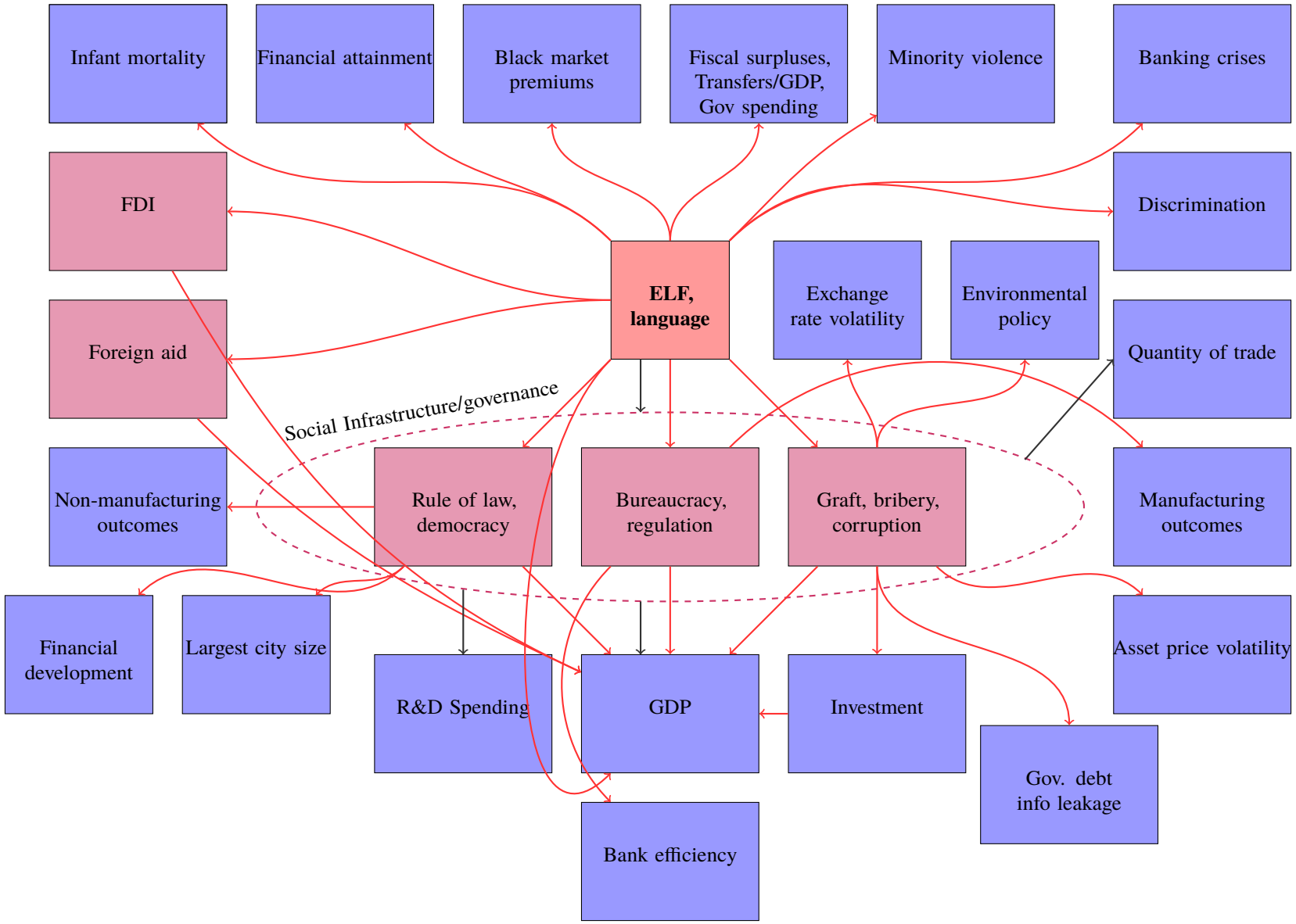

Figure 7: This figure summarizes selected research using ethnolinguistic fractionalization as an instrument. Instrument is in blue, endogeneous covariates in purple, and outcomes in pink. Because ELF is used for both agglomerations of (1) rule of law/democracy, (2) bureaucracy and (3) regulation and graft, bribery and corruption, as well as each individually, we depict with black lines generating from a dashed circle outcomes that use agglomerations (“social infrastructure/governance").

ELF is also used as an instrument for “governance" more broadly, which typically includes not only corruption but also governmental efficiency and the rule of law. For instance, in their large sample regressions, Rodrik, Subramanian, and Trebbi (2004) use fraction speaking english as an instrument, among others, to instrument for both the rule of law and for market integration, finding per-capita GDP is primarily determined by institutions rather than integration. Importantly, the fraction speaking english and other European languages had a significant affect on both concepts. Wang (2013) uses ELF as an instrument on the first principle component of all three types of governance from the Worldwide Governance Index, finding the first principle component of “governance" significantly affects R&D spending. Méon and Sekkat (2008) allow ELF, along with distance to the equator and legal origin, to instrument separately for three different concepts of governance. They find the rule of law may cause a statistically significant increase in non-manufactured goods (but not total trade or manufactured goods), while governmental efficiency (specifically the regulatory framework) affects manufacturing exports (but not total or nonmanufactured exports). Finally Mon and Sekkat also find democracy appears to cause increases in nonmanufactured trade, but not total or manufactured trade. Ades and Glaeser (1995) use ELF, along with other variables, as an instrument for a country being under both dictatorship and its trade policies, which affects main city size.

While noting “social infrastructure" should measure the wedge between social and private returns, Hall and Jones (1999) construct their measure by taking the sample average of measures of (1) law and order, (2) bureaucratic quality (3) corruption (4) expropriation risk (5) government repudiation of contracts and (6) years open to international trade, with the first five given 10% weight each and the last 50% weight. They then instrument this measure with fraction speaking English and fraction speaking a European language, finding it was correlated strongly with total factor productivity. Similarly, Alcala and Ciccone (2004) use the fraction of a country speaking a European language, along with other instrumental variables, to instrument for both institutional quality, (which is a combination of government effectiveness, rule of law, and graft, to be comparable with Hall and Jones) and for quantity of trade (real openness). Importantly, European language is significant in both regressions.

While Hall and Jones argued European languages are naturally correlated with the extent of Western European influence on social infrastructure, it also likely plays a different role through aid. However, having a common language with foreign aid givers is also used as an instrument for foreign aid, which causes growth (Rajan and Subramanian, 2008). Relatedly, Kourtellos, Tan, and Zhang (2007) find ethnolinguistic fractionalization interacted with aid had differential effects on growth. Moreover, in a secondary regression

Delgado, McCloud, and Kumbhakar (2014) instrument for foreign direct investments using ELF, finding it positively related to growth. However, this potentially undermines the suggested relationship between aid and growth. In addition, language is also used as an instrument for gender discrimination, which affects migration from a country (Ruyssen and Salomone, 2018).

Finally, three papers find reduced-form relationships of ELF with a variety of outcomes, with suggestive causal evidence. LaPorta et al. (1999) find ELF is negatively associated with a wide range of government performance inferiority, from property rights and regulation to corruption, delays, tax compliance, public goods, and government intervention. However, they find this is typically reflected through per-capita income and pushed out by latitude: only public good provision and state ownership of firms remain after controlling for those two. Two less causally-focused papers relate ELF to an enormous slew of variables including school attainment, financial attainment, black market premiums, fiscal surpluses, infrastructure spending, discrimination, and minority violence, (Easterly and Levine, 1997), and also banking crises, property rights, business regulation, transfers and subsidies as a fraction of GDP, democracy and political rights, and infant mortality (Alesina et al., 2003). The sheer volume of ELF's correlation with so many potentially interrelated variables should give a researcher pause. Specifically, (1) foreign direct investment, (2) foreign aid, (3) rule of law and democracy (4) bureaucracy and regulation and (5) graft, bribery and corruption all give rise to distinct causal channels.

Religion

Like ethnolinguistic fractionalization, national, local, or personal religion is a frequently-measured and unambiguously important factor for numerous economic outcomes. Because religion shapes culture, it is frequently used as an instrument for many endogenous covariates and as a control, and shows up seven times in "top 5" papers and 37 times in other well-regarded journals. And, like ethnolinguistic fractionalization, it is also occasionally instrumented-for. We discuss both literatures, as the outcomes of some papers naturally interact with the instrumental validity of others.

Historically, religion is discussed by a number of papers that were relatively careful about causality, but noted it was suggestively and intuitively linked to a number of outcomes. Guiso, Sapienza, and Zingales (2003), "well aware of the difficulty in interpreting the observed correlation as causal effects," find religion is linked to an enormous number of outcomes: attitudes toward a variety of topics, such as cooperation, government, working women, the market economy, and racism, but also legal rules and societal thriftiness. Similarly, LaPorta et al. (1999) link religion to property rights, regulation, tax rates,

corruption, bureaucratic delays, the size of government, public rights, infant morality, illiteracy and schooling, and democracy. Stulz and Williamson (2003) find it correlated with investor productions, McCleary and Barro (2006a) with economic growth, and Brainerd and Menon (2014) with infant mortality.

These correlational papers are important when examining instrumental papers, as they highlight the causal structure of religion's effects. We suggest they may help eliminate some stories. For instance, if any of previous variables, such as bureaucratic delay, tax rates, or corruption affect housing prices in ways other than regulation, the very commonly-used measurements of land elasticities from Saiz (2010) may be mismeasured. Similarly, it is difficult to reconcile all these correlations if religion's only affect on entrepreneurship and savings is through trust, as in Guiso, Sapienza, and Zingales (2006).

Other than being used as an instrument for social trust and for land regulation, religion is used in a variety of other situations. Its use in instrumenting for social trust extends to Bjørnskov (2012), which finds it also affects the rule of law and schooling expenditures. It is used as an instrument for societal respect and responsbility in Breuer and McDermott (2013), which affects per-capita GDP, and for democracy, which also affects per-capita GDP (Mobarak, 2005). It is also used as an instrument for national uncertainty aversion, which affects differential industry-level growth in Huang (2008). Hakkala, Norbäck, and Svaleryd (2008) and Arin et al. (2011) use it as an instrument for corruption, which affects FDI as well as the ability of the government to consolidate spending during business cycle contractions. It also is used as an instrument for the free press, which affects the ability of a government to deceive, specifically by stating an exchange rate regime different from the de facto regime Méon and Minne (2014).

At a micro level, religion is more frequently instrumented-for. For instance, Gruber (2005) instruments local religiousity with area ancestry, finding local religiousity to be causally linked to household income, welfare receipt, marriage, and divorce. These present important explanatory hurdles that any paper using religion as an instrument must pass before being given credence. Similarly, distance to Wittenberg is used as an instrument for protestantism in Becker and Woessmann (2009, 2008, 2018), finding that it affects historical literacy, the gender education gap, and suicide rates. Another instrument for religious (mission) presence has been the initial missionary treks in Mexico, which are found to affect a slew of primary, secondary, and postsecondary school outcomes as well as catholicism (Waldinger, 2017). Another interesting historical instrument for protestantism is a prince's religion after the Peace of Ausburg, which affects hours worked (Spenkuch (2017)). Ultimately, when religion is instrumented for, important causal channels are opened, and even papers not using instrumental variables techniques must address these.

McCleary and Barro (2006b) help cement a concern about religiousity by showing that GDP/capita

(instrumented using latitude and land-locked status) affects country-wide religiosity. The same instruments are used to extract exogenous variation in political constraints, which affect the presence of a state religion Barro and McCleary (2005).

To conclude, religion has been shown to be statistically related to an enormous number of important economic variables. Similarly, it is causally linked in a number of papers to many disparate outcomes. The sheer variety of these outcomes suggests a single causal channel is unlikely. The variety of outcomes and instrumented endogenous variables suggest religion affects many important but different aspects of life, including culture, institutions, governments, regulation, personal morals and preferences.

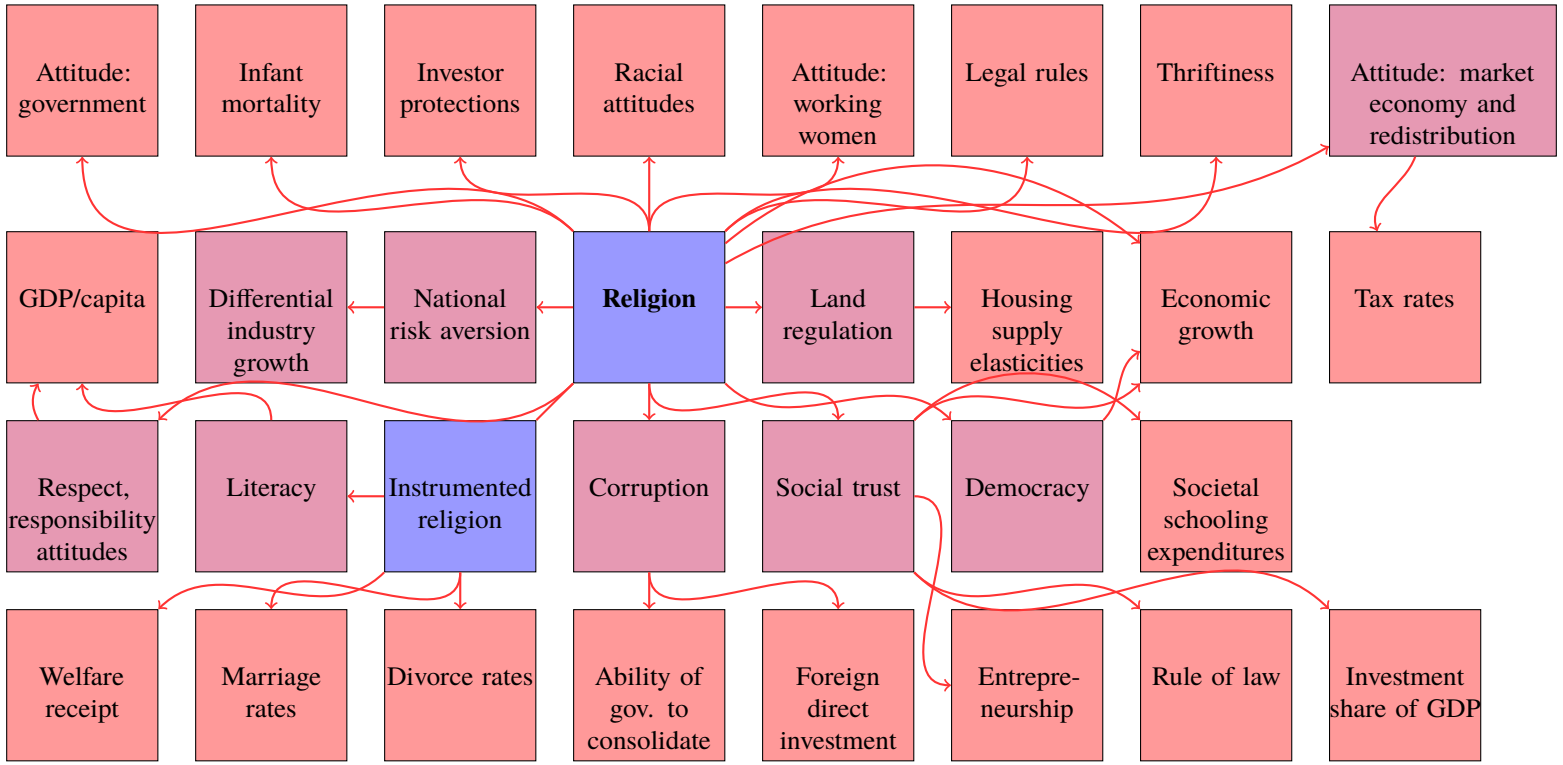

Figure 8: This figure summarizes selected research using religion as an instrument. Instrument is in blue, endogeneous covariates in purple, and outcomes in pink. Many papers link it correlationally to outcomes, which provide potential causal tests of IV papers. Many micro papers instrument for individual religion, and find it correlated with a number of important outcomes. While these papers may not be threatened by other papers in this graph, they may threaten papers and are included for that reason.

Weather

Weather, as distinct from climate, is frequently used as an instrument for a plethora of endogenous covariates, and is in 30 “top five" publications and 40 other well-regarded publications. Perhaps most prominently, rainfall is used as an instrument for income, which affects the likelihood of conflict (Miguel, Satyanath, and Sergenti, 2004), discussed at length by Sarsons (2015). It is used as an instrument for growth or local income shocks, which affects local witch killings (Miguel, 2005), land invasions (Hidalgo et al., 2010), democratic change (Burke and Leigh, 2010; Brückner and Ciccone, 2011), consumption (Kazianga and Udry, 2006), remittances (Arezki and Brückner, 2012a), sale of durable investment goods (Fafchamps, Udry, and Czukas, 1998), trade balance (Brückner and Gradstein, 2013a), urbanization (Brückner, 2012a), manufacturing output, employment and capital investment (Lee, 2018) and the rate of time preference of households (Tanaka, Camerer, and Nguyen, 2010; Di Falco et al., 2019).[17] Rainfall also instruments for both agricultural and fishing productivity (Angrist, Graddy, and Imbens, 2000). Interestingly, while variation in planted crops' susceptibility to rain has been used as a way to generate differential income shocks, Kochar (1999) uses crops planted as a way to better measure weather expectations, suggesting exposure to weather-based shocks is not random.

Rainfall is also used as an instrument for a variety of other outcomes. Rainfall's effects on hydroelectric power and cold/hot days are both used as an instrument for electricity shortages, which affect manufacturing outcomes and industrial output (Allcott, Collard-Wexler, and O'Connell, 2016; Fisher-Vanden, Mansur, and Wang, 2015). Temperature, dew points, and humidity also used to instrument for energy demand, which affects energy prices (Ito and Reguant, 2016). However, agricultural and energy prices are not the only prices affected: rainfall instruments for international commodity prices, and grain prices specifically, (Brückner, 2012b; Mehlum, Miguel, and Torvik, 2006), which affect government tax revenue and crime rates (both property and violent) respectively. It is also used as an instrument for child wages, which affects school attendance (Jacoby and Skoufias, 1997). Indeed, the affect of last month's rainfall on food-staple prices appears to affect this month's trade policy utilization (Giordani, Rocha, and Ruta, 2016). Moreover, rainfall's lag structure itself is used to identify systems of supply and demand equations for staple commodities. Roberts and Schlenker (2013) note past weather shocks affect the supply of storable commodities (via inventories), while current weather shocks affect demand (again via future inventories). Consequently, past rainfall and current rainfall together instrument for supply and demand of corn, rice,

[17] Sarsons (2015) finds rainfall does not affect the agricultural production of districts in India that were downstream of dams, but that conflict in these districts measured via ethnic riots persisted, suggesting conflict was caused by another channel other than income shocks. Sarsons leaves further investigation open for future research.

soybeans, and wheat.

One prominent paper expresses concern about rainfall as an instrument for conflict, Sarsons (2015). Sarsons notes rainfall does not affect income as severely in areas downstream from dams. However, these places still show a strong relationship between rainfall and conflict, suggesting rainfall influenced conflict in ways other than income. While Sarsons (2015) did not find evidence of migration in India in her examination of rainfall as an instrument, others have. Prominently, Munshi (2003) uses past rainfall in a migrant's home community as an instrument for past migration, which affects the size of a migrant community in the U.S., and therefore an immigrant's occupation.[18] Past rainfall's effect on migration also serves to increase ties to a distant location, which reduces savings of stayers, presumably because it reduces the precautionary motive (Giles and Yoo, 2007). Consistent with rainfall-induced migration playing an important role, Jayachandran (2006) finds rainfall affects agricultural productivity, which affects wages differentially depending on the migration costs a district faces. More extreme weather appears to affect migrant flows as well, which acts as an instrument for hourly earnings, lost weeks of work, access to relief jobs, going from full- to part-time work, (Boustan, Fishback, and Kantor, 2010). Drought is also used as an instrument for population, which affects civil conflict (Brückner, 2010).

Weather has a number of potentially more unusual channels as well. Sky cover has been used as an instrument for managerial expansion beliefs (moods), which affect actual hiring and capital investment (Chhaochharia et al., 2018). It reduces the likelihood of industrial inspection that day, which increases industrial pollution (Lin, 2013). It affects pollution in rivers, which affects cancer rates (Ebenstein, 2012). Because viruses thrive in cold and dry conditions, and affect socialization patterns, lagged weather is used as an instrument for disease transmission in flu, acute diarrhea, and chickenpox (Adda, 2016). Rainfall, combined with proximity to health clinics, instruments for acute illness, which affects sectoral labor supply (Adhvaryu and Nyshadham, 2017). It affects protests and thereby later voting behavior (Madestam et al., 2013), and meetings of loan groups, which affects loan defaults (Feigenberg, Field, and Pande, 2013). Rainfall variance (among other variables) is used as an instrument for land concentration, which affects banks per capita (Rajan and Ramcharan, 2011). Finally, it affects first week movie performances, which affects later sales (Gilchrist and Sands, 2016a).

Historical rainfall shocks have also been important. When the United States was on the gold standard, rainfall's effect on cotton production appears to have significantly affected industrial production via a monetary channel (Davis, Hanes, and Rhode, 2009). Vlaicu and Whalley (2016) document that adoption

[18]Giulietti, Wahba, and Zenou (2018) also find that weak ties in a distant location caused by past rainfall's effects on migration increases the probability of own migration.

of a city manager system frequently occurred after severe pre-1936 rainfall shocks. Using historical rainfall events as an instrument for a city manager government (suggesting long-run effects of weather shocks), they find city managers appear to be less prone to political pandering, measured via lower police officer hires and higher officer employment volatility. However, lack of rainfall in the 1930's also instrumentally affected erosion on farmland, and appears to have had long-run affects on agricultural land values for decades afterward (Hornbeck, 2012).[19] Rainfall and rainfall variability is also used as a predictor (but not instrument) for enterprise activity, which affects the enterprise activity of surrounding areas (Felkner and Townsend, 2011).

With so many potential avenues for affecting households and nations, it is perhaps no surprise that rainfall is correlated with long-run affects. For instance, early-life rainfall is correlated with improved health, schooling, and socioeconomic status for women decades later (Maccini and Yang, 2009). Like religion, the sheer variety of endogenous covariates that are instrumented-for, and the number of different outcomes suggests weather, as an instrument, should be looked at carefully. We extend the concern of Sarsons (2015) about rainfall's use as an instrumental variable for income, which affects conflict, by documenting fifteen other uses of rainfall as an instrument that may help explain her results, as well as noting more than thirty other outcomes that may be affected by rainfall.

[19]Using drought as an IV for erosion is only reported in an appendix. Most results are taken as a direct comparison between high- and low-erosion areas.

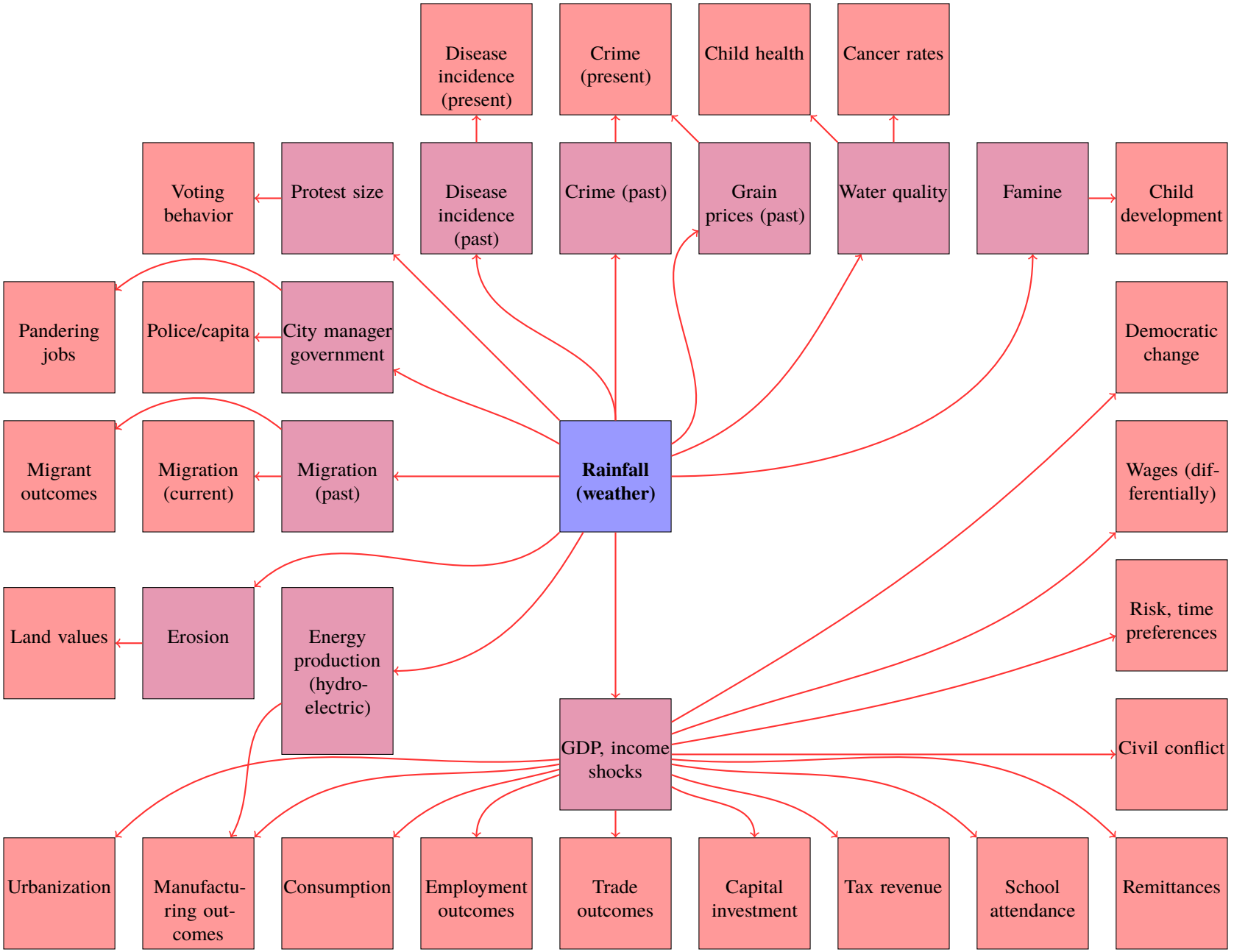

Figure 9: This figure summarizes selected research using weather as an instrument. Instrument is in blue, endogeneous covariates in purple, and outcomes in pink.

Immigrant enclaves

The use of immigrant enclaves is used in 12 “top five" papers and 58 other well-regarded articles. Its use as an instrument begins with Bartel (1989)’s documentation that immigrants appear to migrate to locations where other immigrants have already located. Altonji and Card (1991) use historical immigrant share by industry as an instrument for new immigrant shares by industry, which affect wages. The instrument took on its more classical form in Card (2001), which used historical immigration patterns to predict (instrument for) immigrant inflows, which affect native outflows, employment/population ratios for natives and immigrants, and wages. Importantly, the instrument is not valid under serial correlation: if, for instance, a city underwent a permanent and unmitigated productivity shock that brought both past immigrants and current immigrants to a city while simultaneously increasing wages of natives, then the instrumented effect of immigrants on native wages would be misstated. Unlike other instruments in this paper, the past presence of immigrants is typically only used to instrument for the flow (or new stock) of immigrants today. However, it is found to be connected with a number of highly durable outcomes, raising concerns regarding its validity.

As an instrument, enclaves have been used to measure the effect of immigrants on a number of educational outcomes. Insofar as human capital is a durable good, and education has long-lasting affects on a labor market, we expect the instrument to invalidate itself. Immigrants appear to affect high-school dropout rates (Card and Lewis, 2007), the public/private school choice of natives and student/teacher ratio in public school (Farre, Ortega, and Tanaka, 2018), the choice to major in science and engineering (Orrenius and Zavodny, 2015), vocational enrollment and specialization (Røed and Schøne, 2016). Even cyclical patterns in immigrant presence at universities affects domestic student enrollment in college (Shih, 2017).

Using this same instrument, there is also evidence that change in immigrant populations affect the prices of non-traded, immigrant-intensive goods and services, such as housekeeping and gardening (Cortes, 2008). With lower prices for goods and services that are substitutes for household production, women in the top quartile of the wage distribution increase average hours of market work and more frequently work schedules in excess of 50 or 60 hours in response to an immigration shock (Cortés and Tessada, 2011). If immigrants affect mother’s time at work, plausibly affecting both long-run career decsions (see, for instance, Adda, Dustmann, and Stevens (2017)), and long-run child outcomes (see, for instance, Havnes and Mogstad (2015)), then it is possible long-run effects of an immigration shock today are larger than the short-run effects, as affected agents are able to adjust behavior in the first case and affected children grow

up and join the labor market in the second.

Another source of potentially long-run affects is through firms. Using the enclave instrument, immigrants are found to affect firm capital intensity, investment, and returns (Baum-Snow, Freedman, and Pavan, 2018; Lafortune, Lewis, and Tessada, 2019). It is also found to affect firm intensity of labor use by skill level, firm scale, and firm entry (Dustmann and Glitz, 2015). High-skilled immigration appears to affect patents and citations (Draca, Machin, and Witt, 2011; Peri, Shih, and Sparber, 2015; Bosetti, Cattaneo, and Verdolini, 2015; Ganguli, 2015). It also affects firm probability of exporting, export sales, and diversity of product (Parrotta, Pozzoli, and Sala, 2016; Ottaviano, Peri, and Wright, 2018). Because there is reason to think exporting causally increases firm productivity (see (Park et al., 2010)), this may yield another channel for persistent effects of immigration. Indeed, (Peri, 2012; Ottaviano, Peri, and Wright, 2018) also confirm productivity effects of immigration. Relatedly, immigration also appears to affect the technologies adopted by the firm, such as computers and automation (Lewis, 2011), and the skilled nature of tasks (Peri and Sparber, 2009; D'Amuri and Peri, 2014; Giuntella et al., 2018).

Seven additional channels might allow for persistence in immigration's effects, with each's relevance established through the enclave instrument. First, immigrants appear to affect both rental and housing prices (Saiz, 2007), suggesting another form of slow-depreciating capital to generate long-run effects. Second, growth in the immigrant share may affect political dynamics: Halla, Wagner, and Zweimüller (2017) find immigration causally affects right-wing vote share. Third, it may change the city's composition via out-migration, as is found in the short and long-run in (Morales, 2018). Fourth, larger migrant networks appear to increase both migrant entrepreneurial capital investment and profits (Woodruff and Zenteno, 2007). Sixth, locations with more unemployment see changes in local immigration enforcement (Makowsky and Stratmann, 2014), and immigration enforcement causally affects immigrant poverty rates (Amuedo-Dorantes, Arenas-Arroyo, and Sevilla, 2018). Finally, it's important to note the historical growth instrument ethnolinguistic fractionalization is strongly tied to immigrant share. While ethnolinguistic fractionalization is discussed in the text above, the idea that it causally affects corruption, the share of the labor force in small enterprises, immigrant language acquisition and the size of the black market is significant. Just as religion's inclusion in the estimates of MSA-level housing elasticities joins two potentially concerning instruments together, so too is immigration linked to ELF.

All of these effects are separate from the most studied effect of immigrants: on wages. As in Card (2001), a number of studies find negative effects on low skilled wages (and employment). Dustmann, Frattini, and Preston (2013) find immigration decreases the lower tails and increases the upper tails of the

wage distribution. (Peri, Shih, and Sparber, 2015) find that STEM workers via the H-1B visa have a strong positive effect on college-educated natives and a weak positive effect on non-college educated natives, and Gould (2018) finds an expanding effect of immigrants on the 90/10 ratio in manufacturing wages. Dustmann and Glitz (2015) find large negative effects on wages in the non-traded sector, but no effect on the tradable sector in Germany. Similarly, Morales (2018) finds differential effects of the migrant share on women in the short- and long-run, depending on the skill group. Because heterogeneous effects have been estimated by skill, income, education, and gender, and age[20], concerns about local area treatment effects arise (Imbens and Angrist, 1994). Consistent with this concern, if one-third of the increase in wage inequality is due to city size and nonlinear agglomeration economies, the LATE effect becomes stronger (Baum-Snow and Pavan, 2013).

[20]Kerr, Kerr, and Lincoln (2015) find different effects of skilled immigrants on skilled worker employment by age.

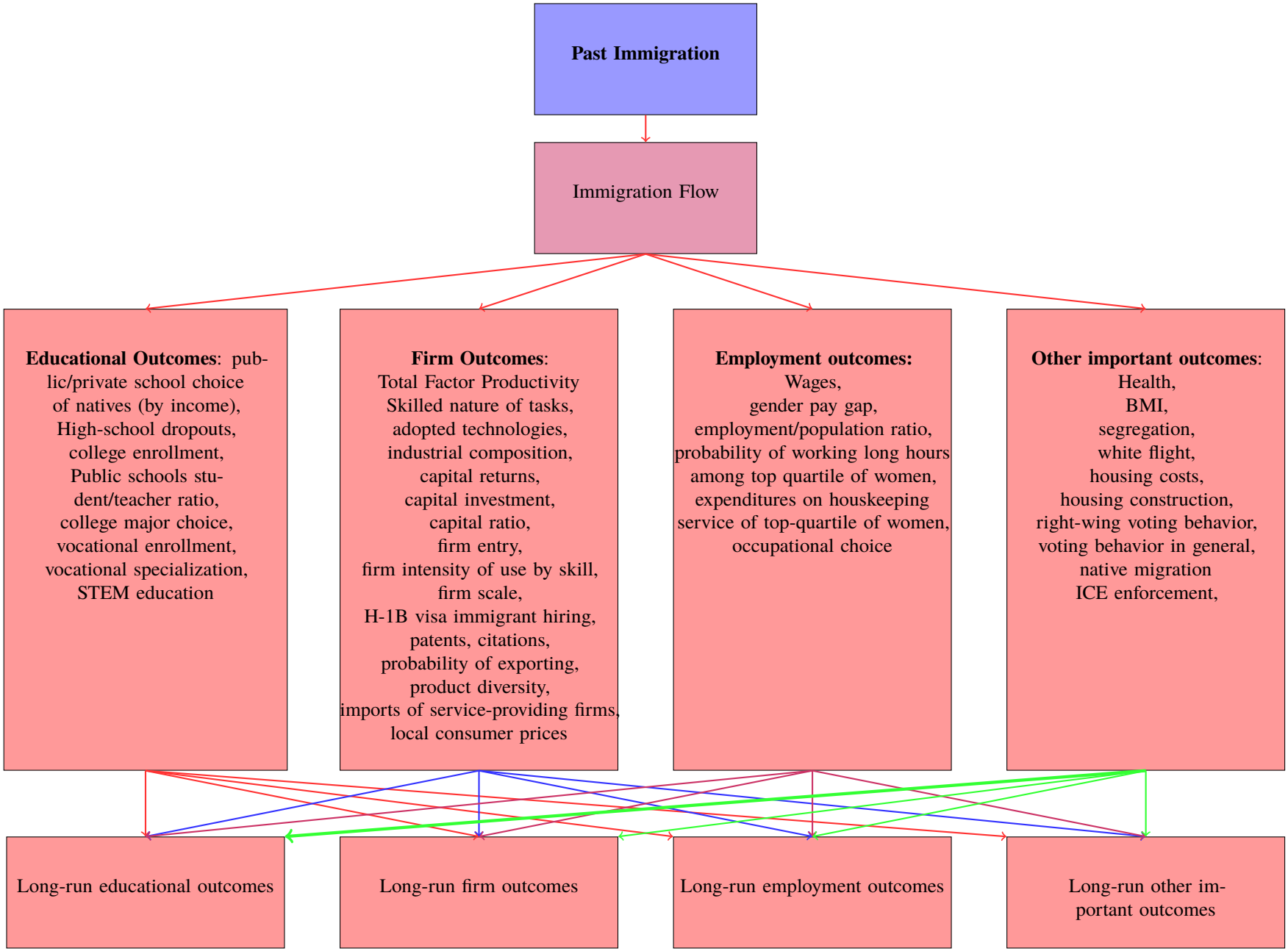

Figure 10: This figure summarizes selected research using immigrant enclaves as an instrument.

V Monte Carlo Exercises

How might a researcher using a common instrument investigate whether their estimated coefficient can be trusted? To understand this problem, we conduct Monte Carlo tests of the multiple-use instrument problem. Consider a single instrument z, that instruments n_x potentially causally-related variables x^j, where j can be considered to be a separate paper's use of an instrument and unique covariate. Each covariate x^j is determined by z, a random shock ϵ, a confounding shock η (which may be correlated between j's) and, after those inputs are realized (to avoid iterating to a fixed point), is affected by and affects other x's. x_i is distributed:

$$x^j_{pre,i} = \gamma^j z_i + \eta^j_i + \epsilon^j_i \tag{1}$$

$$x^j_i = x^j_{pre,i} + \sum_{k \neq i} \delta^{k,j} x^k_{pre,i} \tag{2}$$

These x's potentially each affect both their "own" y^j but also those of other j's, and are confounded without instrumentation by some $x - y$ paper-specific confounder η^j:

$$y^j_i = \sum_{k=1}^{n_x} \beta^{k,j} x^{k,j}_i + \eta^j_i + \omega^j_i \tag{3}$$

To connect our simulated system to our framework, equations 1-3 are depicted graphically in Figure 11.

We run three potential regressions for various levels of n_x: (1) a "standard" OLS regression of y^j on x^j, (2) the "standard" IV regression, which examines the affect of x^j instrumented by z on y^j, and (3) "augmented" IV regression, which uses the x^j's of other papers as exogenous controls in IV regression (2). We choose our main instrument to be normal-inverse-gamma distributed, so that within a Monte-Carlo iteration, the variance of the instrument is drawn from an inverse gamma distribution. Conditional on that variance, the instrument is distributed normally with mean zero. For convenience, we denote this distribution as $\mathcal{N} - \Gamma^{-1}(\mu, mean(\sigma), stdev(\sigma))$ where μ denotes the mean of the normally distributed variable (conditional on σ), and $mean(\sigma)$ and $stdev(\sigma)$ denote the required α and β in a gamma distribution to generate an expected standard deviation σ $mean(\sigma)$ with standard deviation $stdev(\sigma)$.[21] The shocks for x's, y's and confounders (ϵ, ω, and η) are distributed identically.

In what follows, we follow common practice in instrumental variables papers and include only

[21] This is equivalent to choosing $\alpha = \frac{(mean(\sigma))^2 + 2*(stdev(\sigma))^2}{(stdev(\sigma))^2}$ and $\beta = \frac{mean(\sigma)*((\mu^\sigma)^2 + (stdev(\sigma))^2)}{(stdev(\sigma))^2}$ in an Inverse-Gamma distribution.

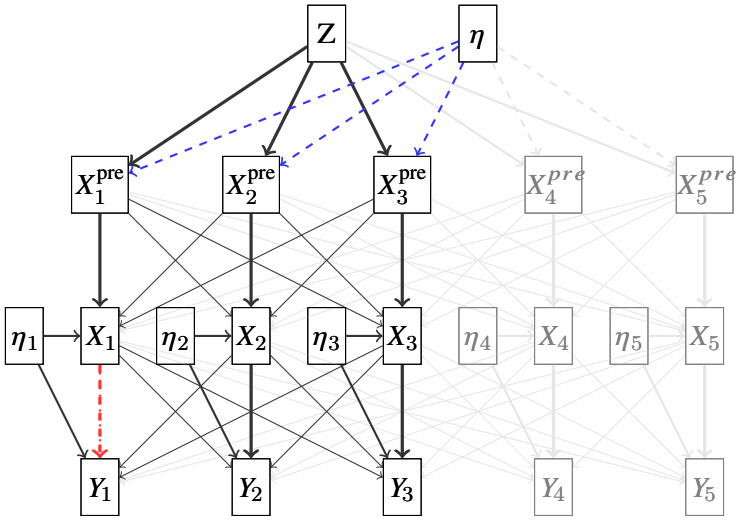

Figure 11: This figure displays the DAG illustrating our Monte Carlo exercises. We are interested in the estimated coefficient between X_1 and Y_1, the dotted red line (set to be unity in all exercises). Thick black lines, such as between Z and X^{Pre}'s, and X_i and the corresponding Y_i, are larger coefficients, in expectation. Thin lines, such as between X_1^{pre} and X_2, denote small average coefficients. When we change the correlation in our Monte Carlo exercises, we are adjusting the strength of η on each of X's relative to Z depicted as the dashed blue line, effectively setting the common component of Z in all X's. When we consider a new "potential IV" we add an extra set of variables X_4, X_5, Y_4, and Y_5 (greyed out) to this DAG. The consequences of the existence of new potential IVs is the focus of this paper.

estimators for which the F-statistic in the main IV regression is above 10 (Stock and Yogo, 2005), and the estimated coefficients are between -9 and 11 (the true coefficient is one), simulating an estimation selection process in which a researcher discards an IV if it generates nonsensical results.[22][23] One potential filter for estimators is to accept an estimate β^{IV} if and only if the "standard" estimate isn't statistically significantly different from the "augmented" results, and when the F-statistics both IVs are strong. We term the IV-estimated coefficient that does not differ from the augmented IV coefficient our "conditional" estimator, and find that it has good properties (low mean square error among accepted coefficients). Figure 12 depicts the mean square error of the four estimators for $\widehat{\beta^{1,1}}$ as a function of distinct potential IV paper uses, where the "true" value $\frac{\partial y^1}{\partial x^1}$ is equal to unity and the fourth estimator uses the selected standard IV point estimates described above, which keeps approximately 14-26% of the estimated coefficients. The top

[22]Dropping unusual estimates is certainly done in empirical research. For instance, Cho and Rust (2017) report considering using interest-free loan installment offers as an instrument for interest rates on consumer demand, but rejected the instrument when it yielded an upward-sloping demand curve.

[23]Failure to do this immediately yields worse mean squared error for the IV estimator due to rare extreme estimates. For instance, while the lowest 1st percentile of IV regression coefficient is -2.5, the lowest 0.1th percentile is -17, and the 0.01th percentile is -190, with a kurtosis of over 190,000, rather than the 3 we would expect from a standard normally distributed variable.

Table 2: Distribution of Monte Carlo Parameters

Description	Variable	Distribution
Main instrument strength	γ^1	$\mathcal{N}(3, 0.2)$
Other regression instrument sign	p^j	$2 * (\mathcal{B}(0.5) - 0.5)$
Other regression instrument strength	γ^j, $j \neq 1$	$p^j \mathcal{N}(3, 0.2)$
Affect of X's on one another	$\delta^{k,j}$	$\mathcal{N}(0.05, 0.1)$
Main affect of interest, x^1's on y^1	$\beta^{1,1}$	1
Affect of x^j's on own y^j	$\beta^{j,j}$, $j \neq 1$	$\mathcal{N}(1, 0.2)$
Affect of x^j's on other y^j	$\beta^{k,j}$, $k \neq j$	$\mathcal{N}(0.1, 0.3)$
Distribution of instrument	z	$\mathcal{N} - \Gamma^{-1}(0, 0.1, 0.1)$
Distribution of confounder	η^j	$\mathcal{N} - \Gamma^{-1}(0, 0.1, 0.1)$
Distribution of noise in x	ϵ^j	$\mathcal{N} - \Gamma^{-1}(0, 0.1, 0.1)$
Distribution of noise in y	ω^j	$\mathcal{N} - \Gamma^{-1}(0, 0.1, 0.1)$

Table 2: This tables displays the parameters governing the Monte Carlo distribution summarized in equations 1-3 and graphically in Figure 11. The $\mathcal{N} - \Gamma^{-1}$ is used to model shocks that are mean zero with an expected standard deviation of 0.1 and a standard deviation of that standard deviation of 0.1 (distributed Gamma). $\mathcal{B}$ denotes the Bernoulli distribution, and is used to flip coefficient signs so that 50% contributed positively to some outcome, and 50% contribute negatively.

two figures depicts “small sample" properties of estimators, with each set of papers generated using 500 observations. The bottom two depict “large sample" properties, with 10,000 observations each. The left two allow for no correlation between X’s, so that controlling for endogenous X’s is the correct procedure. The right two allow for correlation between the X’s, so that any given pair of X’s have a correlation of 0.2 in expectation.

For low-levels of potential instrumental variable uses, OLS is inferior to IV in both small- and large-sample. Importantly, however, the bias of simple OLS does not greatly differ depending on the number of IV uses, while our other estimators do. Controlling for endogenous X’s significantly improves the estimator (reduces MSE) when correlation between X’s is low, but is not a dependable method for improving the estimator under reasonable correlation between endogenous X’s. In general, our conditional estimator does a very good job, typically dominating all other considered regressions except OLS in large samples with large number of IV uses. This conditional estimator has a mean estimated coefficient of 0.996 (compared to a true coefficient of one) and a standard deviation of 0.27. Figure 13 depicts the fraction of regressions whose coefficients are used by the conditional IV estimator. To put the importance of potential IV uses in perspective, in our setup with many observations and little correlation, by the time the number of independent IV uses grows to six, standard IV is worse than OLS, but the IV estimator with controls remains a better estimator than OLS until nine uses are reached. Finally, our selection threshold performs extremely well, .

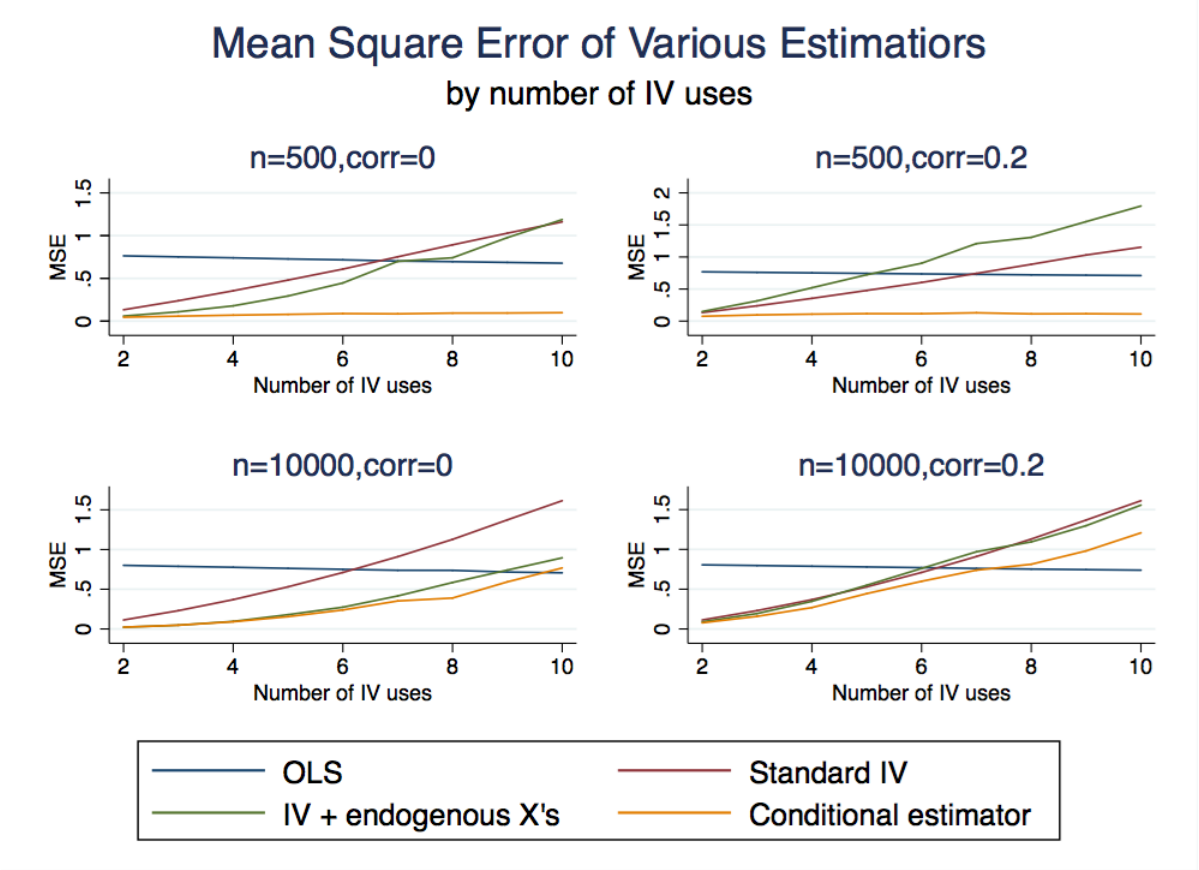

Figure 12: This figure depicts the mean-squared error of five estimators. The first is an OLS regression of y^1 on x^1. The second is the "standard" IV estimator, which instruments for x^1 using z. The third augments the second by including other paper's endogeneous variables as controls. The fourth adds other paper's outcomes as controls. The last uses standard IV estimates if and only if either the second and the third, the second and the fourth, or all three coefficients are not statistically distinguishable at the 10% level and all F-statistics are above the (Stock and Yogo, 2005) threshold of 10.

We conclude by noting that simply controlling for other endogenous X's should play an important role when using a common instrument. When the resulting IV coefficients do not differ significantly from the short regression, the estimator has a dramatically lower mean square error. Moreover, when a common IV estimator is present, the likelihood of generating wildly significant coefficients is greatly increased, particularly in small samples for reasons similar to those driving IV's significance in Young (2019).

VI Conclusion

This paper has discussed some of the issues that arise with "popular" instruments and has discussed six examples of these instruments. The use of these potentially troubling instruments is not rare: by our count,

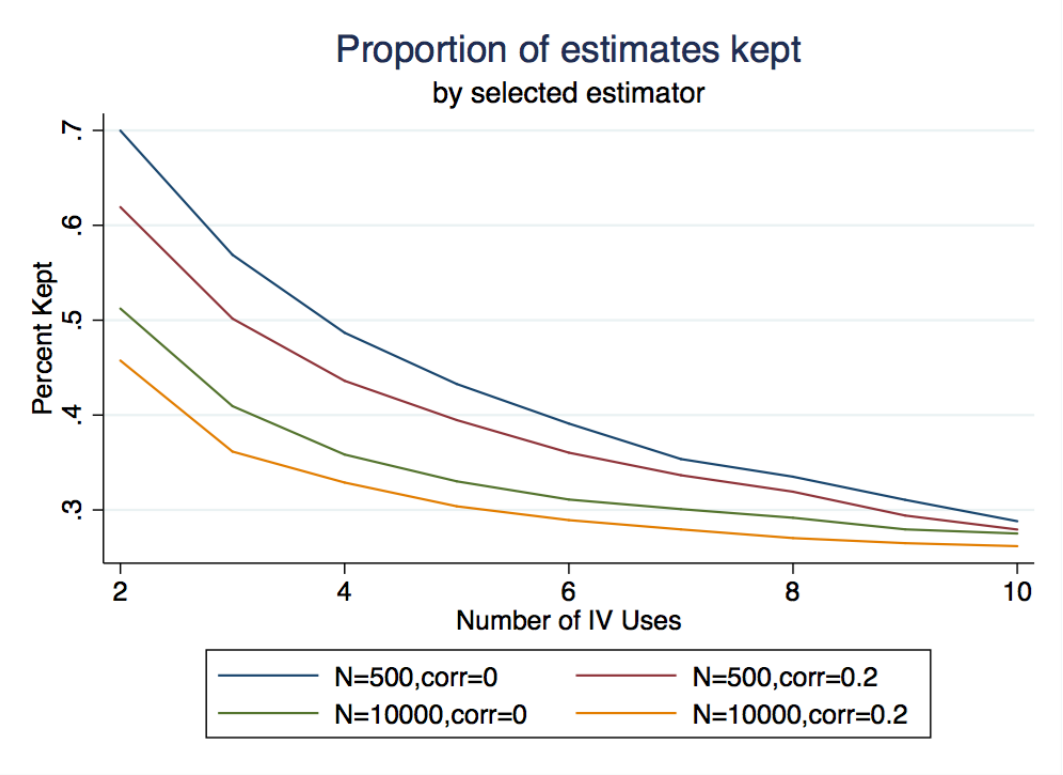

Figure 13: This figure depicts the fraction of estimates kept by our conditional estimator.

which puts only a lower bound on the problem, 303 papers used these instruments, and 86 “top five" papers. Nor has the use of these instruments declined over time.

Importantly, this paper does not condemn instrumental variables as typically practiced. Some of the examples in this paper are surely well-identified. Moreover, the vast majority of IV papers do not use these instruments, but use instruments that are idiosyncratic to their application, or that are less likely to cause concern. We have not focused on these papers.

We provide two clear positive messages going forward: first, more awareness should be paid to the notion that literatures, or sets of literatures, can “collectively invalidate" an instrument. Second, instrumental variables estimates that are robust to the inclusion of other endogenous controls are likely to be good estimators.

We also submit that a number of papers have used the phrase “while this instrument has been used in [another paper], we are the first to use it in this context." While this is taken as a contribution, it should also be a warning. Just because an instrument has “passed what might be called the American Economic Review (AER)-test," in Rodrik, Subramanian, and Trebbi (2004)’s colorful phrasing, does not mean it is a good instrument for a new paper.

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Appendices

Appendix A Supplementary Materials

In addition to the tables for the six potentially problematic IVs below, we also constructed a table of IV uses in the “top five" journals from 1995-2019. The resulting table is too long to include here and is therefore relegated to an online appendix. This is available upon request. Those interested in the code for Monte Carlo simulations, directions used by RAs for the collection of instruments, as well as the underlying latex code for tables should contact the authors.

Appendix B IV Tables

This section documents instances of the six potentially problematic instruments in tabular form. We document each use of an instrument, meaning papers that use the same instrument either for many outcomes or many endogenous variables are documented multiple times. Each entry in the tables below provides the instrument, the endogenous variable, the outcome variable, the corresponding short-hand citation, as well as any notes idiosyncratic to the paper. The complete citation information is available in the references section.

A few notes and disclaimers are necessary. We do not attempt to provide each regressor from every specification, only the instrument, endogenous variable, and outcome variable. In the tables, interactions between two variables are indicated by a “X." Finally, some entries in the table have the term "N/A" in the instrument column. While papers with this designation do not use an IV, the regression specifications and results from these papers have meaningful implications for the six instruments discussed in the text. In this scenario, one should interpret the “Endogenous Variable" column as the independent variable in the regression and the “Outcome" column normally.

Elevation/Bodies of Water-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Water boundaries, elevation, elevation changes	Land unavailability	Housing prices Not an instrument	Saiz (2010)	
Variation in topography (streams)	School governance structure/Tiebout choice index/district fragmentation	Student achievement	Hoxby (2000)	
Variation in topography (streams)	School governance structure/Tiebout choice index/district fragmentation	Student achievement	Rothstein (2007)	
Variation in topography (streams)	Number of county governments	Economic development	Hatfield and Kosec (2013)	
Variation in topography (streams)	Number of county governments	Air quality, employment in polluting industries	Hatfield and Kosec (2019)	
Housing elasticity (Saiz)	Debt and leverage	Change in spending following income shocks	Baker (2018)	
River gradient	Districts suitability for dams	Agricultural increase in district where dam is located, but increased volatility	Duflo and Pande (2007)	
River gradient	Districts suitability for dams	Rural poverty declines in downstream districts	Duflo and Pande (2007)	
River gradient	Districts suitability for dams	Rural poverty increases in districts where dam is located	Duflo and Pande (2007)	

Elevation/Bodies of Water-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Elevation changes/river gradient	Hydropower plant location/electrified (past)	Longevity	Lipscomb, Mobarak, and Barilam (2013)	
Elevation changes/river gradient	Hydropower plant location/electrified (past)	Income	Lipscomb, Mobarak, and Barilam (2013)	
Elevation changes/river gradient	Hydropower plant location/electrified (past)	Education	Lipscomb, Mobarak, and Barilam (2013)	
Elevation changes/river gradient	Hydropower plant location/electrified (past)	Infant mortality	Lipscomb, Mobarak, and Barilam (2013)	
Elevation changes/river gradient	Hydropower plant location/electrified (past)	Gross income per capita	Lipscomb, Mobarak, and Barilam (2013)	
Elevation changes/river gradient	Hydropower plant location/electrified (past)	Poverty rates	Lipscomb, Mobarak, and Barilam (2013)	
Elevation changes/river gradient	Hydropower plant location/electrified (past)	Urbanization	Lipscomb, Mobarak, and Barilam (2013)	
Elevation changes/river gradient	Hydropower plant location/electrified (past)	Illiteracy, human capital, years of school, less than four years education	Lipscomb, Mobarak, and Barilam (2013)	
Lagged presence of subways	Presence of subways	City decentralization	Gonzalez-Navarro and Turner (2018)	
Slope gradients, land cover	Cost of highways	County level gross value added	Faber (2014)	

Elevation/Bodies of Water-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Slope gradients, land cover	Cost of highways	Local government revenue	Faber (2014)	
Slope gradients, land cover	Cost of highways	Industrial composition	Faber (2014)	
Elevation variation	Broadband provision	Aggregate employment, average wages, industrial composition	Ivus and Boland (2015)	
Elevation	piped water	HH sanitation decisions	Bennett (2012)	
Elevation, terrain ruggedness, watercover	Density	Firm earnings	Faberman and Freedman (2016)	
Polynomial in elevation	Male, female income	Child education, marriage, migration outcomes, marital violence	Luke and Munshi (2011)	
Soil orientation, slope, and weather of neighboring vineyards	Historical wine prices	Current prices	Gergaud, Plantinga, and Ringeval-Deluze (2017)	
Distance to body of water covered by highly permeable soil	Density	Firm productivity	Holl (2016)	
Coast Distance to nearest coastline	Share of developed land Access to international markets	Land use regulation Household per capita consumption	Hilber and Robert-Nicoud (2013) Emran and Hou (2013)	

Elevation/Bodies of Water-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Distance to nearest navigable river (including elevation and slope)	Access to domestic market center	Household per capita consumption	Emran and Hou (2013)	
Subterranean geography	Density	Individual vehicle miles travelled	Duranton and Turner (2018)	
Frac. underlain by sedimentary rock, seismic hazard, landslide-hazard	Density	Wages	Rosenthal and Strange (2008)	
Share of local labor market covered by water/marsh, destined to agriculture	Density	Wages	Addario and Patacchini (2008)	
Share of loamy and clay soils	Relative female employment	Child sex ratios in India	Carranza (2014)	
Rivers, topography	level of local enterprise	Level of other enterprises	Felkner and Townsend (2011)	
Number of larger rivers	Segregation	Crime	Bjerk (2010)	
Number of inter-county rivers	Segregation	Education, income, single motherhood(crossed with race)	Cutler and Glaeser (1997)	
Number of municipal townships in 1962	Gini index in 1970, 1980, 1990	Group participation (church, fraternity, service, hobby, sport, youth, school, political)	Alesina and La Ferrara (2000)	

Elevation/Bodies of Water-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Developable share (Saiz)	Cyclical housing and building		Glaeser, Gyourko, and Saiz (2008)	
Housing elasticity (Saiz)	Housing price growth	Debt growth	Mian and Sufi (2011)	
Housing elasticity (Saiz)	Housing net worth shock	Employment growth	Mian and Sufi (2014)	
Housing elasticity (Saiz)	Housing net worth shock	Change in consumption growth, MPC out of housing wealth	Mian, Rao, and Sufi (2013)	
Housing elasticity (Saiz)	Housing net worth shock	Auto sales	Berger and Vavra (2015)	
Saiz (2010)	Change in housing prices	Reliance on bank debt (rather than other kinds of capital)	Robb and Robinson (2012)	
Saiz (2010)	Change in housing prices	MSA income distribution	Gyourko, Mayer, and Sinai (2013)	
Saiz (2010)	Change in housing prices	Corporate investment	Chaney, Sraer, and Thesmar (2012)	
Saiz (2010) (and others)	Housing prices	Industrial composition	Beaudry, Green, and Sand (2012)	
Saiz (2010) (and others)	Housing prices	Industrial wage premium	Beaudry, Green, and Sand (2012)	
Saiz (2010) X national prices	Property values	Portfolio composition	Chetty, Sándor, and Szeidl (2017)	
Saiz (2010) X national prices	Housing prices	Fertility	Dettling and Kearney (2014)	
Saiz (2010) X deregulation of branch banking	Credit	housing prices	Favara and Imbs (2015)	

Elevation/Bodies of Water-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Saiz (2010) X deregulation of branch banking	Credit	housing stock	Favara and Imbs (2015)	
Elasticity of housing supply	Collateralizable housing wealth	Relative growth in franchising compared to company ownership	Fan, Kühn, and Lafontaine (2017)	
Saiz (2010)	Housing prices	State rate of income and population convergence/growth	Ganong and Shoag (2017)	
Housing price changes	Household wealth	Planning behavior	Lusardi and Mitchell (2007)	
N/A	Saiz (2010)	Effect of regulation on growth (structural)	Hsieh and Moretti (2019)	
N/A	Number of streams	Number of municipalities in a county	Alesina, Baqir, and Hoxby (2004)	
N/A	Rugged terrain	Urban sprawl	Burchfield et al. (2006)	
N/A	Number of streams	Number of special districts in a county	Alesina, Baqir, and Hoxby (2004)	

Sibling-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Twins	fertility	mother's labor supply	Jacobsen, Pearce, and Rosenbloom (1999)	
Twins	fertility	divorce	Jacobsen, Pearce, and Rosenbloom (2001)	
Twins	fertility	child schooling	Åslund and Grönqvist (2010)	
Twins	fertility	child GPA	Åslund and Grönqvist (2010)	**Differential Effects** • Sex of child • Parental Education • Family size
Twins	fertility	children's own family size	Kolk (2015)	**Differential Effects** • Sex of child
Twins	fertility	children's geographic distance from their mother	Holmlund, Rainer, and Siedler (2013)	
Twins	family size	IQ scores of children	Black, Devereux, and Salvanes (2010)	
Twins	family size	child personality traits	Fletcher and Kim (2019)	**Differential Effects** • Birth order of child
Twins	family size	# children & Currently married	Bronars and Grogger (1994)	
Twins	family size	Ever married	Bronars and Grogger (1994)	
Twins	family size	Years of education	Bronars and Grogger (1994)	

Sibling-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Twins	family size	Labor force participation	Bronars and Grogger (1994)	
Twins	family size	Earnings	Bronars and Grogger (1994)	
Twins	family size	Family earnings	Bronars and Grogger (1994)	
Twins	family size	welfare reciept	Bronars and Grogger (1994)	
Twins	family size	Poverty status	Bronars and Grogger (1994)	
Twins	family size	child living without a father	Dahl and Moretti (2008)	
First child sex	CEO firm departure	company performance	Bennedsen et al. (2007)	
First child sex	absentee father	child family income	Dahl and Moretti (2008)	
First child sex	absentee father	child poverty rates	Dahl and Moretti (2008)	
First child sex	age when become grandparent	grandparent hours of work	Rupert and Zanella (2018)	
First child sex	martial dissolution	female labor supply	Bedard and Deschenes (2005)	
First child sex	martial dissolution	female earnings	Bedard and Deschenes (2005)	
First child sex	martial dissolution	female earningsXincome	Ananat and Michaels (2008)	
First child sex	martial dissolution	poverty	Ananat and Michaels (2008)	

Sibling-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Gender Mix	family size	IQ scores of children	Black, Devereux, and Salvanes (2010)	**Findings** • Insignificant results
Gender mix	family size	private school attendance	Conley and Glauber (2006)	
Gender mix	family size	on-time academic progress	Conley and Glauber (2006)	
Gender mix	number of children	parent marital status	Cáceres-Delpiano and Simonsen (2012)	
Gender mix	number of children	non-traditional family living	Cáceres-Delpiano and Simonsen (2012)	
Gender mix	number of children	family income	Cáceres-Delpiano and Simonsen (2012)	
Gender mix	number of children	private health insurance	Cáceres-Delpiano and Simonsen (2012)	
Gender mix	total number of children	child BMI, weight-for-age	Palloni (2017)	
Gender mix	total number of children	child illness	Palloni (2017)	
Gender mix	number of children	maternal employment	Cruces and Galiani (2007)	
Gender mix	family size/crowded housing	child educational outcomes	Goux and Maurin (2005)	
Gender mix	larger public housing unit	housing	Currie and Yelowitz (2000)	
Gender mix	larger public housing unit	neighborhood	Currie and Yelowitz (2000)	
Gender mix	larger public housing unit	school quality	Currie and Yelowitz (2000)	

Sibling-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Gender mix	larger public housing unit	repetition of grade	Currie and Yelowitz (2000)	
Gender mix	number of children	parental blood pressure, obesity	Cáceres-Delpiano and Simonsen (2012)	
Sibling Composition	probability of own migration	earnings	Abramitzky, Boustan, and Eriksson (2012)	
Sibling Composition	participation in tribal marriage	martial estrangement	Jacoby and Mansuri (2010)	
Sibling Composition	participation in tribal marriage	domestic abuse	Jacoby and Mansuri (2010)	
Sibling Composition	participation in tribal marriage	depression	Jacoby and Mansuri (2010)	
Sibling Composition	schooling attainment	wage	Light (2001)	**Additional Instruments** • Ability measures, average tuition in state, percent of population with a college education, percent of the population living in an urban area, the unemployment rate, ratio of population to land area.
Sibling Composition	sibling contribution to parental care	own contribution to parental care	Antman (2012)	
Sibling Composition	caregiving	depressive symptoms, self-rated health	Coe and Van Houtven (2009)	

Sibling-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Multiple births, same-sex sib. pairs	family size	mother's labor supply	Angrist and Evans (1998)	
Number of siblings	schooling	wages	Levin and Plug (1999)	
Number of siblings	schooling	smokers quitting smoking	Sander (1995)	**Additional Instruments** • Parent's schooling, age, survey year, region at age 16, rural residence at age sixteen.
Number of siblings	schooling	wages	Korpi and Tåhlin (2009)	**Additional Instruments** • Parent's schooling, age, survey year, region at age 16, rural residence at age sixteen.
Number of siblings	schooling	wages	Taber (2001)	
Number of siblings	informal care	employment and hours worked	Bolin, Lindgren, and Lundborg (2008)	**Findings** • Insignificant for wages
Number of siblings	caregiving	depressive symptoms, self-rated health	Coe and Van Houtven (2009)	
Parent BMI	own BMI	adult wages	Kline and Tobias (2008)	
Biological sibling BMI	Own BMI	wages	Cawley (2004)	
Biological relative BMI	own BMI	medical expenditures	Cawley and Meyerhoefer (2012)	

Sibling-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Sibling BMI	own BMI	adult mortality	Davey Smith et al. (2009)	
Sibling BMI	own BMI	wagesXsocial skill jobs	Johar and Katayama (2012)	
Number of children	parental tobacco use	wages	van Ours (2004)	**Findings** • Author states results are implausibly large
Number of children	parental tobacco use	wages	van Ours (2004)	**Findings** • Author states results are implausibly large
Number of children	wages	labor supply	Ziliak and Kniesner (1999)	
N/A	First-born child sex	marital status	Lundberg and Rose (2003)	
N/A	First-born child sex	probability married to child's father	Lundberg and Rose (2003)	
Number of offspring, eldest child daughter	informal care	use of home health care	Houtven and Norton (2004)	
Number of daughters, sons	informal care	Medicaid expenditures	Houtven and Norton (2008)	
Family structure	receipt of unpaid help	nursing home use	Charles and Sevak (2005)	
Number of Siblings Working	caregiving	depressive symptoms, self-rated health	Coe and Van Houtven (2009)	
Number of children of CEO	number of members on company board	operating return on assets	Bennedsen, Kongsted, and Nielsen (2008)	

Sibling-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Nutritional status of older sibling	Nutritional status of younger sibling	child achievement test scores	Glewwe, Jacoby, and King (2001)	many instruments
Mother age at older sib. birth	presence of younger sibling	probability of marriage by older sibling	Vogl (2013)	
Youngest sibling age	maternal employment	child adverse health events	Morrill (2011)	
Parental lifetime earnings	bequest size	time children spend with parents when old	Bernheim, Shleifer, and Summers (1985)	
Parent's age at child's birth	child's desired number of children	number of children	Rasul (2008)	

Ethnolinguistic Fractionalization-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Ethnolinguistic fractionalization	Corruption	Investment	Mauro (1995)	
Ethnolinguistic fractionalization	rule of law/graft, government efficiency, democracy	trade	Méon and Sekkat (2008)	
Ethnolinguistic fractionalization	Regulation and Policy	Urban population	Davis and Henderson (2003)	System GMM
Ethnolinguistic fractionalization	Regulation and Policy	Democracy	Davis and Henderson (2003)	system GMM
Ethnolinguistic fractionalization	Regulation and Policy	GDP	Davis and Henderson (2003)	system GMM
Ethnolinguistic fractionalization	FDI	growth	Delgado, McCloud, and Kumbhakar (2014)	Secondary regression
Ethnolinguistic fractionalization	dictatorship and trade	urban structure	Ades and Glaeser (1995)	
Ethnolinguistic fractionalization	democracy	economic growth	Tavares and Wacziarg (2001)	System GMM
Ethnolinguistic fractionalization	Income, investment	growth	Tavares and Wacziarg (2001)	System GMM
Ethnolinguistic fractionalization	governance	R&D intensity	Wang (2013)	

Ethnolinguistic Fractionalization-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Ethnolinguistic fractionalization	tax rates	underground economy	Friedman et al. (2000)	**Additional Instruments** • Share of population that is Catholic& Muslim & Protestant, Origin of commercial laws, latitude of country
Ethnolinguistic fractionalization	Over-regulation	underground economy	Friedman et al. (2000)	**See Above**
Ethnolinguistic fractionalization	Legal environment	underground economy	Friedman et al. (2000)	**See Above**
Ethnolinguistic fractionalization	Corruption	underground economy	Friedman et al. (2000)	**See Above**
Ethnolinguistic fractionalization	Public Finance	underground economy	Friedman et al. (2000)	**See Above**
Ethnolinguistic fractionalizaiton (among others)	bank regulation	bank efficiency	Barth et al. (2009)	
Ethnolinguistic fractionalization (minority language)	immigrant English	earnings	Chiswick and Miller (1995)	
Ethnolinguistic fractionalization, legal origin	corruption X party discipline	environmental policy	Fredriksson and Wollscheid (2010)	

Ethnolinguistic Fractionalization-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Ethnolinguistic fractionalization, legal origin	share of labor force in small enterprises	growth	Beck, Demirgüç-Kunt, and Levine (2005)	
Ethnolinguistic fractionalization	corruption	government spending on education	Mauro (1998)	
Ethnic fractionalization	corruption	abnormal government asset returns before downgrade	Michaelides et al. (2015)	
Ethnic fractionalization	corruption	high volatility of asset prices and exchange rates	Michaelides, Milidonis, and Nishiotis (2019)	
Ethnic fractionalization	informal sector size	corruption	Lassen (2007)	
Ethnic fractionalization	media ownership concentration	bank corruption	Houston, Lin, and Ma (2011)	**Additional Instruments** • Latitude, independence
Ethnic fractionalization	the capital requirement, supervisory power and supervisory independence, and market monitoring	bank efficiency	Barth et al. (2013)	
Ethnic fractionalization	legislative competition, checks & balances	financial development	Beck, Demirgüç-Kunt, and Levine (2003)	
Ethnic fractionalization	financial development	GDP	McCaig and Stengos (2005)	

Ethnolinguistic Fractionalization-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Ethnic fractionalization	the capital requirement, supervisory power and supervisory independence, and market monitoring	bank efficiency	Barth et al. (2013)	**Additional Instruments** • Latitude, religions, legal origins, average regulatory level of other countries in the sample
Fractionalization	Total protests, demonstrations, strikes	fiscal balance, government spending	Klomp and de Haan (2013)	
Historical Ethnic fragmentation	Ethnic fragmentation	spending on productive goods: education, roads, sewers, and trash pickup	Alesina, Baqir, and Easterly (1999)	
Past fractionalization (% white)	current % white	charitable giving	Valentina et al. (2016)	
Historical genetic distance from UK	current genetic distance	life expectancy	Hansen (2013)	
Historical genetic distance from UK	current genetic distance	Infant survival rate	Hansen (2013)	
Historical genetic distance from UK	current genetic distance	Adult survival rate	Hansen (2013)	
Ancestral civic attitudes	civic attitudes in home country	unemployment benefits	Algan and Cahuc (2009)	
Ancestral civic attitudes	civic attitudes in home country	employment protection	Algan and Cahuc (2009)	
Ethnic origin	social trust	health-center quality	Hollard and Sene (2016)	

Ethnolinguistic Fractionalization-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Colonial relationship, common language with giving country	aid	growth	Rajan and Subramanian (2008)	
Age at arrival in U.S.	language skills	earnings	Bleakley and Chin (2004)	
Predicted birthplace diversity, predicted share of immigration, predicted diversity of imports	Skilled birthplace diversity, share of skilled immigration	GDP/capita	Alesina, Harnoss, and Rapoport (2016)	
Language	rule of law	GDP	Alexeev and Conrad (2009)	
Speak romance language	search intensity/job search methods	job search time	Eugster et al. (2017)	Used as proxy
Language, ethnicity, geography	social infrastructure	labor productivity	Hall and Jones (1999)	
Gender marking in language	gender discrimination perception	female migration	Ruyssen and Salomone (2018)	
Fraction speaking English (among others)	property rights/rule of law, market integration	GDP/capita	Rodrik, Subramanian, and Trebbi (2004)	
Number and age of children	immigrant language acquisition	earnings	Chiswick and Miller (1995)	
Mass migration	“cultural" fractionalization	output	Ager and Brückner (2013)	
Mass migration	“cultural" polarization	output	Ager and Brückner (2013)	
Zonal ethnolinguistic diversity	school ethnolinguistic diversity	school funding	Miguel and Gugerty (2005)	

Ethnolinguistic Fractionalization-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Large area ethnic diversity	local ethnic diversity	minority harassment	Dustmann, Fabbri, and Preston (2011)	
Large area ethnic diversity	local ethnic diversity	minority precautions	Dustmann, Fabbri, and Preston (2011)	
Ethnicity	distance to nearest market and wage	consumption	Glewwe (1991)	
Frankel-Romer gravity	fractionalization	growth	Bove and Elia (2017)	
Mean distance to coast or river and the duration of human settlement	fractionalization	poverty levels	Churchill and Smyth (2017)	
Cultural distance	openness to trade and immigration	GDP/person	Ortega and Peri (2014)	
Manager's ethnic distance to japan	forward-looking orientation	vertical integration	Kukharskyy (2016)	
Frankel-Romer trade-GDP	migration, trade	GDP/capita	Ortega and Peri (2014)	
Ethnic diversity	creditor protections	bank solvency	Houston et al. (2010)	
Foreign interest rates	income shocks X ethnolinguistic fractionalization	civil conflict	Hull and Imai (2013)	
N/A	ethnic fractionalization	banking crisis	Beck, Demirgüç-Kunt, and Levine (2006)	insignificant
N/A	ethnolinguistic fractionalization	property rights	Alesina et al. (2003)	
N/A	ethnolinguistic fractionalization	business regulation	Alesina et al. (2003)	

Ethnolinguistic Fractionalization-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
N/A	ethnolinguistic fractionalization	corruption	Alesina et al. (2003)	
N/A	ethnolinguistic fractionalization	bureaucratic delays	Alesina et al. (2003)	
N/A	religion	public rights	Alesina et al. (2003)	
N/A	ethnolinguistic fractionalization	infant mortality	Alesina et al. (2003)	
N/A	ethnolinguistic fractionalization	school attainment	Alesina et al. (2003)	
N/A	ethnolinguistic fractionalization	illiteracy rate	Alesina et al. (2003)	
N/A	ethnolinguistic fractionalization	infrastructure quality	Alesina et al. (2003)	
N/A	ethnolinguistic fractionalization	transfers and subsidies as a fraction of GDP	Alesina et al. (2003)	
N/A	ethnolinguistic fractionalization	SOEs in the economy	Alesina et al. (2003)	
N/A	ethnolinguistic fractionalization	public sector employment	Alesina et al. (2003)	
N/A	ethnolinguistic fractionalization	democracy	Alesina et al. (2003)	
N/A	ethnolinguistic fractionalization	political rights	Alesina et al. (2003)	
N/A	Ethnolinguistic fractionalization	School attainment	Easterly and Levine (1997)	
N/A	Ethnolinguistic fractionalization	Financial development	Easterly and Levine (1997)	

Ethnolinguistic Fractionalization-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
N/A	Ethnolinguistic fractionalization	Black market premiums	Easterly and Levine (1997)	
N/A	Ethnolinguistic fractionalization	Fiscal surpluses	Easterly and Levine (1997)	
N/A	Ethnolinguistic fractionalization	Infrastructure development	Easterly and Levine (1997)	
N/A	Ethnolinguistic fractionalization	Discrimination against minorities	Easterly and Levine (1997)	
N/A	Ethnolinguistic fractionalization	Violence against minorities	Easterly and Levine (1997)	
N/A	Ethnolinguistic fractionalization	Separatist movements	Easterly and Levine (1997)	
N/A	Ethnolinguistic fractionalization	Long-run growth	Alesina et al. (2003)	
N/A	Ethnolinguistic fractionalization	Schooling	Alesina et al. (2003)	
N/A	Ethnolinguistic fractionalization	Financial depth	Alesina et al. (2003)	
N/A	Ethnolinguistic fractionalization	Fiscal surplus/GDP	Alesina et al. (2003)	
N/A	Ethnolinguistic fractionalization	Log telephones per worker	Alesina et al. (2003)	
N/A	Ethnolinguistic fractionalization	crime	Fajnzylber, Lederman, and Loayza (2002)	
N/A	Ethnolinguistic fractionalization	property rights	Ali, Fiess, and Macdonald (2011)	
N/A	Ethnolinguistic fractionalization X aid	growth	Kourtellos, Tan, and Zhang (2007)	

Ethnolinguistic Fractionalization-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
N/A	ethnic fractionalization	growth	Brunnschweiler (2008)	
N/A	Ethnolinguistic fractionalization	health	Casabonne and Kenny (2012)	
N/A	Ethnolinguistic fractionalization	growth	Miguel, Satyanath, and Sergenti (2004)	(as a control)
N/A	Ethnolinguistic fractionalization	civil conflict	Miguel, Satyanath, and Sergenti (2004)	(as a control)
N/A	ethnic fractionalization X natural resources	property rights	Hodler (2006)	
N/A	ethnic fractionalization X natural resources	GDP	Hodler (2006)	
N/A	ethnic fractionalization	welfare generosity	Lind (2007)	
Per capita GDP and growth differentials	Immigrants/population	welfare state generosity	Razin, Sadka, and Swagel (2002)	OTHER TABLE?
lagged immigrant share	current immigrant share	life satisfaction	Akay, Constant, and Giulietti (2014)	OTHER TABLE?

Religion-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Religion	land regulation	housing prices	Saiz (2010)	
Religion	social trust	Rule of law	Bjørnskov (2012)	**3SLS and 2SLS** **Additional Instruments** • Monarchy dummy, language drops subjective pronoun, temperature in coldest month, acceptance of homosexuality
Religion	social trust	Schooling expenditures	Bjørnskov (2012)	**See above**
Religion	social trust	Investment Share of GCP	Bjørnskov (2012)	**See above**
Religion	social trust	Price Distortion	Bjørnskov (2012)	**See above**
Religion	social trust	Growth Rate	Bjørnskov (2012)	**See above**
Religion	social trust	Investment Rate	Bjørnskov (2012)	**See above**
Religion	Respect, responsibility	Per-capita gdp	Breuer and McDermott (2013)	
Religion	Respect, responsibility	Per-capita gdp	Breuer and McDermott (2013)	

Religion-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Religion	National uncertainty aversion	Differential industry growth	Huang (2008)	
Religion	Corruption	Foreign direct investment	Hakkala, Norbäck, and Svaleryd (2008)	
Religion	Corruption	Ability of government to consolidate	Arin et al. (2011)	
Religion	free press	declare exchange rate regime different from de facto regime	Méon and Minne (2014)	
Religion	social trust	savings rate	Zak and Knack (2001)	
Religion	social trust	growth	Zak and Knack (2001)	
Religion	morality	GDP/capita	Balan and Knack (2012)	
Religion	democracy	growth	Mobarak (2005)	
Religion	bank regulation	bank efficiency	Barth et al. (2013)	
Religion	trust	entreprenurship	Guiso, Sapienza, and Zingales (2006)	
Religion	trust	savings	Guiso, Sapienza, and Zingales (2006)	
Religion (among others)	democracy	economic growth	Tavares and Wacziarg (2001)	system GMM
Religion, ancestry	beliefs about redistribution	regressivity of tax system	Guiso, Sapienza, and Zingales (2006)	
Religious composition of county	Attendance in catholic school	Schooling	Evans and Schwab (1995)	
Historical religion	egalitarianism	FDI flows	Siegel, Licht, and Schwartz (2013)	

Religion-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Historical religiousity	Modern state support for religious institutions	voting patterns	Huber and Stanig (2011)	
Historical Religious presence	Current religious strength	peasant rebellions after drought	sing Kung and Ma (2014)	
Religious diversity	Book production	Growth	Baten and van Zanden (2008)	insignificant
Other jewish cities (distant only)	Jewish network strength	growth	Johnson and Koyama (2017)	
Islam (among others)	*	Income, investment*	growth	System GMM check
Protestantism	Literacy	Income	Becker and Woessmann (2009)	3SLS
Christianity	distance to nearest market and wage	consumption	Glewwe (1991)	
Catholicism in 1900	# private schools, catholic school share	international math scores	West and Woessmann (2010)	
Catholicism in 1900	# private schools, catholic school share	educational spending	West and Woessmann (2010)	
Area ancestry	Local religiousity	Household income	Gruber (2005)	
Area ancestry	Local religiousity	Welfare receipt	Gruber (2005)	
Area ancestry	Local religiousity	Marriage	Gruber (2005)	
Area ancestry	Local religiousity	Divorce	Gruber (2005)	
Distance to Wittenberg	Protestantism	Literacy	Becker and Woessmann (2009)	
Distance to Wittenberg	Protestantism	Fraction of girls in school as pupils	Becker and Woessmann (2008)	
Distance to Wittenberg	Protestantism	Enrollment Rate	Becker and Woessmann (2008)	

Religion-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Distance to Wittenberg	Protestantism	Suicide	Becker and Woessmann (2018)	
Distance from Mainz	printing press	Protestant	Rubin (2014)	
Distance from Mainz	adoption of printing press,	economic growth	Dittmar (2011)	
Distance to Wittenberg, landownership	Education	fertility	Becker, Cinnirella, and Woessmann (2010)	
Personal catholicism	Attendance in catholic school	Schooling	Evans and Schwab (1995)	
Personal catholicism	Attendance in catholic school	Academic performance	Neal (1997)	
Religious fragmentation	past violence	Democratic Values	Rehman and Vanin (2017)	**Additional Instruments** • Distance from Durand line
Initial missionary treks	mission presence and type	literacy	Waldinger (2017)	
Initial missionary treks	mission presence and type	primary school outcomes	Waldinger (2017)	
Initial missionary treks	mission presence and type	secondary school outcomes	Waldinger (2017)	
Initial missionary treks	mission presence and type	postsecondary school outcomes	Waldinger (2017)	
Initial missionary treks	mission presence and type	catholicism	Waldinger (2017)	
Prince's religion after Peace of Ausburg	protestantism	hours worked	Spenkuch (2017)	

Religion-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Absolute degrees latitude, land-locked	GDP/capita	Religiousity	McCleary and Barro (2006b)	
Existence of state religion, adherence, plurality	Church attendance	Growth	McCleary and Barro (2006b)	
Religious concentration in 1900	religious concentration in present	state religion	Barro and McCleary (2005)	
Landlocked, absolute degrees latitude	political constraints	state religion	Barro and McCleary (2005)	
Legal origins, colonial history	political constraints	state religion	Barro and McCleary (2005)	
Frequency of religious attendance	drug use	wage	Kaestner (1991)	
Number of advanced schools	advanced school attendance	church attendance	Becker, Nagler, and Woessmann (2017)	
News about euro crisis	concern about euro (differential by religion)	subjective well being	Chadi and Krapf (2017)	
Parental religious involvement when young	religiousity	personal ethical measures	Kirchmaier, Prüfer, and Trautmann (2018)	
State climate differences	state religion (and ethnic) differences	firm strategic alliances	Shi and Tang (2015)	
Presence of a temple	firm founder religiousness	assets, leverage, R&D, advertising	Jiang et al. (2015)	
County-level median income, marriage rates, male to female ratio	corporate social responsibility X religiousity	firm value (differential by litigation risk)	Zolotoy, O'Sullivan, and Chen (2019)	

Religion-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Compulsory education	schooling	religiousity of women	Cesur and Mocan (2018)	
Hindu festival calendar day	festival falling on religious muslim day	riots	Iyer and Shrivastava (2018)	
Day of the week of Hindu festival	riots	political party vote share	Iyer and Shrivastava (2018)	
N/A	Personally Religious	work ethic	McCleary and Barro (2006b)	
N/A	Log GDP/capita	work ethic	McCleary and Barro (2006b)	
N/A	distance from mission	polygamy	Fenske (2015)	
N/A	religion	growth	Miguel, Satyanath, and Sergenti (2004)	(as a control)
N/A	religion	civil conflict	Miguel, Satyanath, and Sergenti (2004)	(as a control)
N/A	Religion	banking crisis	Beck, Demirgüç-Kunt, and Levine (2006)	
N/A	religion	property rights	LaPorta et al. (1999)	
N/A	religion	business regulation	LaPorta et al. (1999)	
N/A	religion	top marginal tax rate	LaPorta et al. (1999)	
N/A	religion	corruption	LaPorta et al. (1999)	
N/A	religion	bureaucratic delays	LaPorta et al. (1999)	
N/A	religion	government wages/GDP	LaPorta et al. (1999)	
N/A	religion	public rights	LaPorta et al. (1999)	
N/A	religion	infant mortality	LaPorta et al. (1999)	
N/A	religion	school attainment	LaPorta et al. (1999)	

Religion-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
N/A	religion	illteracy rate	LaPorta et al. (1999)	
N/A	religion	infrastructure quality	LaPorta et al. (1999)	
N/A	religion	transfers and subsidies as a fraciton of GDP	LaPorta et al. (1999)	
N/A	religion	SOEs in the economy	LaPorta et al. (1999)	
N/A	religion	public sector employment	LaPorta et al. (1999)	
N/A	religion	democracy	LaPorta et al. (1999)	
N/A	religion	political rights	LaPorta et al. (1999)	
N/A	religion	Investor protections	Stulz and Williamson (2003)	
N/A	religion	Economic growth	McCleary and Barro (2006a)	
N/A	Religion	Infant mortality	Brainerd and Menon (2014)	
N/A	Religion	att. toward cooperation	Guiso, Sapienza, and Zingales (2003)	
N/A	Religion	att. toward government	Guiso, Sapienza, and Zingales (2003)	
N/A	Religion	att. toward working women	Guiso, Sapienza, and Zingales (2003)	
N/A	Religion	legal rules	Guiso, Sapienza, and Zingales (2003)	
N/A	Religion	thriftiness	Guiso, Sapienza, and Zingales (2003)	
N/A	Religion	attitudes toward market economy	Guiso, Sapienza, and Zingales (2003)	

Religion-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
N/A	Religion	racial attitudes	Guiso, Sapienza, and Zingales (2003)	
N/A	Blue law repeal	Local religious attendance	Gruber and Hungerman (2008)	

Weather-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Rainfall, international price shocks	GDP	urbanization	Brückner (2012a)	
Rainfall	crop yields	manufacturing output	Lee (2018)	
Rainfall	crop yields	employment	Lee (2018)	
Rainfall	crop yields	capital investment	Lee (2018)	
Rainfall on specific day	Meeting frequency during first loan cycle	Loan default	Feigenberg, Field, and Pande (2013)	
Rainfall surprise	Unanticipated income shock	School attendance	Jacoby and Skoufias (1997)	
Rainfall, commodity price shocks	economic growth	urban concentration	Castells-Quintana (2017)	
Rainfall	inspection frequency	industrial pollution	Lin (2013)	
Rainfall in producer countries	prices of good	trade policy	Giordani, Rocha, and Ruta (2016)	
Rainfall	transitory income shocks X credit/GDP	remittances	Arezki and Brückner (2012b)	
Rainfall	Cotton production	Industrial production	Davis, Hanes, and Rhode (2009)	
Rainfall	Village income shock	Local witch killings	Miguel (2005)	
Rainfall	economic growth	civil conflict	Miguel, Satyanath, and Sergenti (2004)	
Rainfall	Income	Risk preferences	Camerer et al. AER 2010	
Rainfall on specific day	Nuclear fallout from Chernobyl	Birth weight	Almond et al. QJE 2009	
Rainfall	water quality	cancer rates	Ebenstein (2012)	
Rainfall	Income changes	Democratic change	Brückner and Ciccone (2011)	
Rainfall	Income	Land invasions	Hidalgo et al. (2010)	

Weather-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Rainfall	agricultural productivity	wages, differentially by poorness, migration-prone, and credit-constrainedness	Jayachandran (2006)	
Rainfall	transitory income shocks	remittances	Arezki and Brückner (2012a)	
Rainfall	transitory income shocks	consumption	Brückner and Gradstein (2013a)	
Rainfall	transitory income shocks	net current transfers	Brückner and Gradstein (2013a)	
Rainfall	transitory income shocks	trade balance	Brückner and Gradstein (2013a)	
Rainfall	severity of famine	cognitive development of children	Ampaabeng and Tan (2013)	
Rainfall	grain prices	property crime	Mehlum, Miguel, and Torvik (2006)	
Rainfall	grain prices	violent crime	Mehlum, Miguel, and Torvik (2006)	
Rainfall	child wages	school attendance	Jacoby and Skoufias (1997)	
Rainfall	exposure to feces	infant health outcomes	Team (1992)	**Additional Instruments** • 15+, See paper

Weather-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Rainfall	Wages	Labor supply	Skoufias (1996)	**Additional Instruments** • Wage rate changes, village dummies, unemployment rate
Rainfall, international commodity prices	real GDP growth	tax revenue	**?**	
Rainfall variability*	Enterprise	Nearby enterprise	Felkner and Townsend (2011)	
Rainfall deviations	income shocks	consumption	Kazianga and Udry (2006)	
Rainfall, family sickness	female labor	women's autonomy	Anderson and Eswaran (2009)	
Rainfall on specific day	Number of protesters on that day	Later voting behavior	Madestam et al. (2013)	
Rainfall, elevation, sunny months	income	consumption	Khandker (2012)	
Average rainfall, variance in rainfall	land concentration	# of banks	Rajan and Ramcharan (2011)	
Rainfall and household head's ability to work	income shocks	rate of time preference	Tanaka, Camerer, and Nguyen (2010)	
Rainfall	Income shocks	rate of time preference -> agricultural investment	Di Falco et al. (2019)	
Rainfall anomalies	income shocks	rate of time preference	Di Falco et al. (2019)	

Weather-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Rainfall and sunshine	wine quality	exports	Chen and Juvenal (2016)	
Lagged rainfallXvillage land	weak ties in a location	my migration	Giulietti, Wahba, and Zenou (2018)	
Lagged rainfall	share of villagers working in distant locations	precautionary savings	Giles and Yoo (2007)	
Lagged rainfall	Aggregate resources	consumption (differentially by risk-aversion)	Mazzocco and Saini (2012)	
Past Rainfall	household food resources	nutritional intake by age/gender	Mangyo (2008)	
Past rainfall in Mexican home community	Size of migrant community in US	Occupation of immigrant	Munshi (2003)	
Historical precipitation shocks	manager government	police officers per capita	Vlaicu and Whalley (2016)	
Historical precipitation shocks	manager government	popular city employment (pandering jobs)	Vlaicu and Whalley (2016)	
Historical rainfall variability	GDP variability	government size	Brückner and Gradstein (2013b)	
Historical Rainfall (1850-1861)	mafia in 19th century	mafia now -> amount of public transfers to local businesses	Barone and Narciso (2015)	
Mafia in 19th century	mafia now	amount of public transfers to local businesses	Barone and Narciso (2015)	

Weather-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Rainfall from more distant stations	Early-life rainfall	health, schooling, socioeconomic status for women	Maccini and Yang (2009)	
Rainfall in nearby rainfall stations	Early-life rainfall	Health/socioeconomic status	Maccini and Yang (2009)	
Neighbor rainfall*	neighbor conflict	own conflict	Harari and Ferrara (2018)	
Rainfall in ally territory	ally fighting	my fighting	König et al. (2017)	
Rainfall X land area	incomeXaccess to outside markets	consumption	Giles (2006)	
Rainfall X proximity to clinic	acute illness	sectoral labor supply	Adhvaryu and Nyshadham (2017)	
Rainfall X hh characteristics	crop income	livestock sales	Fafchamps, Udry, and Czukas (1998)	
Rainfall Shock X Nearby an MPESA Agent Rainfall shock X distance to mobile money agent	Use of MPESAXincome shock	consumption volatility in response to a shock consumption volatility	Jack and Suri (2014) Riley (2018)	
Monthly rainfall X cultivated acreage, capital, acreage under specific crops, number of household males and females of ages 15-45	residual shock	hours of work	Kochar (1999)	

Weather-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Precipitation	economic growth	democratic change	Burke and Leigh (2010)	
Weather today and yesterday	crime yesterday	crime today	Jacob, Lefgren, and Moretti (2007)	
Past weather episodes	Past disease incidence	Current disease incidence	Adda QJE 2016	
Local weather	First day movie searches	First week movie searches	Gilchrist and Sands (2016b)	
Hourly weather variables	Residual energy demand	Energy price premium	Ito AER 2016	
Past weather shocks	supply (via inventories)	price	Roberts and Schlenker (2013)	
Current weather shocks Hydroelectric power from rainfall	demand Electricity shortage	price Manufacturing outcomes	Roberts and Schlenker (2013) Allcott, Collard-Wexler, and O'Connell (2016)	
River flows	power outages	firm sales	Cole et al. (2018)	
Drought (1930's)	Fraction of county in high-erosion area	Changes in land value	Hornbeck (2012)	
Drought	Population size	civil war	Brückner (2010)	
Nile floods	Judge changes	Civil unrest	Chaney (2013)	
Extreme weather	migrant flows	hourly earnings,	Boustan, Fishback, and Kantor (2010)	
Extreme weather	migrant flows	moving away,	Boustan, Fishback, and Kantor (2010)	

Weather-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Extreme weather	migrant flows	lose weeks of work, access to relief jobs, full time-> part time work	Boustan, Fishback, and Kantor (2010)	
Extreme weather	migrant flows	access to relief jobs, full time-> part time work	Boustan, Fishback, and Kantor (2010)	
Extreme weather	migrant flows	full time-> part time work	Boustan, Fishback, and Kantor (2010)	
Foreign disasters (including weather)(Frankel-Romer)	total trade flows	GDP	Felbermayr and Gröschl (2013)	
Disaster X polity, race, finance	openness	change in GDP/capita	Felbermayr and Gröschl (2013)	
Temperature	economic growth	democratic change	Burke and Leigh (2010)	
Temperature (51 more)	Early Viewership	Weekly box-office sales	Gilchrist and Sands (2016b)	
Cold or hot days	electricity scarcity	industrial output	Fisher-Vanden, Mansur, and Wang (2015)	
Average hours of sun	Local housing prices	Openness to land development	Saiz QJE 2010	
Season X village	child wages	school attendance	Jacoby and Skoufias (1997)	
High sea surface temperature	coral bleaching	migration	Chaijaroen (2019)	

Weather-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
High sea surface temperature	coral bleaching	labor supply	Chaijaroen (2019)	
High sea surface temperature	coral bleaching	consumption	Chaijaroen (2019)	
High sea surface temperature	coral bleaching	income	Chaijaroen (2019)	
Bad weather at sea	supply of fish	prices	Angrist, Graddy, and Imbens (2000)	
Weather CEO vacation home	trips to vacation home	company news	Yermack (2014)	
Weather CEO vacation home	trips to vacation home	mandatory disclosure delay	Yermack (2014)	
Weather CEO vacation home	trips to vacation home	stock volatility	Yermack (2014)	
Sky cloud cover	managerial expansion beliefs	hiring	Chhaochharia et al. (2018)	
Sky cloud cover	managerial expansion beliefs	capital investment	Chhaochharia et al. (2018)	
N/A	El Nino	heterogeneous effects on inflation, economic activity	Cashin, Mohaddes, and Raissi (2017)	
N/A	Weather (temperature)	Judge decisions	Heyes and Saberian (2019)	
N/A	rainfall variability	level of local enterprise level of other enterprises	Felkner and Townsend (2011)	
N/A	Weather (rainfall)	infant mortality	Neidell and Currie (2005)	

Weather-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
N/A	Rainfall, temperature	infant birth weight	Currie, Neidell, and Schmieder (2009)	
N/A	Hurricanes	migration	Strobl (2011)	
N/A	Hurricanes	GDP	Strobl (2011)	
N/A	Rainfall	farmer decisions	Fafchamps (1993)	
N/A	Rainfall	food, calorie consumption	Dercon (2004)	
N/A	Disasters (including weather) X revolution	GDP	Cavallo et al. (2013)	
N/A	Rainfall	state capacity	Acemoglu, García-Jimeno, and Robinson (2015)	
N/A	Rain, precipitation	flight cancellation propensity	Rupp and Holmes (2006)	

Immigrant Enclave-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Historical immigrant share by industry	new immigrant share by industry	wages	Altonji and Card (1991)	**Differential Effects** • Race and gender (largely insignificant)
Historical immigrant share by industry	new immigrant share by industry	Employment	Altonji and Card (1991)	**See above**
Historical immigrant share by industry	new immigrant share by industry	Labor force participation	Altonji and Card (1991)	**See above**
Historical immigration patterns	immigrant inflows	native outflows	Card (2001)	
Historical immigration patterns	immigrant inflows	employment/population of natives	Card (2001)	
Historical immigration patterns	immigrant inflows	employment/population of immigrants	Card (2001)	
Historical immigration patterns	immigrant inflows	wages	Card (2001)	
Lagged migration rates	current migration rates	earnings	Biavaschi (2013)	
Distance from coast, border, gateway	linguistic diversity	wages, employment	Ottaviano and Peri (2005)	
East German immigrant flows	all immigrants	wages and employment of old immigrants	D'Amuri, Ottaviano, and Peri (2010)	
Push-immigration (conflict, war, etc.), Card (2001)	relative inflow rate of low-skilled immigration 1980-1990	population of native skill group	Card and DiNardo (2000)	

Immigrant Enclave-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Card (2001)	current Soviet immigration	local consumer prices	Lach (2007)	based on high price elasticity
Card (2001)	low-skilled immigrant concentration	average hours of work among top quartile of women	Cortés and Tessada (2011)	
Card (2001)	low-skilled immigrant concentration	probability of working long hours top quartile of women	Cortés and Tessada (2011)	
Card (2001)	low-skilled immigrant concentration	time spent in household work among top-quartile of women	Cortés and Tessada (2011)	
Card (2001)	low-skilled immigrant concentration	expenditures on houskeeping services among top-quartile of women	Cortés and Tessada (2011)	
Card (2001)	share of immigrants among less-educated workers	skilled nature of native tasks	Peri and Sparber (2009)	
Card (2001) and distance from Mexican border	immigration flows	TFP	Peri (2012)	
Card (2001)	immigrant flows	STEM education among natives	Orrenius and Zavodny (2015)	
Card (2001)	immigrant flows	property crime	Bell, Fasani, and Machin (2013)	
Card (2001)	number of high-school dropouts (immigrants)	technologies adopted by firm (computer, automation)	Lewis (2011)	

Immigrant Enclave-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Card (2001)	change in immigrant population	prices of immigrant-intensive services	Cortes (2008)	
Card (2001)	change in immigrant population	high-school dropouts	Card and Lewis (2007)	
Card (2001)	change in immigrant population	city industrial composition	Card and Lewis (2007)	
Card (2001)	change in immigrant population	local rental prices	Saiz (2007)	
Card (2001)	change in immigrant population	local housing prices	Saiz (2007)	
Card (2001)	immigration	capital returns	Lafortune, Lewis, and Tessada (2019)	
Card (2001)	immigration	capital investment	Lafortune, Lewis, and Tessada (2019)	
Card (2001)	immigration	wages	Lafortune, Lewis, and Tessada (2019)	
Card (2001)	Agricultural, low-skilled immigrants	crop choice	Lafortune, Lewis, and Tessada (2019)	
Card (2001)	Agricultural, low-skilled immigrants	total farming	Lafortune, Lewis, and Tessada (2019)	
Card (2001)	Agricultural, low-skilled immigrants	capital ratio	Lafortune, Lewis, and Tessada (2019)	
Card (2001)	Agricultural, low-skilled immigrants	and value	Lafortune, Lewis, and Tessada (2019)	
Card (2001)	Agricultural, low-skilled immigrants	crop specialization	Lafortune, Tessada, and González-Velosa (2015)	
Card (2001)	migrant share	wages (short- and long-run, for low skilled women)	Morales (2018)	

Immigrant Enclave-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Card (2001)	immigration	wages	Dustmann, Frattini, and Preston (2013)	**Differential Effects** • Across distribution
Card (2001)	immigrant flows	patents	Draca, Machin, and Witt (2011)	
Card (2001)	immigration	public/private school choice of natives	Farre, Ortega, and Tanaka (2018)	**Differential Effects** • By native income
Card (2001)	immigration	student/teacher ratio in public schools	Farre, Ortega, and Tanaka (2018)	
Card (2001)	immigration	labor supply of skilled native females	Farré, González, and Ortega (2011)	
Card (2001)	immigrant share	majoring in science and engineering	Orrenius and Zavodny (2015)	
Card (2001)	immigrant inflow	planned retirement age gap between men and women with a living parent over 80	Peri, Romiti, and Rossi (2015)	**Differential Effects** • By skill, education, and gender
Card (2001)	change in immigrants	health	Giuntella and Mazzonna (2015)	**Differential Effects** • By blue-collar, education
Card (2001)	change in the stock of immigrants	housing prices	Sá (2015)	**Differential Effects** • By immigrant education

Immigrant Enclave-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Card (2001)	immigrant share	imports of service-providing firms	Ottaviano, Peri, and Wright (2018)	
Card (2001)	immigrant share	exports of service-providing firms	Ottaviano, Peri, and Wright (2018)	
Card (2001)	immigrant share	productivity of service-providing firms	Ottaviano, Peri, and Wright (2018)	
Card (2001)	current immigrants	physical burden of jobs	Giuntella et al. (2018)	**Differential Effects** • By job type
Card (2001)	low-skilled immigration	gender pay gap, gender hours gap	Cortés and Pan (2019)	
Card (2001)	immigration	voting for center-right (municipality fixed effects)	Barone et al. (2016)	
Card (2001)	growth in immigrant share	far-right voting	Halla, Wagner, and Zweimüller (2017)	
Card (2001)	immigrant population	native immigration flows (by skill)	Wozniak and Murray (2012)	Includes MSE-YEar FE
Card (2001)	immigration	political accountability	Batista and Vicente (2011)	
Card (2001) (by nationality)	change in skill mix (immigrants)	wage changes	Dustmann and Glitz (2015)	
Card (2001) (by nationality)	change in skill mix (immigrants)	firm entry (by skill)	Dustmann and Glitz (2015)	
Card (2001) (by nationality)	change in skill mix (immigrants)	firm intensity of use (by skill)	Dustmann and Glitz (2015)	

Immigrant Enclave-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Card (2001) (by nationality)	change in skill mix (immigrants)	firm scale	Dustmann and Glitz (2015)	**Differential Effects** • By manufacturing vs. trading sector
Card (2001) climate, Saiz (2010)	housing costs	industrial composition	Beaudry, Green, and Sand (2012)	
Card (2001) climate, Saiz (2010)	industrial composition	housing costs	Beaudry, Green, and Sand (2012)	
Card (2001) X GDP	own child migration	adult subjective health, BMI, ability to live independently, nutrition	Böhme, Persian, and Stöhr (2015)	
Card (2001) (black migration)	current black migration	white flight	Boustan (2010)	
Card (2001) (by occupation)	neighborhood concentration of occupation	segregation	Cutler, Glaeser, and Vigdor (2008)	
Card (2001) (high-skilled immigrants)	nurse migration	native nurse occupational choice	Cortés and Pan (2014)	
Card (2001) (immigrant, native skill groups)	immigrant population share, native skill group populations	labor outcomes (insignificant)	Dustmann, Fabbri, and Preston (2005)	
Card (2001) (country-skill cell)	country-skill immigrant flows	native employment	D'Amuri and Peri (2014)	
Card (2001) (country-skill cell)	country-skill immigrant flows	task intensity	D'Amuri and Peri (2014)	
Card (2001) (foreign scientists and engineers, H-1B visa)	firm changes in H-1B visa immigrants	patents	Peri, Shih, and Sparber (2015)	

Immigrant Enclave-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Card (2001) (firm share of immigrants, H-1B visa)	firm changes in H-1B visa immigrants	skilled worker employment	Kerr, Kerr, and Lincoln (2015)	**Differential Effects** • By age
Card (2001) (STEM workers, H-1B visa)	increase in foreign STEM workers	wages (by skill and origin) & wages	Peri, Shih, and Sparber (2015)	**Differential Effects** • By education **Additional Results** • Simulates TFP and skill-bias effects using estimated parameters
Card (2001) (STEM workers, H-1B visa)	STEM increases	Employment	Peri, Shih, and Sparber (2015)	
Card (2001) (by industry)	change in stock of immigrants (by industry)	vocational enrollment (building and construction)	Røed and Schøne (2016)	
Card (2001) (by industry)	change in stock of immigrants (by industry)	construction wages	Røed and Schøne (2016)	
Card (2001) (by industry)	change in stock of immigrants (by industry)	vocational specialization	Røed and Schøne (2016)	
Card(2001), past high-rise stock, attitudes toward immigrants	immigrant share	probability of exporting	Parrotta, Pozzoli, and Sala (2016)	

Immigrant Enclave-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Card(2001), past high-rise stock, attitudes toward immigrants	immigrant share	export sales	Parrotta, Pozzoli, and Sala (2016)	
Card(2001), past high-rise stock, attitudes toward immigrants	immigrant share	diversity	Parrotta, Pozzoli, and Sala (2016)	
Card (2001) (SDY migrants)	more migrants	lower consumption volatility and asset holding	Kinnan, Wang, and Wang (2018)	
Card (2001) (by skill)	current immigrant (by skill)	Skilled/unskilled ratio	Baum-Snow, Freedman, and Pavan (2018)	
Card (2001) (by skill)	current immigrant (by skill)	capital intensity	Baum-Snow, Freedman, and Pavan (2018)	
Card (2001) (by skill)	current immigrant (by skill)	wages, skill-premium	Baum-Snow, Freedman, and Pavan (2018)	
Card (2001) (by skill)	current immigrant (by skill)	skill-premium	Baum-Snow, Freedman, and Pavan (2018)	
Card (2001) (manufacturing)	current immigrants in manufacturing	90/10 ratio of wages (inequality)	Gould (2018)	
Card (2001) (location dictated by state)	current immigrant flow	native unemployment	Aydemir and Kirdar (2017)	**Differential Effects** • By age, education

Immigrant Enclave-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Card (2001) (by university)	current increase of immigrants (cyclical)	domestic student enrollment	Shih (2017)	
Card (2001) (by education)	share of immigrants in skilled labor	patents, citations	Bosetti, Cattaneo, and Verdolini (2015)	
Card (2001), origin community violence	displaced migrant share	long-run wages (low-skilled female)	Morales (2018)	
Card (2001), origin community violence	displaced migrant share	short-run wages (low-skilled female)	Morales (2018)	
Card (2001), origin community violence	displaced migrant share	out migration (short run, all skill/gender groups)	Morales (2018)	
Card (2001), origin community violence	displaced migrant share	out migration (long run, all skill/gender groups)	Morales (2018)	
Card (2001)	unskilled immigration flow	intensive and extensive margin of work for native-born women	Forlani, Lodigiani, and Mendolicchio (2015)	
Card (2001) (Soviet-born)	Post-soviet distribution of immigrants	citations, patents	Ganguli (2015)	
Card (2001) (natives)	native share	ethnic employment gap	Combes et al. (2016)	
Card (2001) (ethnic diversity)	current diversity	employment status (insignificant)	Hémet and Malgouyres (2018)	
Card (2001) (also distance from coast, border, gateway)	linguistic diversity	wages, employment	Ottaviano and Peri (2005)	
Card (2001) (among others)	population of same language speakers	wages	Li (2013)	

Immigrant Enclave-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Card (2001) (by immigrant gender)	change in gender ratio of immigrants	pre-marital investments (education, age at first marriage)	Lafortune (2013)	
Card (2001) (by university-immigrant country) (not main)	university-immigrant student supply	academic publications, citations	Stuen, Mobarak, and Maskus (2012)	
Card (2001) (adjusting for bilateral country flows)	migration to Italy	robberies (other affects insignificant)	Bianchi, Buonanno, and Pinotti (2012)	
Card (2001) workplaces (by ethnic, education, demographic)	educational diversity, demographic diversity	transition to self employment	Marino, Parrotta, and Pozzoli (2012)	
Card (2001) (past foreign nurses)	current supply of nurses	nurse wages	Kaestner and Kaushal (2012)	
Card (2001), distance from Mexico	immigrant population	youth employment	Smith (2012)	
Card (2001) (foreign female workers)	immigrant population which provides household services	native women's time at work	Barone and Mocetti (2011)	
Card (2001) (for Mexican-Central American immigrants by skill-cell, relative to rest of US) & population by skill, native wages, labor supply Card (2001)	immigration flows	employment	González and Ortega (2011)	**Differential Effects** • By education

Immigrant Enclave-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Card (2001) (for Mexican-Central American immigrants by skill-cell, relative to rest of US) & population by skill, native wages, labor supply Card (2001)	immigration flows	wages	González and Ortega (2011)	**See above**
Card (2001) (for Mexican-Central American immigrants by skill-cell, relative to rest of US) & population by skill, native wages, labor supply Card (2001)	immigration flows	production structure	González and Ortega (2011)	**See above**
Card (2001) (for Mexican-Central American immigrants by skill-cell, relative to rest of US)	Immigration	Wages	Peri (2011)	
Card (2001) (for Mexican-Central American immigrants by skill-cell, relative to rest of US)	Immigration	Employment	Peri (2011)	
Card (2001)	immigrant share	correlation between female labor force participation and fertility	Furtado and Hock (2010)	

Immigrant Enclave-Related Instruments

Instrument	Endogenous Variable	Outcome	Citation	Notes
Card (2001) (by industry, not locality)	immigrant presence by industry	native, off-shoring employment (not always significant)	Ottaviano, Peri, and Wright (2013)	
Card (2001), Cortes and Pan (2015)	current immigration	voting behavior	Barone et al. (2016)	
Card (2001) (highly-educated foreigners)	years of college per worker	TFP	Iranzo and Peri (2009)	**Additional Instruments** • Compulsory schooling laws, proximity to land-grant colleges
Card (2001) (by skill)	immigrant skill mix	education wage gap (dropout, high-school, college)	Card (2009)	