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Trade Shocks and the Provision of Local Public Goods†

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We analyze the impact of trade-induced income shocks on the size of local government and the provision of public services. Areas in the United States with declining labor demand and incomes due to increasing import competition from China experience relative declines in housing prices and business activity. Since local governments are disproportionately funded through property and sales taxation, declining property values and a decrease in economic activity translate into less revenue, which constrains the ability of local governments to provide public services. State and federal governments have limited ability to smooth local shocks, and the impact on the provision of public services is compounded when local income shocks are highly correlated with shocks in the rest of the state. The outcome is a relative decline not only in incomes but also in the quality of public services and amenities in trade exposed localities. (*JEL* F14, F16, H41, H71, R12, R31, R51)

The size and role of government in an increasingly globalized world is an important but understudied question. While free trade results in gains in aggregate welfare, the distribution of these gains is uneven across regions and segments of the population within a country.[1] An increase in trade openness or changes in global patterns of comparative advantage increases the uncertainty associated with these gains and exposes workers to riskier economic environments.[2] Governments may play an important role in this context both by mitigating risk through welfare spending (Rodrik 1998) and by investing in public services such as high-quality education and infrastructure to ensure the competitiveness of workers and firms (Sachs 2011). At the same time, globalization may restrain a government's ability to adjust

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[1] A large empirical literature has examined the important question of how trade might affect the wages of workers in different human capital or occupational categories. Feenstra and Hanson (2003), Davidson and Matusz (2004), Goldberg and Pavcnik (2007), and Harrison (2006) provide excellent survey treatments.

[2] International competition, by posing a limit on price variability, could reduce the stabilizing role of prices and expose an economy to higher output volatility (Newbery and Stiglitz 1984). Similarly, increased openness may increase risk for individual workers due to an increase in the elasticity of labor demand (Rodrik 1997, Slaughter 2001, Senses 2010) and a weakening of domestic institutions for risk sharing (McLaren and Newman 2002). Krebs, Krishna, and Maloney (2010) for Mexico and Krishna and Senses (2014) for the United States find a statistically and economically significant association between openness and persistent income risk.

spending due to budgetary pressures and increased factor mobility (Cerny 1995 and Rodrik 1997). In this paper, we contribute toward an understanding of the impact of globalization on the size of government by studying the effects of local income shocks due to increased imports from China on local government finances and the provision of local public services in the United States.

Unlike in other industrialized countries, funding for public services such as education, fire and police protection, parks and recreation, public transport, and public housing for low-income families is highly localized in the United States, with heavy reliance on property and sales tax revenues. Local funding of public services allows jurisdictions to tailor spending and service provision according to local priorities. It also leads to vast differences in taxation and the quality of public services. When income shocks differentially affect US localities, these localities correspondingly adjust services according to budget constraints. A decline in the level of local economic activity and incomes in a labor market depresses revenues and restricts the ability of local governments to fund services. Unless federal or state governments provide complete insurance against the decline in revenues, the outcome is a reduction of local government expenditures, leading to worsening measures of public goods provision relative to other parts of the country. As we show in this paper, the incidence of these expenditure cuts typically falls upon those who rely the most on government services, namely low-income households and families with dependent children.

In identifying the effects of changes in local incomes on public good provision, we exploit the variation in trade exposure across US labor markets. Due to differences in initial industry composition, the magnitudes of trade shocks vary across labor markets and lead to differential changes in employment and income (Topalova 2007; McLaren and Hakobyan 2010; Autor, Dorn, and Hanson 2013; Kovak 2013). The trade shock we consider is the rise in imports from China to the United States between 1990 and 2007, as in Autor, Dorn, and Hanson (2013).[3] The resulting variation in exposure to Chinese import competition across localities can be viewed as an external shock to individual US labor markets.[4]

[3] The surge in low-income country imports into the United States during this period is mostly driven by China. China's increase in exports can be attributed to internal reforms: the country's transition to a market economy, the migration of over 150 million workers from rural to urban areas, the adoption of foreign technologies, and the country's accession to the World Trade Organization (WTO).

[4] The increase in Chinese import competition can be considered an external shock to the extent it was not driven by a decline in local productivity or changes in local demand in the United States. Following Autor, Dorn, and Hanson (2013), we use growth in Chinese exports to other high-income countries as an instrument for the growth in US imports from China. The instrumentation strategy we implement resembles the Bartik (1991) instrument commonly used in the public finance and urban economics literatures (e.g., see Baum-Snow and Ferreira 2014 for a review). The Bartik instrument is based on an interaction of cross-sectional differences in base-year industrial composition and national changes in industry employment. The assumption for credible identification is that initial industry composition does not directly predict the outcomes of interest conditional on controls. This is a strong assumption especially when using one-digit sector classifications as is often done to avoid situations where employment in an industry is highly concentrated in a few localities. For our instrument, we use local employment decomposed at the four-digit Standard Industrial Classification (SIC) level and interact these initial shares of local employment with the change in Chinese exports in specific four-digit product categories. Our instrumentation strategy is based not only on initial employment shares and national changes to employment (as is the case with the Bartik instrument), but on initial employment shares in specific industries that directly compete with Chinese imports. Over 75 percent of the variation in our instrument is driven by initial differences in employment *within* manufacturing across localities.

The literature currently documents relative declines in both wages and employment in labor markets that are more exposed to low-income-country import competition. It also finds that negative labor market outcomes spill over to the non-manufacturing sector and continue to persist even when social assistance and trade adjustment programs at the federal level are taken into account (McLaren and Hakobyan 2010; Autor, Dorn, and Hanson 2013). In this paper, we extend the analysis of trade shocks by examining whether negative labor market outcomes result in a deterioration of local public finances and services. By focusing on the local public finance implications of trade shocks, our paper complements the findings of the recent literature examining the impact of trade on labor outcomes such as employment, wages, and income. This is important as the response of the local governments, and their ability to provide local services and local amenities, will help mitigate or further amplify the effects of the initial negative economic shock on the locality. The localities that experience a decline in incomes may have greater difficulty in recovering from these shocks if they fail to provide high-quality public services.[5]

The key findings of this paper are as follows. First, increased competition from Chinese imports negatively affects local finances and the provision of public services across US localities. Specifically, localities that experience a relative decline in employment and incomes due to their differential exposure to Chinese imports experience a relative decline in housing prices and business activity. The resulting decline in local government revenues, mainly due to declining property and sales tax receipts, translates into a decline in local expenditures on almost all major budget items. A $1,000 increase in Chinese imports per worker results in a relative decline in per capita expenditures on public welfare (by 7.7 percent), on public transport (by 2.4 percent), on public housing (by 6.8 percent), and on public education (by 0.9 percent); public safety spending remains unchanged.

Second, the demand for local public goods such as education, public safety, and public welfare is increasing more in trade-affected localities when resources for these services are declining or remaining constant. We show that public safety expenditures remain constant at a time when local poverty and unemployment rates are rising, resulting in higher property crime rates (by 3.5 percent). Similarly, a relative decline in education spending coincides with an increase in the demand for education as students respond to a deterioration in employment prospects for low-skilled workers by remaining in school longer. The result is an increase in student-teacher ratios in public schools. In localities that are more exposed to trade shocks, we also document an increase in the share of poor and low-income households, which tend to rely more on government services such as public housing and public transportation, both of which experience spending cuts.

[5]Roback (1982) shows that in low amenity localities, firms must compensate with higher wages in order to attract workers. Cullen and Levitt (1999) show that high-income and highly educated families value public safety and are more likely to move in response to an increase in crime rates. Also related is a recent literature that focuses on the impact of trade on social outcomes such as health, education, and crime (McManus and Schaur 2015; Greenland and Lopresti 2013; Iyer and Topalova 2014; Dix-Carneiro, Soares, and Ulyssea 2016; Deiana 2016). In this paper, we highlight the public finance channel as a contributing factor to changes in these social outcomes across US localities.

Third, state and federal intergovernmental transfers incompletely insure against trade-induced income shocks, especially when local shocks are correlated with shocks in the rest of the state. This is important since intergovernmental transfers could theoretically be used to help equalize local per capita expenditures and public good provision across localities. Because intergovernmental transfers do not buffer against local income shocks, there is a relative decline not only in incomes but also in the quality of public services and amenities in trade exposed localities.

The remainder of the paper proceeds as follows. Section I provides information on the rise of Chinese imports and discusses the interrelation between local income shocks, public finances, and public service provision in the United States. Section II presents the empirical framework. Our main results are presented in Section III, and Section IV provides extensions and robustness checks to assess the validity of our results. Finally, Section V concludes.

I. Motivation

Since the early 1990s, the value of China's exports to the rest of the world has grown exponentially due mostly to structural reforms within the Chinese economy. For the United States, this growth has translated into greater competition from Chinese imports, which increased more than tenfold from $26 billion in 1991 to $330 billion in 2007. For comparison, imports from other countries into the United States grew approximately threefold from $369 billion in 1991 to $992 billion in 2007. Importantly, there is substantial heterogeneity in exposure to imports from China across industries and localities. Localities in the United States that specialize in producing manufactured goods, especially those heavily exported by China, are the most negatively affected by the surge in Chinese competition, whereas localities with the majority of employment in industries that do not directly compete with Chinese products are hardly affected at all.[6] Autor, Dorn, and Hanson (2013) find this heterogeneity in import exposure to be important in explaining the variation in labor market outcomes across the United States, with labor markets that are more exposed to import competition from China experiencing relative declines in employment and earnings. Our hypothesis is that localities experiencing relative declines in income and economic activity due to trade will also experience relative declines in home values and tax revenues and a relative increase in demand for public services. Unless there are countervailing adjustments in other sources of revenue, such as intergovernmental transfers, this will result in greater difficulty in providing local public services.

[6] For example, during the period we analyze, one of the localities that faced the largest increases in import competition from China was Providence, Rhode Island, a major manufacturer of toys and costume jewelry. Meanwhile, employment in areas such as Washington, DC (which specializes in government services) and New Orleans, Louisiana and Orlando, Florida (which specialize in tourism) were hardly affected by Chinese import competition.

A. *Public Finances in Local Labor Markets*

A key component of our paper involves how localities fund public services. We begin by defining the concept of a locality as a commuting zone and then examine the main sources of revenue and expenditures by function.

Commuting Zones.—In our analysis, a commuting zone is the geographic unit defining a local labor market (Tolbert and Sizer 1996). We group counties characterized by strong commuting patterns into 722 commuting zones for the United States using the concordances from Autor, Dorn, and Hanson (2013). The notion of commuting zones resembles metropolitan areas with the exception that it includes the entire mainland United States (both urban and rural areas) and that it subdivides some larger metropolitan areas into smaller units based on residents' commuting patterns. We consider the commuting zone as the appropriate unit of analysis for three reasons. First, a commuting zone is designed to include an individual's place of employment and residence even if these are in different counties. This overlap between employment and residential locations ensures the impact of trade shocks on labor market outcomes, public finances, and public service outcomes collectively occur within the same unit of analysis. Second, using commuting zones helps circumvent issues of selective migration, for example, migration from cities to suburbs, that may influence the provision of public goods within specific jurisdictions but not on average across an entire commuting zone. Lastly, local public goods are provided by a variety of government entities such as cities, counties, and specially created districts such as school districts or transit authorities. In using commuting zones, we take the aggregate of revenues and expenditures for all of these local entities and focus on overall public service provision at the entire commuting zone level.[7]

Revenues.—Local governments in the United States rely on locally generated revenues and intergovernmental transfers to fund public services. Panel A of Table 1 describes the revenue side of public finances for 1990 and 2007.[8] The majority of local government revenues are locally generated: on average, about 61 percent of total revenue at the local level is from own sources, with the remainder (39 percent) coming from intergovernmental transfers.[9] Total revenue from own sources comes

[7]Most local government expenditures are accounted for by school districts (31 percent) and municipalities (32 percent) followed by county governments (23 percent), special districts (11 percent), and lastly by townships (3 percent). School and special districts have specialized functions. Direct education spending is done almost entirely by school districts (about 80 percent). About half of all expenditures of special districts are on enterprise expenditures (water, electric, gas, and transit), with the remainder spent on environment and housing. Cities, towns, and counties spend on public safety, education, transportation, government administration, public welfare, environment, and housing. It is possible that multiple levels of government are responsible for providing various services determined by the state government. For example, public safety could include a municipal police force and a county police force.

[8]The data on local government expenditures and revenues are sourced from the US Census Bureau's historical data on State and Local Government Finances. This dataset comprises detailed revenue and expenditure information on individual local governments, including counties, cities, townships, special districts, and independent school districts. In our analysis, we aggregate this information to the commuting zone level. See Appendix A for detailed variable definitions and information on data construction.

[9]There is substantial heterogeneity in the importance of various revenue sources across juristictions in the United States. As described in the next section, we estimate all specifications in first differences to account for

TABLE 1—LOCAL REVENUE AND EXPENDITURE SHARES BY CATEGORY

	1990		2007	
	Mean	SD	Mean	SD
Panel A. Revenue shares by category				
Rev. from own sources in tot. rev.	61.14	10.89	60.47	11.49
Gen. rev. in rev. from own sources	84.36	12.34	85.30	11.68
Tax rev. in gen. rev. from own sources	57.35	12.88	56.31	13.47
Property taxes in tax rev.	80.13	15.47	75.27	16.30
Sales, income, and license taxes in tax rev.	16.83	13.99	23.27	16.04
Other taxes in tax rev.	3.04	3.48	1.46	2.44
Charges in gen. rev. from own sources	42.65	12.88	43.69	13.47
Other rev. in rev. from own sources	22.52	31.59	20.77	29.66
Int. gov. transfers in tot. rev.	38.86	10.89	39.54	11.49
Federal gov. in int. gov. transfers	8.34	5.94	8.99	6.31
State gov. in int. gov. transfers	84.59	8.90	84.46	7.81
Local gov. in int. gov. transfers	7.07	6.44	6.55	5.27
Panel B. Expenditure shares by category				
General expenditure				
Education	44.25	9.88	43.56	10.47
Public safety	6.10	2.29	7.43	2.96
Public welfare	2.37	3.10	1.97	2.66
Public housing	1.39	1.33	1.62	1.39
Transportation	6.77	3.51	5.77	3.54
Parks and natural resources	2.03	1.27	2.48	1.82
Sewage and solid waste management	3.57	1.88	3.86	1.89
Other general expenditures				
Health and hospitals	8.77	7.63	9.68	9.73
Government administration	5.10	1.52	5.07	1.71
Interest on general debt	3.72	4.25	2.27	2.40
Other, NEC	5.21	2.47	6.46	3.97
Liquor stores, utility, and insurance trust sectors	10.72	9.62	9.85	8.93

Notes: Means and standard deviations calculated over 722 commuting zones for each year. Revenue from own sources plus intergovernmental transfers (from local, federal, and state governments) is equal to total revenue. Revenue from own sources is the sum of general revenue from own sources and other revenue from liquor stores, utilities, and the insurance trust sector. General revenue from own sources is equal to tax revenue (property, sales, income, license, and other taxes) plus charges. Since the revenues from the insurance trust sector can take on negative values, the shares in own revenue do not add up to 100 percent. Public safety includes expenditures on police and fire protection, corrections and protective inspection, and regulation. Transportation includes expenditures on highways, parking facilities, and transit subsidies. Government administration includes financial administration, judicial and legal, central staff services, general public buildings, and employment security administration. Other, NEC includes expenditures on miscellaneous commercial activities, libraries, ports and airports, and expenditures that are classified as "other or unallocable."

mostly from general revenue (85 percent) or from other sources such as the insurance trust sector, liquor stores, and utilities (22 percent).[10] Local taxes comprise the majority of general revenues (about 60 percent), with property taxes being by far

time-invariant heterogeneity across localities. We additionally include state- or region-specific time dummies to allow for state- or region-specific trends in public finance institutions. Nevertheless, the summary statistics and estimates reported in this paper should be viewed as reflecting the typical behavior of local governments as a useful benchmark that may not be representative of specific individual jurisdictions.

[10]Revenue from utilities is from the sale of utility commodities and services and accounts for 90 percent of other revenue from own sources, with all commuting zones reporting a positive dollar value during the 1990–2007 period. Insurance trust revenues are from required contributions for financing social insurance programs operated by the government, and earnings on assets held on such systems. Since unrealized gains or losses on cash and security holdings that are subject to market variation are included, revenues from the insurance trust sector can take on negative values (18 such observations in our sample). Forty-seven percent and 37 percent of the commuting zones in our sample reported positive dollar revenues for this revenue item, in 1990 and 2007, respectively. Revenue from

the most important component accounting for around 80 percent of total tax revenue (and 45 percent of general revenue from own sources). The remainder of general revenues comes from various charges, fines, fees, and other taxes (individual income taxes, general sales taxes, and specific excise taxes).

Since general revenues are highly dependent on local economic activity, a decline in local economic activity can depress revenues and strain local public finances. The link between revenues and economic activity is both direct and indirect. The direct link is associated with sales and income tax collection, which vary closely with economic activity. The indirect link is associated with property tax collection: a decline in economic activity implies lower employment and wages, which reduces local housing demand, suppresses housing prices, and thereby reduces property tax collection.[11]

The level of economic activity in a locality could also impact locally generated revenues through its effect on the insurance trust sector. First, a local investment bias (in some cases, a requirement) in management of these funds could result in more trade-affected localities with adversely impacted firms, earning lower returns on these funds.[12] Second, faced with negative fiscal shocks, state and local governments can legally borrow from their employee retirement, health care, and pension funds, which would reduce the principal and earnings from these funds and increase future liabilities.[13] Finally, fiscal pressures following a decline in local economic activity can result in a decrease in the number of government employees eligible to contribute to the insurance trust sector.

A decline in locally generated revenues results in a proportional decline in expenditures unless intergovernmental transfers compensate for the own-revenue loss. On average, intergovernmental transfers comprise about 40 percent of total local revenues. Transfers from the state are the largest component, accounting for 85 percent of all intergovernmental transfers, with the remainder coming from the federal government (8 percent) and other local governments (7 percent). There is substantial variation in the magnitude of transfers across localities and over time,

the sale of liquor by local liquor store operations, which are collected only in about 10 percent of commuting zones, accounts for the remainder of other revenue from own sources.

[11] Lutz, Molloy, and Shan (2010) highlight several channels through which the housing market impacts tax revenues. First is the property tax channel, which is a function of the value of real estate and the volume of real estate transactions. Given the high dependence of local revenues on property tax collection, even small changes in housing values can have large effects on revenue. It is possible, however, that policymakers adjust the effective tax rate to offset some or all of the decline in revenue. Observed changes in property tax collection therefore reflect the combined effects of changes in property values and local government tax policies. Lutz (2008) reports that policy makers offset about 60 percent of house price changes by adjusting the effective tax rate. This observation implies that as house prices decline, policymakers increase the effective tax rate (often by delaying downward adjustments in property assessments). The decline in property values also has a secondary effect on local revenues through its impact on consumption. Since housing is the most important component of wealth for many households, a relative decline in home values tends to suppress homeowners' perceived wealth and their consumption of goods and services, which further reduces local sales tax revenues. The recent literature on local public finance shows that declines in housing prices have a lagged effect on local property tax collections, but once a decline in local public revenues occurs, localities react by cutting expenditures. For evidence on the relationship between housing prices and local government budgets, see Lutz, Molloy, and Shan (2010); Chernick, Langley, and Reschovsky (2011); Alm, Buschman, and Sjoquist (2014); and Cromwell and Ihlanfeldt (2015).

[12] Brown, Pollet, and Weisbenner (2015) find state pension plans to overweight the equity from companies that are headquartered in state (by about three times more relative to other institutional investors).

[13] See for example, Chaney, Copley, and Stone (2002), which documents that fiscally stressed states meet balanced budget requirements through reduced funding of pensions.

with federal and state transfers apportioned based on formulas depending on a locality's population and poverty rates measured during census years (Suárez Serrato and Wingender 2016). As such, any migration response or change in the share of poor in a locality following an income shock may result in an adjustment of transfers and provide some degree of buffer against the negative shock.

There are several reasons why the insurance provided via intergovernmental transfers from state and federal governments may be incomplete. First, since allocation formulas are not specifically based on changes in localities' own revenues or economic conditions, the adjustments in intergovernmental transfers are not automatic. This is especially the case in response to trade-induced income shocks for which there is no evidence of a significant migration response.[14] Second, the ability of state governments to distribute funds is limited by their own revenue collection, which may be highly correlated with the revenue collection of their localities. For instance, localities in states that are not diversified in terms of industrial composition are less likely to receive transfers from the state government following a negative trade shock that also affects economic outcomes and revenues in the rest of the state. Third, some transfers from federal and state governments, for example, for education and highway maintenance, are dedicated to particular expenditure categories and cannot be re-allocated to different functions. As a result, the level of insurance the state or federal government provide against a negative shock could vary across expenditure items.

Overall, our information on local government finances suggests that funding of local services relies heavily on own revenues, which tend to fluctuate with local economic activity. While intergovernmental transfers can theoretically alleviate fiscal constraints, in practice, the extent that these transfers prevent a decline in expenditures following a decline in locally generated revenues may be fairly limited.

Expenditures.—In the bottom panel of Table 1, we summarize local public expenditures by major categories. Education comprises the largest expenditure category, accounting for approximately 45 percent of local government spending. Public safety, including police and fire protection, and transportation, including roads and transit subsidies, are each about 6 to 7 percent of total expenditures. Public welfare, public housing, natural resource management, and sewage and solid waste management, each account for 1 to 4 percent of local spending. Other general expenditures include expenditures on health, government administration, and interest on debt, and items classified as "other and unallocable." The remaining expenditures (of about 10 percent) are on government-run liquor stores, utilities, and the insurance trust sector. On average, spending shares across these categories remained fairly constant between 1990 and 2007.

While the majority of local government revenue is locally generated, it is possible that particular local public services are disproportionately funded by state and federal governments. For the key categories described in the bottom panel of Table 1, 36 percent of total education expenditures, 57 percent of transportation

[14] See Table C1 replicated from Autor, Dorn, and Hanson (2013).

expenditures, and 42 percent of public welfare and public housing expenditures come from locally generated revenue, with the remainder coming from intergovernmental transfers. Transfers from state governments represent almost all of the remaining revenues used to fund local education and transportation, while remaining revenues used to fund local welfare programs come nearly evenly from state and federal governments. For the other expenditure categories in the bottom panel of Table 1, we do not have a detailed breakdown of revenue sources; however, we note that just education, transportation, and welfare account for 86 percent of all state transfers and 64 percent of all federal transfers to localities. The importance of state transfers, especially for education, underscores our rationale for examining the ability of states to smooth local revenue shocks despite the fact that these transfers are unlikely to be very responsive to changing local economic conditions.

Demand for Locally Provided Services.—In analyzing the effect of trade shocks on public service outcomes, there are two considerations. First, as discussed earlier, by reducing local revenues and expenditures, an increase in import competition may negatively affect the provision of local public services. Second, trade shocks may affect the demand for these services. As incomes decline, there may be greater dependence on local governments for services such as public education, transportation, public safety, welfare, and housing.[15] For example, a decline in incomes and an increase in unemployment and poverty are associated with higher property crime rates.[16] Similarly, as employment prospects for low-skilled workers decline, there is evidence that demand for education increases: students remain in school longer to acquire more skills.[17] For public transport, welfare, and housing, there is again evidence that these services are more heavily used by lower income residents, suggesting that as local incomes decline, demand for these services is likely to increase (Glaeser, Kahn, and Rappaport 2008; Katz, Kling, and Liebman 2001; Olsen and Barton 1983).

B. *Local Outcomes and Public Finances*

In Table 2 we provide summary statistics for measures of income, home values, local public finances, and selected public service outcomes across commuting zones.[18] On average, per capita income increased and poverty rates declined during our sample period. Between 1990 and 2007, median values for owner-occupied

[15] According to Boustan (2013), a decrease in the share of rich households can make areas even less attractive to remaining households by reducing the size of the tax base and altering local electorate preferences for public services. Relatedly, Boustan et al. (2013) find that income inequality may be beneficial to the funding of local public goods, with high-income individuals disproportionately paying for and subsidizing services for the rest of the local population.

[16] An extensive literature links rising unemployment, higher poverty, and declines in wages for low-wage workers to increases in property crimes, with little or no change in violent crimes (Machin and Meghir 2004, Raphael and Winter-Ebmer 2001).

[17] For evidence of this link between education demand and employment prospects, see Greenland and Lopresti (2013) and Foster and Rosenzweig (1996).

[18] For our analysis, we supplement data from the State and Local Government Finances with data from the County Business Patterns Database, the Census Integrated Public Use Micro Samples, and the American Community Survey. We also rely on replication data from Autor, Dorn, and Hanson (2013), which were made available via the website of the *American Economic Review* at dx.doi.org/10.1257/aer.103.6.2121. A detailed description of these data sources and the construction of variables is provided in Appendix A.

TABLE 2—SUMMARY STATISTICS

	Income per capita	Poverty rate	Median home price	Local rev. per capita	Local expend. per capita	Educ. expend. per student	Student-teacher ratio	Prop. crime rate
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1990	25.23	16.97	66.11	2.57	2.54	5.47	16.56	33.50
	(4.44)	(6.94)	(36.52)	(0.99)	(0.96)	(1.42)	(4.64)	(17.07)
2000	30.18	14.63	84.71	3.20	3.17	7.12	14.49	27.37
	(5.43)	(5.66)	(44.41)	(1.06)	(1.02)	(1.53)	(2.34)	(12.56)
2007	30.86	15.86	109.03	3.87	3.77	8.98	14.18	25.89
	(5.30)	(5.40)	(73.95)	(1.43)	(1.41)	(2.78)	(2.68)	(11.14)

Notes: Means and standard deviations (in parentheses) are for commuting zones. All dollar values are in thousands of US dollars adjusted for inflation. $N = 722$ per year, except for student-teacher ratios and property crime rates per 1,000 population due to missing values in the data.

housing increased from $66,000 to nearly $109,000 in real terms. Total locality revenues per capita were $2,567 in 1990, increasing to $3,871 by 2007, with expenditures closely tracking these changes. Similar increases are evident for education expenditures per school age child, which rose from $5,471 in 1990 to $8,983 in 2007 in real terms, with these increases being associated with a reduction in student-teacher ratios, from 16.6 students per teacher in 1990 to 14.2 in 2007.[19] During this period, property crimes decreased from 33.5 in 1990 to 25.9 per 1,000 persons in 2007.

In Figure 1, we document the strong association between income, home values, public finances, and public good provision across commuting zones. Income per capita in a locality is positively associated with home values. Both lower income per capita and lower home values are associated with lower local government revenue per capita. Localities that collect less revenue per capita also tend to have lower per capita expenditures, with a nearly one-to-one relationship. Localities that spend less per person also spend less on education per student, and lower spending per student is associated with higher student-to-teacher ratios. Finally, there is only a weak relationship between per capita local government expenditures and crime.

While helpful in motivating the intuition for our paper, Figure 1 also highlights the need for exogenous variation in incomes across localities to establish causality for the association between income changes, housing values, local public finances, and local public good provision. For example, we propose that the association among local incomes, government revenue, and expenditures is due to shocks to income that affect home values and tax collection and thereby influence resources available for funding public services. A possibility, however, is that causation flows in the opposite direction: high-quality public goods are expensive and require more tax collection, and wealthy households value these goods and are willing to pay more for them, and so they select

[19] Student-teacher ratios differ from class sizes. To calculate student-teacher ratios, we use data from the National Center for Education Statistics on the total number of public school students and the total number of full-time equivalent teachers employed in public schools in a county (aggregated to the commuting zone level). The data used to calculate this ratio includes teachers who are not necessarily involved in classroom instruction (e.g., teachers who also serve as administrators, substitute teachers, and teachers' aides who are certified as teachers).

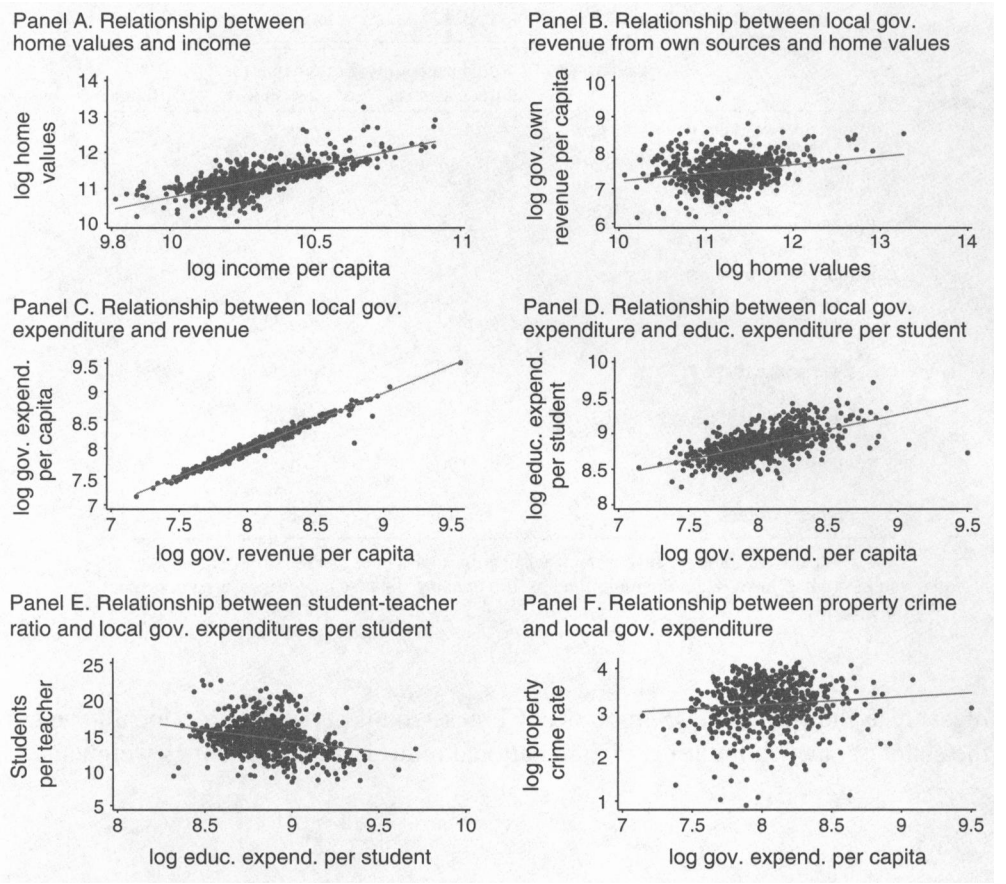

FIGURE 1. TRADE SHOCKS, INCOME, HOME VALUES, LOCAL PUBLIC FINANCES, AND PUBLIC GOOD PROVISION

Notes: Correlations are based on raw data for $N = 722$ commuting zones (except for crime rates due to missing data) for 2000. The coefficient estimates (standard errors) on β for $y = \alpha + \beta x + \varepsilon$, where y is the y-axis variable and x is the x-axis variable are as follows: 1.703 (0.069) for panel A; 0.138 (0.028) for panel B; 0.977 (0.011) for panel C; 0.417 (0.031) for panel D; −3.193 (0.433) for panel E; and 0.179 (0.081) for panel F.

into more expensive commuting zones where such services are well-provided. To estimate a causal relationship, we need exogenous changes in local area incomes.

II. Empirical Framework

Our estimation strategy of deriving a causal relationship between trade-induced income shocks, local public finance, and service outcomes is based on the empirical framework developed in Autor, Dorn, and Hanson (2013). In this section, we introduce the instrumental variable approach for our main specifications and briefly discuss possible threats to identification.

A. *Trade-Induced Shocks to Local Labor Markets*

We use a measure of exposure over time to Chinese imports at the commuting zone level as the source of variation in employment and incomes. We construct this

TABLE 3—COMMUTING ZONES WITH LARGEST AND SMALLEST TRADE SHOCKS, 2000–2007

	Top quartile of trade shocks	Bottom quartile of trade shocks	Difference
Δ Imports per worker (IPW)	4.31	0.24	4.07
Δ ln avg. HH income	−1.57	7.87	−9.45
Δ Poverty rate	2.36	−0.44	2.80
Δ ln med. value own. occ. housing	13.84	23.90	−10.07
Δ ln total local rev. pc	16.43	20.95	−4.53
Δ ln total local exp. pc	14.70	18.99	−4.30
Δ ln local educ. exp. per school age	19.84	26.05	−6.21
Δ Students per teacher	−0.20	−0.45	0.25
Δ ln property crimes	2.73	−21.38	24.11

Notes: Means are for respective groups. Change in imports per worker is in thousands of US dollars. All Δ ln variables are multiplied by 100 to approximate changes measured in percentage points.

measure as the change in US imports of Chinese goods per worker in a locality, using the share of each commuting zone in national industry employment as weights:

$$\Delta IPW_{uit} = \sum_j \frac{L_{ijt}}{L_{ujt}} \frac{\Delta M_{ucjt}}{L_{it}}. \tag{1}$$

In equation (1), L_{ijt} is initial employment in commuting zone i in sector j for time period t, L_{ujt} is initial total employment in the United States in sector j for time period t, ΔM_{ucjt} is the overall change in the value of US imports from China in sector j, and L_{it} is initial total employment in commuting zone i.[20] The expression in equation (1) apportions the change in the value of US imports from China in a specific industry depending on how employment in that industry is initially distributed across commuting zones in the United States and then rescales this value by total commuting zone employment.

To further motivate our analysis, Table 3 depicts changes in incomes and local outcomes for commuting zones experiencing the smallest and largest changes in Chinese import competition per worker between 2000 and 2007. For the most negatively affected (top quartile) of commuting zones, the average increase in Chinese imports per worker was $4,310, while it was only $243 for commuting zones that were hardly affected (bottom quartile). Average household income declined by approximately 1.6 percent for commuting zones in the top quartile but increased by

[20]This variable, ΔIPW_{uit}, is constructed in Autor, Dorn, and Hanson (2013) using the UN Comtrade Database for measures of Chinese imports at the six-digit product level and the County Business Patterns Database for manufacturing employment in each US county (concorded to commuting zones) by four-digit SIC code. See the data Appendix for further information.

nearly 8 percent for commuting zones in the bottom quartile. Poverty rates increased by 2.4 percentage points in the top quartile but declined by 0.4 percentage points in the bottom quartile. While housing values increased in both groups of commuting zones, they increased by substantially more among those in the bottom quartile. The same pattern holds for changes in total locality revenues and expenditures: they increased by more in localities less affected by trade shocks. While education expenditures per student also increased overall, they did so to a greater extent in localities less exposed to Chinese import competition, and a corresponding pattern holds for student-to-teacher ratios: they declined slightly more in localities in the bottom quartile. Finally, while property crimes increased slightly (by 2.7 percent) among localities in the top quartile, they declined substantially (by 21.4 percent) among localities least exposed to Chinese import competition.

B. *Endogeneity of Trade-Induced Shocks*

One concern in identifying a causal relationship between US imports of Chinese goods and local outcomes across US commuting zones is that industry level demand shocks in the United States might be correlated with imports from China, implying, in other words, that changes in US incomes could be driving changes in US imports per worker.[21] The alternative we emphasize is that growth in US imports of Chinese goods was primarily due to structural reforms within China that led to a surge of Chinese imports into the United States. To capture this exogenous variation in imports, we use the change in other high-income country imports of Chinese goods, ΔIPW_{oit}, as an instrument for US changes in imports per worker, as in Autor, Dorn, and Hanson (2013). The instrument, ΔIPW_{oit}, is calculated as follows:

$$\Delta IPW_{oit} = \sum_{j} \frac{L_{ijt-1}}{L_{ujt-1}} \frac{\Delta M_{ocjt}}{L_{it-1}}. \tag{2}$$

The expression in equation (2) uses employment levels by industry and region from *prior* decades and uses the change in the value of other high-income countries' imports of Chinese goods in each sector (ΔM_{ocjt}). The use of lagged employment levels mitigates the possibility that employment is contemporaneously adjusting to anticipated Chinese trade, and the use of other high-income countries' imports of Chinese goods, as opposed to US imports of these goods, circumvents the possibility that demand factors in the United States were simultaneously driving both the surge in Chinese imports and the changes in the outcome variables we consider.

The identification strategy relies on the assumption that the variation in the instrumental variable is supply driven and due to a combination of a fall in trade costs and improvements in China's comparative advantage in specific sectors. Autor, Dorn, and Hanson (2013) discuss three possible threats to identification: correlated product demand shocks across high-income countries, an increase in high-income country

[21] For example, US imports of specific goods from China could be increasing because US demand for these goods is increasing overall. This would potentially imply an increase in both Chinese imports and US production of these goods, which would then benefit the commuting zones that specialize in producing these goods.

imports from China due to a negative productivity shock in the United States, and common technological developments in high-income countries (e.g., automation) that drive the increase in imports from China. They rule out the first by estimating a modified gravity model designed to isolate changes in China's exports driven solely by supply and trade shocks. While they cannot explicitly rule out the latter two possibilities, they argue that forces internal to China are likely the dominant factors explaining the Chinese export surge, which greatly outpaced that of other low- and middle-income nations during this period.

C. *Main Specifications*

We estimate the effects of changes in Chinese imports per worker on local public finances and the provision of public goods using the following equation:

$$\Delta Y_{it} = \gamma_t + \beta_1 \Delta IPW_{uit} + X_{it}'\beta_2 + \varepsilon_{it}. \tag{3}$$

In equation (3), ΔY_{it} is the change in the local outcome variable in commuting zone i calculated over two time periods, 1990–2000 and 2000–2007. The latter period is rescaled so as to capture ten-year equivalent changes. The main local outcomes we consider are the level and distribution of household incomes, median housing values, total government revenues, revenues by source (e.g., locally generated revenues from taxes and fees, and intergovernmental transfers), and local government expenditures. Changes in the provision of local public services are measured using changes in expenditures for each public service item (e.g., education, transportation, public safety, public welfare, public housing, parks and natural resources, and sewage and solid waste management) and more direct measures of changes in public service outcomes, when data are available, in the case of public safety (property and violent crime rates) and public education (student-teacher ratios).

Each specification is estimated using two-stage least squares (2SLS) by instrumenting the change in US imports per worker of Chinese goods in commuting zone i (ΔIPW_{uit}) with the change in other high-income countries' imports of Chinese goods (ΔIPW_{oit}). First differencing controls for locality characteristics that may influence the outcome variables but are fixed over time. Each specification includes decade fixed effects (γ_t) and locality controls capturing start-of-period demographic characteristics and labor force composition (X_{it}), which might independently influence the outcome variables. Specifically, we include the share of employment in manufacturing, the share of the population that is college educated, the share of the population that is foreign-born, the share of women in the workforce, the share of routine occupations in employment, and the average offshorability index of occupations. Our main specification includes geographic dummies for the nine census divisions to absorb any region-specific trends in variables of interest; we also experiment with using state fixed effects in Section IV. Standard errors are clustered at the commuting zone level.[22]

[22] To the extent that states can smooth local outcomes, clustering at the state level in our main specification actually yields smaller standard errors. We therefore report standard errors clustered at the commuting zone level, which are more conservative, but show, in Section IV, that our main results hold with clustering at the state level.

We are also interested in examining the ability of larger and more economically diverse states to smooth local government finances via intergovernmental transfers. This is important since, on average, about 40 percent of revenues at the commuting zone level come from intergovernmental transfers, and 85 percent of these transfers are from state governments. In testing for state-level smoothing, we first modify equation (3) to replace the trade exposure measure at the commuting zone level with a measure at the state level. Then we estimate the separate impact of an increase in trade exposure at the commuting zone level and in the rest of the state using the following equation:

$$\Delta Y_{it} = \gamma_t + \gamma_1 \Delta IPW_{uit} + \gamma_2 \Delta IPW_{ut,s-i} + X'_{it}\gamma'_3 + u_{it}, \tag{4}$$

where the only difference from equation (3) is the inclusion of $\Delta IPW_{ut,s-i}$, which reflects the change in imports per worker in the remainder of the state.

III. Results

In this section, we present our findings on the impact of increased Chinese import competition on local public finances and service provision. The coefficient estimates we report represent the differential effect of imports across localities that are more exposed to Chinese competition relative to those that are less exposed. In discussing the magnitudes of our findings, we evaluate all coefficient estimates for a $1,000 increase in Chinese imports per worker. This value corresponds approximately to the interquartile difference for the change in Chinese imports per worker across localities between 2000 and 2007. In other words, we are examining differences in local public finances and service provision in highly exposed commuting zones relative to those that face little competition from Chinese imports.

A. *Population Composition, Employment, and Incomes*

The starting point of our empirical analysis is two key findings from Autor, Dorn, and Hanson (2013). First, an increase in import exposure does not result in a reallocation of workers across commuting zones: localities that are differentially exposed to trade shocks do not experience a differential change in total population or a differential change in the skill composition of the population.[23] This finding, which we replicate in Table C1, is important to our analysis as it suggests that a local trade shock does not quickly diffuse across localities in the United States via labor mobility; workers do not out-migrate (neither as a whole, nor differentially) from areas that experience trade-induced income shocks to arbitrage wage and quality-of-life differentials across localities. Second, an increase in exposure of local labor markets to Chinese imports leads to a significant decline in employment and earnings

[23] This finding coincides with Topel (1986), Blanchard and Katz (1992), and Glaeser and Gyourko (2005) who similarly find that mobility responses to labor demand shocks across US localities are slow and incomplete. It differs from Bound and Holzer (2000) and Notowidigdo (2011) who report changes in population composition due to differential mobility patterns.

TABLE 4—EFFECT OF CHINESE IMPORT EXPOSURE ON EMPLOYMENT, INCOME, AND POVERTY

	Δ Share unemployed (1)	Δ Share not in labor force (2)	Δ ln avg. HH income (3)	Δ ln avg. HH wage inc. (4)	Δ ln avg. HH transfer inc. (5)
Panel A. Employment and income					
Δ Chinese imports per worker	0.221	0.553	−1.476	−2.142	2.119
	(0.059)	(0.157)	(0.416)	(0.595)	(0.754)
R^2	0.40	0.39	0.68	0.43	0.52
Observations	1,444	1,444	1,444	1,444	1,444
Number of clusters	722	722	722	722	722
	Δ Share HH inc. < 30K	Δ Share HH inc. 30–60K	Δ Share HH inc. > 60K	Δ Pov. rate	Δ Child pov. rate
Panel B. Income distribution and poverty					
Δ Chinese imports per worker	0.704	−0.172	−0.532	0.576	0.867
	(0.198)	(0.151)	(0.219)	(0.154)	(0.199)
R^2	0.60	0.69	0.26	0.35	0.44
Observations	1,444	1,444	1,444	1,444	1,444
Number of clusters	722	722	722	722	722

Notes: Panel A is replicated from Autor, Dorn, and Hanson (2013). All regressions include a constant, a dummy for the 2000–2007 period, geographic dummies for the nine census divisions, and the following start-of-period locality control variables: the share of employment in manufacturing, the college-educated share of the population, the foreign-born share of the population, the share of women in the population, the share of routine occupations in employment, and the average offshorability index of occupations. Observations are weighted by the start-of-period commuting zone share of the national population. Robust standard errors, clustered at the commuting zone level, are reported in parentheses.

in these localities. In Table 4, panel A, we replicate this finding from Autor, Dorn, and Hanson (2013). An increase of $1,000 per worker in a commuting zone's import exposure results in a 0.22 percentage point increase in the unemployment rate and a 0.55 percentage point increase in the share of the population that is not in the labor force. The increase in exposure results in a relative decline in average household incomes by 1.48 percent (or about $492 per working age adult per year). While transfer incomes increase in response (by 2.12 percent, which amounts to only $17 per year), this increase does not offset the decline in wage and salary incomes (of 2.14 percent, which amounts to $549 per year).

As discussed earlier, an increase in trade exposure could impact local government size and the provision of public services through its impact on the mean level of income in a locality as well as through its impact on the distribution of local income. If, for example, an increase in competition from China results in an increase in the share of low-income households, this could amplify the financial constraints faced by localities by raising demand for public services while reducing the tax base. Our findings reported in panel B of Table 4 provide evidence that this is indeed the case. We find that higher trade exposure is associated with a relative increase in the share of the population living in households with annual incomes less than $30,000 (in nominal US$) and a decline in the share of the population living in households with annual incomes above $60,000; the relative decline in the share of households with annual incomes between $30,000 and $60,000 is small and statistically insignificant. Moreover, an increase in trade exposure leads to an

TABLE 5—EFFECT OF CHINESE IMPORT EXPOSURE ON HOME VALUES

	Δ ln median val. own. occ. housing (1)	Δ Median val. own. occ. housing (2)	Δ Share homes < 150K (3)	Δ Share homes 150–300K (4)	Δ Share homes > 300K (5)	Δ ln median rent (6)	Δ Median annualized rent (7)
Δ Chinese imports per worker	−5.404	−7,661.22	1.536	2.469	−4.005	−2.471	−186.84
	(1.489)	(3,379.50)	(1.264)	(1.455)	(1.773)	(0.648)	(62.20)
R^2	0.33	0.51	0.49	0.50	0.64	0.07	0.22
Observations	1,444	1,444	1,444	1,444	1,444	1,444	1,444
Number of clusters	722	722	722	722	722	722	722

Notes: All regressions include a constant, a dummy for the 2000–2007 period, geographic dummies for the nine census divisions, and the following start-of-period locality control variables: the share of employment in manufacturing, the college-educated share of the population, the foreign-born share of the population, the share of women in the population, the share of routine occupations in employment, and the average offshorability index of occupations. Observations are weighted by the start-of-period commuting zone share of the national population. Robust standard errors, clustered at the commuting zone level, are reported in parentheses.

increase in poverty rates, especially for households with children, which are particularly dependent on public assistance.

B. *Home Values and Business Activity*

Our hypothesis is that the observed decline in the number of employed workers and household incomes, together with an increase in the share of low-income households, results in a relative decline in the tax base and higher demand for public services among localities more exposed to import competition. We test a subset of this hypothesis by focusing on property values and business activity as one of the channels through which trade with China could impact local public finances. This is an important channel as more than half of locally generated general revenue is from local taxes, with property taxes accounting for about 80 percent of total tax revenue.

We start by examining whether the deterioration in economic outcomes in localities that are differentially impacted by trade with China results in a relative decline in home values. In column 1 of Table 5, we report estimates from specification (3) with ten-year changes in the median value of owner-occupied housing units as the dependent variable.[24] We find that a commuting zone with an increase of $1,000 in Chinese imports per worker experiences lower median housing values by 5.4 percent (column 1) or about $7,660 (column 2). This finding is consistent with a relative decline in household incomes and housing demand. We find the relative decline in the value of housing to be driven by an increase in the share of homes valued between $150,000 and $300,000 and a decrease in the share of homes valued above $300,000.

[24] We use information on median self-reported home values for owner-occupied housing from the Census of Population and Housing as a proxy for assessed property values, which is the base for property taxation. While the changes in assessed values are correlated with changes in market values, note that reassessments are not automatic and may involve lags.

TABLE 6—EFFECT OF CHINESE IMPORT EXPOSURE ON BUSINESS ACTIVITY

	Δ ln number of establishments (1)	Δ ln number of est. < 50 empl. (2)	Δ ln number of est. 50–499 empl. (3)	Δ ln number of est. ≥ 500 empl. (4)
Δ Chinese imports per worker	−0.483 (0.647)	−0.395 (0.629)	−1.894 (1.029)	−2.857 (1.263)
R^2	0.41	0.41	0.45	0.31
Observations	1,444	1,444	1,444	1,444
Number of clusters	722	722	722	722

Notes: All regressions include a constant, a dummy for the 2000–2007 period, geographic dummies for the nine census divisions, and the following start-of-period locality control variables: the share of employment in manufacturing, the college-educated share of the population, the foreign-born share of the population, the share of women in the population, the share of routine occupations in employment, and the average offshorability index of occupations. Observations are weighted by the start-of-period commuting zone share of the national population. Robust standard errors, clustered at the commuting zone level, are reported in parentheses.

The median housing values for owner-occupied units are based on self-reported values, which are subjective and may be biased.[25] As a robustness check, we replace the dependent variable in specification (3) with changes in the annual median contract rents of renter-occupied units. The reporting error in monthly rents is likely to be smaller, and housing values and rental prices are highly correlated. Estimates reported in columns 6 and 7 are in line with our findings for owner-occupied units: a $1,000 increase in a commuting zone's import exposure per worker results in a relative decline of 2.5 percent in median rents in the commuting zone or about $187 on an annualized basis.[26]

Businesses also typically pay local property taxes and contribute to local revenue generation through sales taxes, licenses, and fees. While data limitations prevent us from separately analyzing the impact of trade shocks on commercial and industrial real estate values,[27] we use information from County Business Patterns data on the number and size of business establishments in each commuting zone to highlight the likely impact of import competition on revenue generated from local business. In Table 6, we report the change in the total number of establishments due to an increase in Chinese import exposure. While the coefficient estimate on the total number of establishments is negative, it is not significant (column 1). We also do not find any significant effect on the number of small establishments, i.e., those with fewer than

[25] Although there is some evidence that self-reported home values (in levels) may be an overestimate of sales values (Kiel and Zabel 1999), these biases are likely to be smaller in our case, as we focus on decadal changes in housing values (Skinner 1994).

[26] We also conduct robustness checks at the state level where we have information on mean (as opposed to median) housing prices recorded as an index based on several different sources of data (Enterprise, FHA, and Real Property County Recorder Data Licensed from DataQuick). The estimate based on state-level house price indices suggests that mean housing prices in a state decline with exposure to trade shocks [coefficient estimate (standard error) of −1.544 (0.343) on the change in Chinese imports per worker variable, not reported in Table 5]. The decline in mean prices relative to less affected states suggests that trade shocks do not simply lead to a mean-preserving change in the distribution of housing prices.

[27] Gyourko (2009) finds the commercial and housing real estate sectors to exhibit similar time series patterns with a simple correlation between the appreciation rates in two sectors of nearly 40 percent.

TABLE 7—EFFECT OF CHINESE IMPORT EXPOSURE ON LOCAL REVENUES PER CAPITA

	Total (1)	Intergov. transfers (2)	Total from own sources (3)	General from own sources (4)	Total taxes (5)	Property taxes (6)	Sales, inc., and license taxes (7)	Other taxes (8)	Charges (9)	Other rev: Liq. stores, utility, and ins. trust (10)
Panel A. Percent changes (per capita)										
Δ Chinese imports per worker	−1.884 (0.761)	−0.068 (0.650)	−2.910 (0.949)	−1.535 (0.776)	−1.720 (0.768)	−1.466 (0.849)	−3.317 (3.357)	−33.302 (25.529)	−0.799 (1.149)	−11.092 (3.421)
R^2	0.18	0.13	0.29	0.14	0.17	0.16	0.29	0.18	0.08	0.39
Panel B. Value changes (per capita)										
Δ Chinese imports per worker	−117.732 (52.921)	−3.496 (9.928)	−114.236 (49.393)	−48.117 (27.632)	−45.331 (23.252)	−17.280 (11.319)	−22.189 (13.084)	−5.862 (4.511)	−2.787 (14.460)	−66.119 (29.898)
R^2	0.44	0.19	0.44	0.37	0.40	0.33	0.34	0.29	0.17	0.36
Observations	1,444	1,444	1,444	1,444	1,444	1,444	1,444	1,444	1,444	1,444
Number of clusters	722	722	722	722	722	722	722	722	722	722

Notes: Total revenue (1) is equal to intergovernmental transfers (2) plus revenue from own sources (3). Revenue from own sources (3) is the sum of general revenue from own sources (4) and revenue from liquor stores, utilities, and the insurance trust sector (10). General revenue from own sources is the sum of total taxes (property (6); sales, income, and license (7); and other taxes (8)) and charges (9). All regressions include a constant, a dummy for the 2000–2007 period, geographic dummies for the nine census divisions, and the following start-of-period locality control variables: the share of employment in manufacturing, the college-educated share of the population, the foreign-born share of the population, the share of women in the population, the share of routine occupations in employment, and the average offshorability index of occupations. Observations are weighted by the start-of-period commuting zone share of the national population. The dependent variables are calculated as log changes per capita in panel A and changes in per capita dollar values in panel B. Robust standard errors, clustered at the commuting zone level, are reported in parentheses.

50 employees (column 2). However, we find significant declines in the number of medium and large establishments, those with 50 to 499 employees and those with more than 500 employees (columns 3 and 4). A $1,000 increase in a commuting zone's import exposure per worker results in a relative decline of approximately 1.9 percent and 2.9 percent, respectively, in the number of medium and large establishments. We interpret these declines in the number of medium and large establishments, coupled with the preceding information on local employment, as suggestive of declines in local economic activity with negative implications for local government revenues.

C. *Local Government Size*

Next, we examine whether areas more exposed to Chinese import competition experience a differential change in local government size. Our estimation results are reported in Table 7 for revenues and in Table 8 for expenditures. In all specifications, revenues and expenditures are calculated in per capita terms. The top and bottom panels in each table, respectively, report the impact of a change in Chinese imports per worker in percent changes (the dependent variable being changes in log values) and in dollar amounts (the dependent variable being changes in absolute values). While per capita changes in dollar amounts are informative, we focus our discussion on results calculated in percent changes since the benefits from most public good categories we study are unevenly distributed across the population.

TABLE 8—EFFECT OF CHINESE IMPORT EXPOSURE ON LOCAL EXPENDITURES PER CAPITA

	Total (1)	General (2)	Educ. (3)	Public safety (4)	Public welfare (5)	Public housing (6)	Transp. (7)	Parks and natural resources (8)	Sewage and solid waste manag. (9)	Other general exp. (10)	Liq. stores, utility, ins.trust (11)
Panel A. Percent changes (per capita)											
Δ Chinese imports per worker	−0.892 (0.531)	−0.886 (0.506)	−0.869 (0.457)	0.329 (0.796)	−7.697 (3.772)	−6.746 (2.500)	−2.392 (1.282)	−2.351 (1.532)	−2.547 (1.380)	−0.556 (1.386)	−3.276 (1.482)
R^2	0.09	0.12	0.25	0.19	0.06	0.04	0.04	0.08	0.10	0.09	0.05
Panel B. Value changes (per capita)											
Δ Chinese imports per worker	−43.515 (25.551)	−42.555 (21.258)	−17.581 (7.986)	0.077 (4.244)	−3.620 (2.653)	−4.278 (2.311)	−6.358 (2.489)	−3.914 (1.977)	−5.805 (2.509)	−1.078 (19.519)	−0.960 (20.421)
R^2	0.23	0.30	0.31	0.25	0.20	0.15	0.03	0.12	0.09	0.17	0.04
Observations	1,444	1,444	1,444	1,444	1,444	1,444	1,444	1,444	1,444	1,444	1,444
Number of clusters	722	722	722	722	722	722	722	722	722	722	722

Notes: Total expenditure (1) is equal to general expenditures (2) plus other expenditures on liquor stores, utilities, and the insurance trust sector (11). General expenditure consists of expenditure on education, public safety, public welfare, public housing, transportation, parks and natural resources, sewage and solid waste management, and other general expenditures. All regressions include a constant, a dummy for the 2000–2007 period, geographic dummies for the nine census divisions, and the following start-of-period locality control variables: the share of employment in manufacturing, the college-educated share of the population, the foreign-born share of the population, the share of women in the population, the share of routine occupations in employment, and the average offshorability index of occupations. Observations are weighted by the start-of-period commuting zone share of the national population. The dependent variables are calculated as log changes per capita in panel A and changes in per capita dollar values in panel B. Robust standard errors, clustered at the commuting zone level, are reported in parentheses.

Our results in Table 7 suggest that total revenues per capita decline by 1.9 percent for every $1,000 increase in Chinese imports per worker (column 1). On average, intergovernmental transfers remain unchanged (column 2); almost all of the decline in total revenues is from a decrease in local revenue from own sources, which decline by 2.9 percent (column 3). While the finding on intergovernmental transfers is broadly consistent with the lack of significant population changes in response to a negative trade shock, it is possible that the average effect masks heterogeneity across localities in states which differ in their ability to smooth shocks. We explore this possibility in Section IIIE.

Both sources of locally generated revenue, namely, general revenue (column 4) and revenue from other sources (column 10), are lower in localities that experience larger trade shocks. Almost all of the decline in general revenue from own sources is from a decline in total tax revenue (by 1.7 percent for every $1,000 increase in Chinese imports, shown in column 5), with this decline nearly evenly split in absolute values between declines in property tax revenue (column 6) and declines in local sales, income, and vehicle taxes (column 7). The estimated declines in revenues from other taxes (column 8) and miscellaneous fines and charges (column 9) are small and statistically indistinguishable from zero. A decomposition of the change in revenue from other sources, reported in Table C2, suggest that almost the entire decline in revenue from other sources is due to a decline in revenue from the

insurance trust sector ($61 of $66).[28] This relative decline in trade-exposed localities is consistent with lower returns due to a local investment bias and with a reduced principal and earnings from these funds due to local government borrowing and a decline in the number of government employees.[29]

As expected, changes in local expenditures per capita closely track changes in local revenues per capita. As shown in Table 8, total expenditures per capita (column 1) decline by nearly 1 percent for every $1,000 increase in Chinese imports, which is very close in absolute magnitude to the decline in general revenue from own sources ($44 versus $48 per capita). This decline is entirely due to a decline in general expenditures; the contribution of a decline in expenditures on liquor stores, utilities, and insurance trust is negligible. The breakdown of expenditures by the public service category uncovers interesting heterogeneity in the effects of exposure to Chinese imports. We find that all major expenditure categories, with the exception of public safety, experience varying declines following an increase in Chinese imports.

Specifically, while the relative decline in per capita education expenditures (of nearly 1 percent, shown in column 3) is proportional to the relative decline in total expenditures per capita, we find no differential impact in terms of public safety expenditures (column 4). This is despite the relative decline in incomes and increase in unemployment and poverty rates in these localities, which are all factors documented to be positively associated with higher crime rates. Spending on public welfare (column 5) and public housing (column 6) each decrease by about 7–8 percent, and expenditures on local transport and sewage and solid waste management each decline by about 2–3 percent in response to a $1,000 increase in Chinese import competition. The estimated spending impacts on parks and natural resources and other expenditures are also negative, although the coefficients are not statistically significant.

Our results suggest that expenditures on public services, especially those that disproportionately benefit low-income households (e.g., public welfare, public housing, and public transport), differentially change in commuting zones in the top quartile of the trade shock distribution relative to those in the bottom quartile.[30] We interpret the relative decline in expenditures precisely at a time when the share of the poor in these localities is increasing as suggestive evidence of a deterioration of

[28] This result is robust to restricting the analysis to commuting zones that report nonzero revenues from the insurance trust sector in all periods and to including an indicator variable for commuting zones that do not report any such revenues.

[29] While we report the estimation results for the subcategory of revenues from other sources that includes revenues from liquor stores, utilities, and the insurance trust sector, we focus most of our discussion on the implications to the general sector. More than half of the commuting zones do not report positive values for the three categories that make up other sources of revenues and therefore the changes in this component are driven by a small number of commuting zones. Moreover, in contrast to the general revenues, which are intended to cover current local government operations, the revenue sources reported under other revenues are more likely to be earmarked for specific functions and allow less flexibility in funding local public good provision.

[30] The expenditure on public welfare, public housing, public transport, and public education benefit only a share of the local population. While in panel B of Table 8, we report changes in per capita expenditures to ensure comparability of the magnitudes across different expenditure categories, note that these magnitudes are lower than the decline in expenditure per affected population for most categories. Any compositional changes in these localities toward low-income households who are more dependent on these public services are likely to increase the gap between change in expenditure per capita and expenditure per affected population.

TABLE 9—EFFECT OF CHINESE IMPORT EXPOSURE ON PROVISION OF LOCAL PUBLIC GOODS

	Δ ln property crime (1)	Δ ln violent crime (2)	Δ Student-teacher ratio (3)	Δ PK12 student-teacher ratio (4)
Δ Chinese imports per worker	3.464	−0.117	0.209	0.253
	(1.699)	(1.451)	(0.098)	(0.099)
R^2	0.38	0.29	0.12	0.14
Observations	1,068	1,049	1,429	1,429
Number of clusters	568	560	722	722

Notes: All regressions include a constant, a dummy for the 2000–2007 period, geographic dummies for the nine census divisions, and the following start-of-period locality control variables: the share of employment in manufacturing, the college-educated share of the population, the foreign-born share of the population, the share of women in the population, the share of routine occupations in employment, and the average offshorability index of occupations. Observations are weighted by the start-of-period commuting zone share of the national population. Robust standard errors, clustered at the commuting zone level, are reported in parentheses.

public service outcomes in these localities.[31] For public education and public safety —two expenditure items for which we have fairly good proxies for public service outcomes—we test whether the relative changes in outcome measures in response to an increase in imports are broadly consistent with such an interpretation of the expenditure results.

D. *Public Good Provision: Education and Crime*

In the case of public safety, our results in earlier sections suggest that while income and employment decreased in trade exposed localities, these localities did not increase public safety spending. Given the documented association between worsening economic outcomes and higher crime rates, the fact that public safety spending does not change suggests that crime rates are likely to increase. Estimates reported in the first two columns of Table 9 suggest this is the case:[32] a $1,000 increase in Chinese imports per worker is associated with a relative increase in property crime rates by 3.5 percent, with no significant effect on violent crimes (columns 1 and 2).[33]

[31] The positive association between local expenditures on public services and local public service outcomes would be weaker if a decline in local expenditures are offset by federal transfers that operate outside of the local budget. For most public services, we consider (public safety, public education, local government administration, and public housing) this is unlikely to be the case, as almost all transfers from the Federal government are in the form of grants to the local government. Even in the case of welfare spending, where direct transfers from the Federal government to individuals are more prevalent (in the form of Social Security, federal retirement and disability payments, veterans' benefits, Medicare, unemployment compensation, SNAP benefits, housing assistance, farm payments, and the Earned Income Tax Credit), such transfers from the Federal government do not fully offset the decline in wage and salary incomes in trade exposed localities (see Table 4). Our results reported in Table 8 suggest that local governments are unlikely to cover the difference either, as welfare expenditure by local governments (spending from own revenue plus federal and state grants) on assistance to needy persons (in the form of cash assistance, payments to private purveyors for medical care, burials, etc.) declines in these localities.

[32] Data flags in the original datasets indicate errors and missing information on crime and student-teacher ratios for some counties. We exclude commuting zone observations that contain these counties from the sample, resulting in smaller sample sizes for the specifications reported in Table 9.

[33] These findings are consistent with Iyer and Topalova (2014); Dix-Carneiro, Soares, and Ulyssea (2016); and Deiana (2016) who document, for India, Brazil, and the United States, that negative shocks to income due to trade are associated with higher crime rates.

Similarly, we previously demonstrated that per capita spending on education differentially decreases in trade exposed localities. Our estimates suggest that a decline in education expenditures leads to higher student-teacher ratios (measured as total number of students to full-time equivalent teachers in column 3 and pre-kindergarten to twelfth grade students to full-time equivalent teachers in column 4). This is suggestive evidence that the decline in expenditures translates into a deterioration of public education services in these localities. Moreover, the relative decline in the quality of education services may be taking place precisely in localities where the demand for education appears to increase differentially. Specifically, Greenland and Lopresti (2013) document a relative decrease in high school dropout rates in response to an increase in imports from China, suggesting that students in these localities respond to a deterioration of employment prospects for low-skilled workers and a resulting increase in the relative returns to skill acquisition by remaining in school longer.[34] The implication is that demand for local public goods such as education and public safety is increasing at a time when funding and resources for these services are declining or remaining constant. We view these results for the quality of public safety and education as indicative of what might be happening to other public services, whose quality we cannot measure, as local government spending declines.

E. *State-Level Smoothing via Intergovernmental Transfers*

As discussed in Section IA, state governments provide local governments with a large share of funding for specific public goods such as education, transportation, and public welfare. In this section, we examine variation in states' abilities to provide a buffer for negative shocks faced by their local governments. We begin by testing how responsive public finance outcomes of commuting zones are to changes in trade exposure at the state level.[35] In Table 10, panel A, we find that local revenues—total, own revenue, and intergovernmental transfers—decline as imports per worker in the state increase. State-level exposure to trade is negatively associated with education expenditures per capita, and commuting zones in states that experience an increase in Chinese import competition consequently report a relative deterioration of education quality as measured by student-teacher ratios. We find a similar negative association between state-level imports from China and spending on public welfare and housing.

[34] In unreported results at the state level, in addition to a decline in high school dropout rates (for both 16 to 19 year olds and 16 to 24 year olds), we find an increase in continuation rates to at least some college education for 19 to 24 year olds in states differentially exposed to trade. See also Foster and Rosenzweig (1996), who argue that workers respond to positive employment shocks in an industry requiring higher levels of skill by seeking out further investments in human capital. Our analysis of the change in number of students and change in number of teachers seperately suggests that the relative increase in student-teacher ratios in these localities are mainly due to a relative increase in the number of students (total, as a share of population and relative to the number of teachers) without a corresponding change in the total number of teachers (coefficients estimated negative but small and insignificant).

[35] Some commuting zones overlap state boundaries as they are constituted of counties located in different states. In our benchmark specifications, we classify commuting zones into the state with the highest share of its population. We also do robustness checks by omitting all commuting zones that overlap state boundaries from our analysis, and by constructing the measure of exposure in the rest of the state as the population-weighted average of exposure in all states the commuting zone overlaps. The latter measure incorporates the fact that commuting zones that span more than one state are eligible to receive transfers from more than one state. All results reported in Table 10 are robust to these changes, both qualitatively and quantitatively.

TABLE 10—STATE-LEVEL SMOOTHING VIA INTERGOVERNMENTAL TRANSFERS

	Δ ln total revenue pc (1)	Δ ln total rev. from own sources pc (2)	Δ ln total intergov. transfers pc (3)	Δ ln educ. exp. pc (4)	Δ Student-teacher ratio (5)	Δ ln exp. on transport pc (6)	Δ ln exp. on welfare and housing pc (7)
Panel A. Local outcomes on state-level imports per worker							
Δ Chinese imports per worker in state	−3.509	−3.023	−4.384	−2.108	0.361	−3.379	−13.988
	(1.372)	(1.567)	(1.932)	(1.195)	(0.378)	(2.309)	(4.731)
R^2	0.22	0.32	0.16	0.26	0.12	0.05	0.11
Observations	1,444	1,444	1,444	1,444	1,429	1,444	1,438
Number of clusters	48	48	48	48	48	48	48
Panel B. Local outcomes on CZ and rest of state imports per worker							
Δ Chinese imports per worker in CZ	−1.839	−3.073	0.410	−0.758	0.227	−2.154	−3.713
	(0.705)	(0.941)	(0.647)	(0.440)	(0.121)	(1.461)	(1.656)
Δ Chinese imports per worker in rest of state	−1.141	0.984	−5.512	−2.031	0.193	−3.686	−8.608
	(1.238)	(1.578)	(1.662)	(0.998)	(0.371)	(3.431)	(5.213)
R^2	0.19	0.28	0.16	0.26	0.12	0.04	0.09
Observations	1,440	1,440	1,440	1,440	1,425	1,440	1,434
Number of clusters	46	46	46	46	46	46	46

Notes: All regressions include a constant, a dummy for the 2000–2007 period, geographic dummies for the nine census divisions, and the following start-of-period locality control variables: the share of employment in manufacturing, the college-educated share of the population, the foreign-born share of the population, the share of women in the population, the share of routine occupations in employment, and the average offshorability index of occupations. Observations are weighted by the start-of-period commuting zone share of the national population. Robust standard errors, clustered at the state level, are reported in parentheses.

Next, we decompose the total effect of an increase in trade exposure into changes in own exposure at the commuting zone level and residual exposure at the state level. As shown in Table 10, panel B, we find that total local revenue is more dependent on shocks to the commuting zone than on shocks to the remainder of the state. As expected, changes in revenues from own sources are entirely due to shocks at the commuting zone level whereas intergovernmental transfers decline substantially when the rest of the state experiences an adverse trade shock.[36] Both local education expenditures per capita and expenditures on public welfare and housing per capita decline as imports per worker in the commuting zone increase, and they decline further as imports per worker in the remainder of the state increase. Rising imports per worker in both the commuting zone and in the remainder of the state are associated with higher student-teacher ratios, although only the effect at the commuting zone level remains significant when clustering errors by state.

These results suggest that state intergovernmental transfers can function as a mechanism to smooth local outcomes but only when commuting zones and the remaining areas of a state face different economic shocks. When both the commuting zone and the remaining areas of a state experience negative economic shocks, or in other words, when shocks at the commuting zone and remainder of state level

[36] Since intergovernmental transfers are allocated to commuting zones based on population and poverty rates at decennial census years, it is possible that it takes longer than a decade for these transfers to adjust to the trade shock. Our analysis of intergovernmental transfers in long differences (from 1990–2007) yield very similar estimates to those reported in Table 10, suggesting this is not the case.

are highly correlated,[37] then effects on local revenues, expenditures, and outcomes can become compounded.

IV. Extensions and Robustness

In this section, we consider an extension of our empirical strategy in which we consider the direct effects of shocks to household earnings on local public finances and service provision and use variation in trade shocks across localities to estimate income elasticities for various local public finance outcomes. We also present extensive robustness checks to verify that our results are not due to preexisting trends and are not overly sensitive to alternative specifications, alternative measures of trade exposure, or methods of clustering.

A. *Income Shocks and Local Outcomes*

To assess the effects of income shocks on local public finance outcomes, for each outcome of interest we estimate a 3SLS specifications with the main explanatory variable as household income predicted by exogenous variation in the change in Chinese imports per worker in commuting zone (second stage); the change in Chinese imports per worker in commuting zone is in turn instrumented with the lagged change in other high-income countries' Chinese imports per worker (first stage).[38] The estimation results for the final stage are reported in Table 11.

Estimates in Table 11 suggest that an increase in household incomes is associated with higher housing values, higher local revenues, higher local expenditures, and better public good outcomes. Our point estimates suggest that a 1 percent decline in household incomes due to trade shocks corresponds to a 3.7 percent decline in property values, a 1.3 percent decline in total local revenue per capita, a 2.0 percent decline in total own revenue per capita, a 0.6 percent decline in total local expenditures per capita, a 0.59 percent decline in total education expenditures per capita, a 2.9 percent increase in property crime rates, and an increase of 0.14 students per teacher.[39] We caution that, while these results provide suggestive evidence of how changes in local incomes affect local housing prices, finances, and public good outcomes, unlike our results on the effect of increased imports from China, these associations are not necessarily causal.

[37] We find this to be the case for the trade shock we consider: the increase in Chinese imports per worker at the commuting zone and at the rest of the state are correlated with $\rho = 0.42$.

[38] The first stage is identical to the specification reported in panel A of Table C1 (0.631 (0.088)); the second stage is identical to that reported in column 3 of Table 4, panel A (−1.476 (0.416)). The 3SLS estimation is equivalent to replacing ΔIPW_{uit} (the change in US imports per worker of Chinese goods) with Δ ln avg. HH inc. (the change in log average household incomes) in (3), and conducting the estimation using the same instrument, ΔIPW_{oit} (the lagged change in other high-income countries' Chinese imports per worker), as before.

[39] To calibrate these magnitudes relative to our previous findings, it is worth recalling that a $1,000 increase in Chinese imports per worker is associated with a 1.48 percent decline in average household incomes. Multiplying the coefficient estimates of Table 11 by −1.476 yields the same magnitudes as obtained in previous tables where the variable of interest was the change in Chinese imports per worker. For the property crime sample with information on 568 commuting zones, the change in average household incomes corresponding to a $1,000 increase in Chinese imports per worker is −1.20 percent; multiplying the coefficient estimate on property crimes by −1.20 yields the same coefficient estimate as obtained in Table 9.

TABLE 11—EFFECT OF CHANGES IN HOUSEHOLD EARNINGS ON LOCAL OUTCOMES

	Δ ln median val. own. occ. housing (1)	Δ ln tot. loc. rev. pc (2)	Δ ln tot. rev. from own sources pc (3)	Δ ln tot. loc. exp. pc (4)	Δ ln tot. educ. exp. pc (5)	Δ ln property crimes per 1,000 pop. (6)	Δ Student-teacher ratio (7)
Δ ln avg. HH income	3.661	1.276	1.971	0.604	0.589	−2.876	−0.140
	(1.086)	(0.378)	(0.463)	(0.361)	(0.288)	(1.518)	(0.067)
R^2	0.36	0.10	0.13	0.13	0.01	0.02	0.03
Observations	1,444	1,444	1,444	1,444	1,444	1,068	1,429
Number of clusters	722	722	722	722	722	568	722

Notes: The estimates reported in each column are the final stage from a 3SLS specification with the main explanatory variable as household income predicted by exogenous variation in change in Chinese imports per worker in CZ (second stage); the change in Chinese imports per worker in CZ is in turn instrumented with the lagged change in other high-income countries' Chinese imports per worker (first stage). All regressions include a constant, a dummy for the 2000–2007 period, geographic dummies for the nine census divisions, and the following start-of-period locality control variables: the share of employment in manufacturing, the college-educated share of the population, the foreign-born share of the population, the share of women in the population, the share of routine occupations in employment, and the average offshorability index of occupations. Observations are weighted by the start-of-period commuting zone share of the national population. Robust standard errors, clustered at the commuting zone level, are reported in parentheses.

B. *Testing for Preexisting Trends*

A potential explanation for the results we observe is that omitted locality characteristics jointly determine changes in local outcomes as well as changes in Chinese imports per worker. This might be the case, for example, if declining localities also happen to be more vulnerable to Chinese import competition.

To examine this possibility, we experiment with several robustness checks and placebo tests, the results of which are shown in Table 12. For reference, we show in column 1 the base case results from estimating equation (3) for several of our main dependent variables. In column 2, we include as a regressor the 1980–1990 value of the dependent variable as a way of controlling for preexisting trends. None of the coefficient estimates for the change in current Chinese imports for any of our main dependent variables are significantly different from the base case. In column 3, we instrument for the 1980–1990 values of the dependent variable using 1980 levels of the dependent variable.[40] The coefficient estimates for the change in current period Chinese imports per worker remain similar to our base case estimates, although standard errors become larger. As a placebo check, we regress our main dependent variables calculated over 1980–1990 (the pre-period) on future Chinese import exposure, calculated as the average between 1990–2000 and 2000–2007. We report estimates from specifications without any locality controls in column 4 and with only census region fixed effects in column 5. None of the coefficient estimates on future

[40] Our dependent variables are stacked first differences covering two periods, 1990–2000 and 2000–2007. By also including a control variable that captures changes during the 1980–1990 period, we are potentially introducing a mechanical bias and contaminating all of our coefficient estimates since 1990 values now appear on both sides of the equation. We attempt to address this problem by instrumenting for 1980–1990 changes using 1980 levels of our dependent variables.

TABLE 12—TESTING FOR PREEXISTING TRENDS IN MAIN DEPENDENT VARIABLES

Dependent variable	Explanatory variable	Base case (1)	Incl. dep. var. 1980–1990 as exog. control (2)	Incl. dep. var. 1980–1990 as endog. control (3)	Future IPW predicting current dep. var. (4)	Future IPW predicting current dep. var.; region FE (5)
Δ ln avg. HH income	Δ Current Chinese imports per worker	−1.476	−1.500	−1.635		
		(0.416)	(0.419)	(0.439)		
	Δ ln avg. HH income 1980–1990		3.746	24.804		
			(4.545)	(18.116)		
	Δ Future Chinese imports per worker				0.008	−0.0001
					(0.008)	(0.0051)
Δ ln med. val. own. occ. housing	Δ Current Chinese imports per worker	−5.404	−5.188	−4.047		
		(1.489)	(1.506)	(2.091)		
	Δ ln med. val. own. occ. housing 1980–1990		−0.128	−0.804		
			(0.052)	(0.632)		
	Δ Future Chinese imports per worker				2.747	0.026
					(2.457)	(1.595)
Δ ln tot. loc. rev. pc	Δ Current Chinese imports per worker	−1.884	−1.832	−2.204		
		(0.761)	(0.754)	(0.934)		
	Δ ln tot. loc. rev. pc 1980–1990		−0.116	0.715		
			(0.035)	(0.264)		
	Δ Future Chinese imports per worker				0.611	0.681
					(0.459)	(0.463)
Δ ln tot. loc. exp. pc	Δ Current Chinese imports per worker	−0.892	−0.893	−1.239		
		(0.531)	(0.541)	(0.658)		
	Δ ln tot. loc. exp. pc 1980–1990		0.002	0.577		
			(0.060)	(0.110)		
	Δ Future Chinese imports per worker				0.804	0.906
					(0.474)	(0.503)
Δ ln tot. educ. exp. pc	Δ Current Chinese imports per worker	−0.869	−0.970	−0.673		
		(0.457)	(0.441)	(0.551)		
	Δ ln tot. educ. exp. pc 1980–1990		−0.225	0.433		
			(0.039)	(0.200)		
	Δ Future Chinese imports per worker				0.268	0.404
					(0.774)	(0.597)
Δ ln property crimes per 1,000 pop.	Δ Current Chinese imports per worker	3.464	3.659	4.628		
		(1.699)	(1.588)	(5.175)		
	Δ ln property crimes per 1,000 pop. 1980–1990		−0.368	4.470		
			(0.087)	(7.648)		
	Δ Future Chinese imports per worker				−0.404	0.829
					(1.550)	(1.335)

Notes: For reference, we show in column 1 the base case results from estimating equation (3) for several of our main dependent variables. In column 2, we include the 1980–1990 values of the dependent variable in the specification. In column 3, we instrument for the 1980–1990 values of the dependent variable using 1980 levels of the dependent variable. We regress our main dependent variables on future Chinese import exposure and omit all locality controls (column 4) except census region fixed effects (column 5). Observations are weighted by the start-of-period commuting zone share of the national population. The specifications for columns 1–3 include a constant, a dummy for the 2000–2007 period, geographic dummies for the nine census divisions, and the following start-of-period locality control variables: the share of employment in manufacturing, the college-educated share of the population, the foreign-born share of the population, the share of women in the population, the share of routine occupations in employment, and the average offshorability index of occupations. Robust standard errors, clustered at the commuting zone level, are reported in parentheses.

Chinese imports per worker are significant except for the ones on the change in total locality expenditures per capita, suggesting, if anything, that areas with rising per capita expenditures (not declining per capita expenditures) were the ones eventually more exposed to Chinese import competition. These results suggest that the potential bias, to the extent any exists, works against our main findings. Importantly, these robustness checks and placebo tests indicate that preexisting trends in our dependent variables are unlikely to be driving our results.[41]

C. *Alternative Specifications*

To gauge sensitivity of our estimates to alternative specifications and clustering, we experiment with replacing region fixed effects with state fixed effects, clustering at the state rather than commuting zone level, omitting all locality-level controls except state and time fixed effects, and excluding potential outlier states such as California, which limits property tax collection. All of our results hold. We report these additional robustness checks for select variables in Table C3.[42]

Next, we confirm that our main findings are robust to alternative measures of trade exposure of US commuting zones.[43] We start by estimating our benchmark specifications with alternative measures constructed in Autor, Dorn, and Hanson (2013). In particular, in panel B of Table C4[44] we report estimates from 2SLS specifications replacing the main explanatory variable in equation (3) with an import exposure measure that includes international import exposure through its effect on US sales in foreign markets, excludes intermediate inputs purchased by US firms, is net of exports to China, is constructed using the factor content of US net imports from China, and estimates from an ordinary least squares (OLS) specification with a gravity-based measure of exposure to imports from China. Our estimates are very robust across these different specifications.

To address any bias due to changes in sector-specific demand that are common across countries, we construct an instrument as in Costa, Garred, and Pessoa (2014).[45] While this instrument is analogous to the one implemented in our benchmark specification, it differs in several dimensions: the instrument is constructed using differences in growth rates (rather than in levels) of trade between China and the rest of the world (rather than a set of high-income countries) and fixed effects from a set of auxiliary regressions that clean out changes in world prices and quantities. These modifications aim at diminishing the importance of high-growth sectors and at dealing with the possibility of correlated worldwide shocks. In panel C of Table C4, we report 2SLS estimates for imports from China. The estimates reported

[41] For student-teacher ratios, we do not have data prior to 1990 and cannot test for preexisting trends. When conducting the placebo tests (columns 4 and 5), we no longer have stacked first differences: data for the dependent variables are for one period only, 1980–1990 (the pre-period), while the change in future Chinese imports per worker is calculated as the average of the changes between 1990–2000 and 2000–2007 (the future periods).

[42] We also reran our estimations excluding one state at a time. Our results are not sensitive to individual states.

[43] We describe each of these alternative estimation strategies in greater detail in Appendix C.

[44] Each cell in Table C4 presents estimates from a different specification, with the dependent variables in column headings and main explanatory variables in row headings; the additional controls are identical to those included in the benchmark specification (replicated in panel A for reference).

[45] We are grateful to Francisco Costa, Jason Garred, and Joao Paulo Pessoa for making their replication programs available to us.

in (6) and (7) are from specifications including only imports from China and including exports from China in addition to imports (constructed and instrumented in an analogous fashion), respectively. As all world price changes, including those due to China, are purged out, the results reported in panel C can be viewed as more conservative estimates of the effects of China on US local labor markets.

Finally, we implement an identification strategy based on a natural policy experiment, the United States granting China Permanent Normal Trade Relations (PNTR), which by eliminating the need for annual renewals for China's continued access to low tariff rates, removed the uncertainty over future trade costs. Pierce and Schott (2016a) show that manufacturing industries more exposed to PNTR (i.e., those with a higher gap between the low NTR rates and higher non-NTR rates that would have prevailed if the annual renewal had failed) experienced a relative increase in imports from China and a decline in employment. Following Pierce and Schott (2016b), we estimate a difference-in-difference specification to test whether commuting zones with higher NTR gaps due to their initial industry mix, experienced a differential change in local public finances and public good provision after the implementation of the policy.[46] In panel D of Table C4, we report the estimated coefficient for the interaction of a post-PNTR (i.e., $t > 2000$) indicator and the time-invariant NTR gap. Estimates reported in (9) also include time-varying commuting zone level controls for the import tariff rate (NTR) and the sensitivity of the commuting zone to the phasing out of the global Multi-Fiber Agreement (MFA). Our estimates are broadly consistent with both our benchmark results and those reported in Pierce and Schott (2016b).[47]

While, as we discuss in Appendix B, the interpretation of the coefficients and the samples are slightly different across specifications, the estimates reported in Table C4 suggest that the main results of the paper are broadly consistent across specifications implementing alternative instruments and exploiting different sources of variation: a relative increase in imports from China is associated with a relative decline in incomes and housing values, and a deterioration of local public finances and locally provided public goods.

V. Conclusion

There has recently been increased interest in the localized effects of trade and income shocks and on the ability of individuals to out-migrate from negatively affected areas in order to arbitrage away quality-of-life differences. While the literature had previously emphasized labor mobility as a means of maintaining parity in locational preferences (Rosen 1979, Roback 1982), recent empirical research suggests that labor mobility is slow and incomplete (Topel 1986, Blanchard and Katz 1992, Glaeser and Gyourko 2005) and that the costs and benefits of national policies like trade liberalization are therefore unequally distributed across localities.

[46] We are grateful to Justin Pierce and Pierce Schott for providing the PNTR exposure measure at the commuting zone level and for very helpful discussions.

[47] Since the coefficients reported in rows 8 and 9 are in changes in log points, to ensure comparability to the rest of the coefficients, in rows 8′ and 9′, we also report the implied impact of PNTR for each dependent variable (as described in Appendix B3).

We contribute to this literature by showing that trade-induced income shocks constrain local resources and lead to a relative deterioration in the quality of local public goods. Since high-skilled workers and new growth industries tend to value high-quality public goods (Black 1999, Moretti 2012), the fact that areas negatively affected by trade shocks face greater difficulty in providing these goods makes it more challenging for them to compete economically against other localities and recover from shocks.

The results of this paper, in tracing out how trade and income shocks can ultimately affect local public services, constitute an important input to the design of government policies. Trade assistance programs and intergovernmental transfers are currently insufficient to arrest the declines in incomes and public service quality in localities negatively affected by trade liberalization. At the same time, an array of policies makes it more difficult for workers, especially low-skilled workers, to migrate to more economically vibrant areas (Glaeser 2011). The consequence is greater disparity both in incomes and in the quality of essential public services across the United States, suggesting a potential for welfare enhancing government interventions to either equalize opportunities or reduce barriers to migration across localities.

Appendix A: Data Sources

This Appendix contains detailed descriptions of the variables and data sources underlying our analysis. All variables were analyzed within a commuting zone (CZ) unless otherwise noted. When changes in variables are referenced in the paper, the relevant time periods are from 1990 to 2000 and from 2000 to 2007; any exceptions are discussed below.

A. *Chinese Import Shocks*

Information on Chinese import shocks at the CZ level comes from Autor, Dorn, and Hanson (2013).[48] The continental United States is divided into 722 commuting zones, based on county-level commuting data compiled by Tolbert and Sizer (1996) using the 1990 US Census. For each commuting zone, the County Business Patterns database is used to determine the local employment structure in 1980, 1990, and 2000. In cases where individual employment numbers were not reported directly, they are imputed based on aggregate employment in the industry, the number of firms in each industry, and typical firm size. Then, data on US imports from China (1991–2007) at the six-digit Harmonized System product level from the United Nations Commodity Trade Statistics Database (UN Comtrade) is mapped to four-digit SIC industries and is merged with the CZ industry composition to construct trade exposure at the CZ level. The instrument, the change in other high-income country imports of Chinese goods, was also compiled by Autor, Dorn, and Hanson (2013) using the same UN Comtrade database and the same methodology. Other

[48] All replication programs and datasets are made publicly available online by the authors at http://www.ddorn.net/data.htm.

high-income countries include Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain, and Switzerland.

B. *Local Government Finances*

Information about local government revenue and expenditure came from the US Census Bureau's historical data on State and Local Government Finances, the March 2013 version containing information from 1967–2007, for every five years (years ending with 2 and 7). The data for 1990 and 2000 are interpolated using data for 1987 and 1992, and 1997 and 2002, respectively. This dataset comprises individual local governments records, including counties, cities, townships, special districts, and independent school districts. For our analysis, we aggregate expenditures and revenues of individual local governments to the commuting zone level. Variables described as per capita reflect the line item divided by the local population. Population data came from the Census Integrated Public Use Micro Samples for 1970, 1980, 1990, and 2000 and the American Community Survey for 2006 to 2008 and then mapped on to commuting zones. Definitions below are informed by the US Census Bureau's "Glossary of Selected Terms Used in US Census Bureau Publications on City Government Finances" (available online at http://www.census.gov/govs/state/definitions.html).

Total revenue: The sum of all sources of revenue for the local government.
Total revenue from own sources: Includes general revenue generated from local taxes, charges, or other miscellaneous revenues, and revenue generated by government enterprises or utilities, but not intergovernmental transfers.
General revenue from own sources: Revenue generated from local taxes, charges, or other miscellaneous revenues, including property tax, sales tax, and income tax, parking fees, port fees, and parks and recreation fees, but not revenue from government enterprises or utilities, liquor stores, or employee retirement and other insurance trust revenue.
Total taxes: Total tax revenue, including property tax, sales tax, income tax, gasoline tax, and alcohol and tobacco taxes.
Property taxes: Revenue from property taxes.
Sales, income, and license taxes and fees: Tax revenue from sales and income taxes and vehicle taxes, but excluding property tax.
Revenue from fines and charges: Revenue from miscellaneous charges and fees, such as airport fees, port fees, housing and community development charges, and sewage fees.
Other taxes: Tax revenue from sources other than property tax, sales tax, income tax, and vehicle tax.
Utility revenue: Revenue from sale of utility commodities and services to the public and to other governments.
Liquor store revenue: Revenue from sale of liquor by local liquor store operations.
Insurance trust revenue: Revenues from contributions required of employers and employees for financing social insurance programs operated by the government (such as, insurance protection of persons or their survivors against economic

hazards arising from retirement, disability, death, accident, illness, unemployment, etc.) and earnings on assets held for such systems.

Intergovernmental transfers: Revenue transfers from state, federal, and other local governments received as fiscal aid in the form of shared revenues and grants-in-aid, as reimbursements for performance of general government functions and specific services for the paying of government (e.g., care of prisoners or contractual research), or in lieu of taxes. Excludes amounts received from other governments for sale of property, commodities, and utility services.

Total expenditure: The sum of all expenditures by the local government.

Education expenditure: Expenditure on schools and other educational facilities and services, including public elementary and secondary and higher education, as well as payments to private institutions and special educational programs. Also includes school lunch services, athletic events, and other commercial or auxiliary services.

Public safety expenditure: Expenditure on police protection, fire protection, correctional facilities, and the regulation of private enterprises for the protection of the public.

Expenditure on utilities: Expenditure for construction of utility (water supply, electric light and power, gas supply, or transit system) facilities or equipment, for production and distribution of utility commodities and services (except those furnished to the parent city), and for interest on utility debt. Does not include expenditure in connection with administration of utility debt and investments (treated as general expenditure) and the cost of providing services to the parent city government (such costs, when identifiable, are treated as expenditure for the function served).

Transportation expenditure: Expenditure on highways, parking facilities, water transport, and terminals, and transit subsidies.

Public welfare expenditure: Assistance to needy persons, including cash assistance, payments to private purveyors for medical care, burials, and other commodities and services, and provision and operation of welfare institutions. Also includes payments to other governments for welfare purposes, amounts for administration, support of private welfare agencies, and other public welfare services.

Parks and natural resources expenditure: Expenditures on public parks and natural resources.

Housing and community development expenditure: Expenditures on construction and operation of housing and redevelopment projects, and other activities to promote or aid housing and community development.

Other general expenditure: Remaining expenditures not included in the main categories described above, including expenditures on health and hospitals, government administration, interest on general debt, miscellaneous commercial activities, libraries, ports and airports, and expenditures that are classified as "other or unallocable."

C. *Local Business Activity*

For each commuting zone, the County Business Patterns database was used to determine the number of firms. The data came from the US Census Bureau's

Business Register of US companies and was then aggregated up to the commuting zone level. The database includes all companies with paid employees, covering most North American Industry Classification System (NAICS) industries except for crop and animal production; rail transportation; the National Postal Service; pension, health, welfare, and vacation funds; trusts, estates, and agency accounts; private households; and public administration, as well as most establishments reporting government employees.

D. *Local Outcomes*

Information about local outcomes, including crime rates, poverty rates, housing prices, household income, and income distribution, came from the US Census Bureau's USA Counties database, which compiles data produced or gathered by various US government agencies and sources (US Bureau of Labor Statistics, US Department of Justice, the American Community Survey, etc.).

Crime Rates: Data on crime are compiled by the US Department of Justice based on submissions by contributors to the Uniform Crime Reporting Program, under which local law enforcement agencies throughout the United States voluntarily report crime statistics either directly to the state Uniform Crime Reporting Program or by reporting statistics to the Federal Bureau of Investigation. Data is published annually at http://www.fbi.gov.

Property Crime: The number of burglaries, larceny theft, theft of a motor vehicle, and arson known to police, with values referenced for 1980, 1990, 2000, and 2007.

Violent Crime: The number of murders and willful manslaughter, forced sexual acts, robberies, and aggravated assault known to police, with values referenced for 1981, 1990, 2000, and 2007.

Poverty: Poverty data are compiled via the US Census Bureau, the American Community Survey, and American FactFinder.

Poverty Rate: The number of persons classified as poor divided by the number of persons for whom poverty status has been determined. Poverty status is determined for each individual by family or individual income (if unattached) relative to a threshold based on family or individual demographics. Available for 1989, 1999, and 2005–2009.

Child poverty rate: The number of related children under 18 years of age classified as poor divided by the number of related children under 18 years of age for whom poverty status has been determined. Available for 1989, 1999, and 2005–2009.

Household income: Defined as total money income (sum of wages or salaries, self-employment, Social Security, and wealth derived from regularly received government assistance programs) received in a calendar year by all household members (related or unrelated) 15 years and over (US Census County and City Data Book: 2007, pp. A-8). The total is calculated before deductions are made for personal income tax, Social Security payments, bond purchases, dues owed to unions, etc. Data on households are compiled by the US Census Bureau, American Community Survey Data (2005–2009).

Share of households with income below $30,000: Aggregation of the number of households with income less than $10,000, households with income of $10,000 to $14,999, households with income of $15,000 to $19,999, households with income of $20,000 to $24,999, and households with income of $25,000 to $29,999, divided by the total number of households. Available for 1989, 1999, and 2005–2009.

Share of households with income between $30,000 and $60,000: Aggregation of the number of households with income of $30,000 to $34,999, households with income of $35,000 to $39,999, households with income of $40,000 to $44,999, households with income of $45,000 to $49,999, and households with income of $50,000 to $59,999, divided by the total number of households. Available for 1989, 1999, and 2005–2009.

Share of households with income above $60,000: Aggregation of the number of households with income of $60,000 to $74,999 and households with income of $75,000 or more, divided by the total number of households. Available for 1989, 1999, and 2005–2009.

Average household wage income: Includes household income from employment and wage earnings only.

Average household transfer income: Includes household income from transfers such as Social Security, disability, and direct cash welfare assistance.

Unemployment: Data produced by US Bureau of Labor Statistics, Local Area Unemployment Statistics at http://bls.gov/lau.

Share unemployed: The population (civilians 16 and over) with status "unemployed-civilian labor force" divided by the population with status "in labor force."

Share not in the labor force: The population age 16 years and over minus the population with employment status "in labor force," divided by the population age 16 years and over.

Median value of owner occupied housing: The median value of specified owner-occupied housing units. Values for 1980 (complete), 1990 (complete), and 2000 (sampled) drawn from the census. Values for 2005–2009 drawn from the American Community Survey.

E. *Student-Teacher Ratios*

Information on student-teacher ratios was calculated using data from the National Center for Education Statistics within the US Department of Education and the Institute of Education Sciences for the 1992–1993, 2000–2001, and 2007–2008 academic years.

Totals for the number of teachers, the number of students, and students in pre-kindergarten through twelfth grade were accessed at the county level and then aggregated up to the commuting zone level.

Student-teacher ratio: The total number of teachers in the commuting zone divided by the total number of students enrolled.

Student-teacher ratio, pre-K to twelfth grade: The total number of teachers in the commuting zone divided by the total number of students enrolled in pre-kindergarten through twelfth grade.

Appendix B: Alternative Measures of Trade Exposure of US Commuting Zones

This Appendix contains detailed descriptions of alternative estimation strategies we conducted in order to gauge the sensitivity of our results to the use of different measures of trade exposure of US commuting zones. The estimation results from these specifications for our main dependent variables—household income, housing values, per capita total revenue, per capita total expenditure, per capita expenditure on education, teacher to student ratios, per capita expenditure on public safety, and property crime rates— are reported in Table C4. Note that each cell in Table C4 presents estimates from a different specification, with the dependent variables in column headings and main explanatory variables in row headings; the additional controls are identical to those included in the benchmark specification (replicated in panel A for reference).

While, as discussed below, the interpretation of the coefficients and the samples are slightly different across specifications, the estimates reported in Table C4 suggest that the main results of the paper are broadly consistent across specifications implementing alternative instruments and exploiting different sources of variation: a relative increase in imports from China is associated with a relative decline in incomes and housing values, and a deterioration of local public finances and locally provided public goods.

A. *Alternative Measures of Exposure from Autor, Dorn, and Hanson (2013)*

In panel B of Table C4 we report the results from estimating our benchmark specifications with alternative measures constructed in Autor, Dorn, and Hanson (2013). In particular, we report estimates from specifications using a modified import exposure measure that:

(i) includes international import exposure through its effect on US sales in foreign markets. In doing so, equation (1) is modified to include a term capturing growth in third markets' imports from China (weighted by initial share of spending in these markets on US exports) in addition to the domestic import exposure; the instrument in equation (2) is adjusted in a similar manner. This modified measure captures the fact that Chinese exports not only impact sales of US producers in the US market but also sales of US producers in foreign export markets. The mean (and standard deviation) of the trade exposure measure is 2.88 (2.17).

(ii) excludes intermediate inputs purchased by US firms from the measure of imports from China in equation (1). The modified measure of exposure abstracts away from any increase in labor demand due to productivity gains to US importers that result from access to a higher variety of inputs. The mean (and standard deviation) of the trade exposure measure is 1.46 (1.48).

(iii) is net of exports of United States to China. In doing so, equation (1) is modified by subtracting US exports from US imports by industry. The net import

measure is instrumented by the measure of imports from China by other high-income countries and a newly constructed measure of exports to China by these countries. The mean (and standard deviation) of the trade exposure measure is 1.58 (1.66).

(iv) is constructed using the factor content of US net imports from China. The net imports per worker (as in (iii) above) is replaced with change in net imports of effective labor services (imputed direct plus indirect labor services embodied in net imports); the instrument is analogous to that in (iii) above. The mean (and standard deviation) of the trade exposure measure is 1.50 (1.48).

(v) is a gravity based measure of exposure to imports from China, constructed in Autor, Dorn, and Hanson (2013) as a proxy for the change in US imports from China predicted by China's changing comparative advantage and declining trade costs. The OLS estimates reported in row 5 of Table C4 reflect net rather than gross imports (comparable to (iii) above) and should be exponentiated for comparison, since the gravity residual corresponds to a measure of productivity in logarithms. The mean (and standard deviation) of the trade exposure measure is 1.40 (1.79).

B. *Accounting for Changes in Common Sector-Specific Demand Shocks*

In order to address any bias due to changes in sector-specific demand that are common across countries, we construct an instrument as in Costa, Garred, and Pessoa (2014). Specifically, we first run the following auxiliary regressions, using data on total exports of country i in sector j in year t to all countries other than the United States ($\tilde{X}_{ijt}$) in 1991, 2000, and 2007 for all countries available in the Comtrade dataset except the United States:

$$\frac{\Delta \tilde{X}_{ij}}{\tilde{X}_{ij}} = \alpha_j + \delta_{China,j} + \mu_{ij}. \tag{5}$$

We estimate equation (5) separately for 1991–2000 and 2000–2007 and weight observations by export volumes in 1991 and 2000, respectively. The sector-fixed effects captures the mean growth rate across countries, net-of-US exports in that sector; the China-specific-dummies reflect the deviation in the growth rates of China's exports in sector j (excluding trade with the United States), from this weighted cross-country average. The instrument is then constructed using the China-specific dummies from the above specification as follows:

$$ivIS_{it} = \sum_j \frac{L_{ij,t-1}}{L_{uj,t-1} L_{i,t-1}} \Delta I_{j,t-1} \hat{\delta}_{China,jt}. \tag{6}$$

While the instrument is analogous to the one implemented in our benchmark specification, it differs in several dimensions: It is constructed using differences in growth rates (rather than in levels) of trade between China and the rest of the world (rather than a set of high-income countries), and by using fixed effects from a set of auxiliary regressions that clean out changes in world prices and quantities. These

modifications aim at diminishing the importance of high-growth sectors and at dealing with the possibility of correlated worldwide shocks. In panel C of Table C4, we report 2SLS estimates for imports from China. The estimates reported in rows 6 and 7 of Table C4, panel C are from specifications including only imports from China and including exports from China in addition to imports (constructed and instrumented in an analogous fashion), respectively. As all world price changes, including those due to China, are purged out, the results reported in panel C can be viewed as more conservative estimates of the effects of China on US local labor markets.

C. *Policy Experiment: Permanent Normal Trade Relations (PNTR) between China and the United States*

Next, we implement an identification strategy based on a natural policy experiment—United States granting China Permanent Normal Trade Relations (PNTR)—which by eliminating the need for annual renewals for China's continued access to low tariff rates, removed the uncertainty over future trade costs. Following Pierce and Schott (2016b), we estimate a difference-in-difference specification to test whether commuting zones with higher NTR gaps due to their initial industry mix, experienced a differential change in local public finances and public good provision after the implementation of the policy. NTR gap is calculated using ad valorem equivalent tariff rates in 1999 (the year before passage of PNTR) as follows:

$$NTRGap_j = NonNTRRate_j - NTRRate_j. \tag{7}$$

Here, NTRGap reflects the rise in US tariffs on Chinese goods that would have occurred in the event of a failed annual renewal of China's NTR status prior to PNTR. The exposure of a US commuting zone to PNTR is then calculated as the employment-share weighted average of NTR gap calculated across industries present in the CZ:

$$NTRGap_i = \sum_j \frac{L_{ij,1990}}{L_{i,1990}} NTRGap_j. \tag{8}$$

The difference-in-difference specification we estimate is analogous to that in Pierce and Schott (2016b) and tests if commuting zones with higher NTR gaps experience differential changes in public finances and public good provision, after the change in US trade policy:

$$\begin{aligned} Y_{it} = {} & \gamma_1 PostPNTR_t \times NTRGap_i + \theta X_{it} \\ & + \alpha PostPNTR_t \times X_i + \delta_c + \delta_t + \epsilon_{it}. \end{aligned} \tag{9}$$

In panel D of Table C4 (rows 8 and 9), we report the estimated coefficient of the interaction of post-PNTR (i.e., $t > 2000$) indicator and the time-invariant NTR gap ($\hat{\gamma}_1$). Estimates reported in row 9 also include time-varying commuting zone level controls for the import tariff rate and the sensitivity of the commuting zone to the phasing out of the global Multi-Fiber Agreement. The sample time-period ranges from 1990 to 2007, although the year coverage varies across specifications,

depending on data availability. The sample for specifications with household income and median housing values cover 1990, 2000, and 2007, specification with total revenue, total expenditure, education, and public safety expenditures cover 1992, 1997, 2002, and 2007, and specifications with student-teacher ratios and property crime rates cover annual data spanning 1992–2007 and 1990–2007, respectively. We assess the economic significance of these estimates by computing the change in the dependent variable associated with moving a commuting zone from the twenty-fifth percentile of the NTR gap distribution to the seventy-fifth percentile (i.e., from 2.8 to 8.5 percent). As we indicated in the bottom two rows of the table, the implied change in the dependent variables measured in logarithms are then calculated as $100 \times (e^{\hat{\gamma}_1 \times (8.5-2.8)} - 1)$.

Appendix C: Additional Results and Robustness Checks

Table C1—Effect of Chinese Import Exposure on Population Composition

	Δ Chinese imports per worker in United States		
Panel A. First stage			
Δ Chinese imports per worker in other countries (lagged)	0.631		
	(0.088)		
F-statistic	51.17		
R^2	0.58		
Observations	1,444		
Number of clusters	722		
	Δ ln workage pop. (1)	Δ ln workage pop. college educ. (2)	Δ ln workage pop. no college educ. (3)
Panel B. Second stage			
Δ Chinese imports per worker in United States	−0.050	−0.026	−0.047
	(0.675)	(0.627)	(0.753)
Share of emp. in manufacturing$_{-1}$	−0.145	−0.177	−0.086
	(0.082)	(0.081)	(0.091)
Share of college grads in population$_{-1}$	−0.146	−0.595	−0.090
	(0.101)	(0.104)	(0.104)
Share of foreign grads in population$_{-1}$	0.028	−0.039	0.069
	(0.072)	(0.075)	(0.082)
Share of females in employment$_{-1}$	0.339	0.394	0.241
	(0.120)	(0.128)	(0.130)
Share of routine occ. in employment$_{-1}$	−0.277	−0.420	−0.341
	(0.386)	(0.362)	(0.420)
Offshorability index of occupations$_{-1}$	4.412	4.965	5.831
	(2.563)	(2.332)	(2.866)
R^2	0.42	0.35	0.52
Observations	1,444	1,444	1,444
Number of clusters	722	722	722

Notes: All regressions include a constant, a dummy for the 2000–2007 period, geographic dummies for the nine census divisions, and the following start-of-period locality control variables: the share of employment in manufacturing, the college-educated share of the population, the foreign-born share of the population, the share of women in the population, the share of routine occupations in employment, and the average offshorability index of occupations. Observations are weighted by the start-of-period commuting zone share of the national population. Robust standard errors, clustered at the commuting zone level, are reported in parentheses.

TABLE C2—THE EFFECT OF CHINESE IMPORT EXPOSURE ON LOCAL REVENUES PER CAPITA

	Δ ln other rev. from liq. stores, util., and ins. trust (1)	Δ ln rev. from insurance trust (2)	Δ ln rev. from utilities (3)	Δ ln rev. from liquor stores (4)
Panel A. Percent changes (per capita)				
Δ Chinese imports per worker	−11.092	−12.673	−2.605	0.597
	(3.421)	(10.069)	(1.619)	(2.029)
R^2	0.39	0.62	0.03	0.43
Observations	1,444	524	1,444	143
Number of clusters	722	278	722	75
Panel B. Value changes (per capita)				
Δ Chinese imports per worker	−66.119	−61.487	−4.613	−0.019
	(29.898)	(27.971)	(6.952)	(0.144)
R^2	0.36	0.41	0.03	0.03
Observations	1,444	1,444	1,444	1,444
Number of clusters	722	722	722	722

Notes: Other revenues from liquor stores, utilities, and insurance trust (column 1) is the sum of revenues from the insurance trust sector (column 2), utilities (column 3), and liquor stores (column 4). All regressions include a constant, a dummy for the 2000–2007 period, geographic dummies for the nine census divisions, and the following start-of-period locality control variables: the share of employment in manufacturing, the college-educated share of the population, the foreign-born share of the population, the share of women in the population, the share of routine occupations in employment, and the average offshorability index of occupations. Observations are weighted by the start-of-period commuting zone share of the national population. Robust standard errors, clustered at the commuting zone level, are reported in parentheses.

TABLE C3—ADDITIONAL ROBUSTNESS CHECKS

Dependent variable	(1)	(2)	(3)	(4)
Δ ln avg. HH income	−1.637	−1.637	−1.401	−1.580
	(0.414)	(0.322)	(0.335)	(0.502)
Δ ln median val. own. occ. housing	−5.240	−5.240	−3.849	−3.762
	(1.704)	(2.199)	(1.037)	(1.854)
Δ ln total revenue pc	−2.312	−2.312	−1.196	−2.448
	(0.819)	(0.755)	(0.576)	(0.939)
Δ ln total expenditure pc	−1.381	−1.381	−0.631	−1.528
	(0.523)	(0.644)	(0.380)	(0.601)
Δ ln property crimes per 1,000 pop.	4.153	4.153	4.805	3.168
	(2.032)	(1.926)	(1.477)	(1.724)
Δ Student-teacher ratio	0.288	0.288	0.105	0.282
	(0.108)	(0.140)	(0.061)	(0.100)
State fixed effects	Yes	Yes	Yes	Yes
Commuting zone controls	Yes	Yes	No	Yes
Clustering	CZ	State	CZ	CZ
Sample	Full	Full	Full	Omit CA

Notes: Each cell represents the coefficient estimate on Δ Chinese imports per worker from a different specification. In column 1, state fixed effects (instead of census-division fixed effects) are included; in column 2, standard errors are clustered at the state-level (instead of commuting zone level); in column 3, all commuting zone level controls are omitted; and in column 4, California is omitted from the sample. All regressions include a constant, a dummy for the 2000–2007 period, and state fixed effects. The following are used as start-of-period locality control variables: the share of employment in manufacturing, the college-educated share of the population, the foreign-born share of the population, the share of women in the population, the share of routine occupations in employment, and the average offshorability index of occupations. Observations are weighted by the start-of-period commuting zone share of the national population. Robust standard errors, clustered at the commuting zone or state level, are reported in parentheses.

TABLE C4—ROBUSTNESS CHECKS: ALTERNATIVE SPECIFICATIONS

	Δ ln avg. HH income	Δ ln median housing val.	Δ ln total revenue pc	Δ ln total exp. pc	Δ ln educ. exp. pc	Δ Student-teacher ratio	Δ ln total safety exp. pc	Δ ln property crimes
Panel A								
Δ Chinese imports/worker	−1.476	−5.404	−1.884	−0.892	−0.869	0.253	0.329	3.464
(2SLS)	(0.416)	(1.489)	(0.761)	(0.531)	(0.457)	(0.099)	(0.796)	(1.699)
Panel B								
(1) Δ Overall exposure to Chinese imports/worker (2SLS)	−1.225	−4.352	−1.532	−0.732	−0.748	0.217	0.352	2.977
	(0.350)	(1.291)	(0.641)	(0.445)	(0.393)	(0.083)	(0.681)	(1.434)
(2) Δ Chinese imports net of interm. inputs/worker (2SLS)	−0.782	−3.182	−1.471	−0.280	−0.561	0.188	0.805	3.788
	(0.571)	(1.764)	(0.759)	(0.638)	(0.527)	(0.106)	(0.819)	(1.758)
(3) Δ Chinese net imports/ worker (2SLS)	−0.969	−2.926	−1.582	−0.933	−0.668	0.114	0.670	2.793
	(0.462)	(1.471)	(0.670)	(0.499)	(0.447)	(0.093)	(0.714)	(1.790)
(4) Δ Factor content of Chinese net imports/ worker (2SLS)	−1.007	−4.575	−1.708	−0.676	−0.664	0.186	0.810	2.636
	(0.440)	(1.366)	(0.750)	(0.614)	(0.504)	(0.108)	(0.734)	(1.970)
(5) Δ Chinese comp. adv. (OLS)	−0.567	−1.944	−0.821	−0.371	−0.469	0.135	0.185	0.942
	(0.193)	(0.667)	(0.316)	(0.244)	(0.225)	(0.053)	(0.360)	(1.075)
Panel C								
(6) Import shock (2SLS)	−0.905	−3.448	−1.170	−0.974	−0.985	0.256	−0.007	0.945
	(0.308)	(0.944)	(0.472)	(0.290)	(0.319)	(0.083)	(0.504)	(1.659)
(7) Import shock (2SLS) (Export shock included)	−0.847	−4.644	−1.378	−1.029	−0.748	0.239	−0.194	0.372
	(0.271)	(0.795)	(0.414)	(0.294)	(0.316)	(0.072)	(0.455)	(1.725)
Observations	1,444	1,444	1,444	1,444	1,444	1,429	1,444	1,068
Panel D. (Dependent variables in levels)								
(8) PostPTNR × NTR Gap	−0.004	−0.010	−0.001	−0.003	−0.001	0.078	0.000	0.011
	(0.002)	(0.006)	(0.002)	(0.002)	(0.002)	(0.034)	(0.002)	(0.003)
(9) PostPTNR × NTR Gap (MFA and NTR included)	−0.006	−0.012	−0.003	−0.004	−0.002	0.059	−0.003	0.009
	(0.002)	(0.008)	(0.002)	(0.002)	(0.002)	(0.038)	(0.002)	(0.004)
(8′) Implied Impact of PNTR (from (8))	−2.254	−5.541	−0.568	−1.696	−0.568	0.445	0.000	6.471
(9′) Implied Impact of PNTR (from (9))	−3.362	−6.611	−1.695	−2.254	−1.133	0.336	−1.695	5.263
Observations	2,166	2,166	2,888	2,888	2,888	11,478	2,888	10,396
Time period	90,00,07	90,00,07	92,97,02,07	92,97,02,07	92,97,02,07	1992–2007	92,97,02,07	1990–2007

Notes: Each cell represents the coefficient estimate from a different specification. Panel A replicates the benchmark specifications. Panel B reports estimates from 2SLS specifications replacing the main explanatory variable with an import exposure measure that (1) includes international import exposure through its effect on US sales in foreign markets, (2) excludes intermediate inputs purchased by US firms, (3) is net of exports to China, and (4) is constructed using the factor content of US net imports from China. Estimates from an OLS specification with a gravity based measure of exposure to imports from China are reported in (5). Panel C reports 2SLS estimates with a modified trade exposure measure accounting for changes in sector-specific demand that are common across countries. (7) are from specifications including exports from China in addition to imports (constructed and instrumented in an analogous fashion). Panel D reports DID OLS regression coefficients for the interaction of the commuting zone's NTR gap with an indicator for the post-PNTR period (years after 2000). (9) includes controls for NTR and the sensitivity of the CZ to the phasing out of the global MFA. (8′) and (9′) report the implied impact of PNTR calculated from (8) and (9), respectively. All regressions include a constant, a dummy for the 2000–2007 period, and state fixed effects. The following are used as start-of-period locality control variables: the share of employment in manufacturing, the college-educated share of the population, the foreign-born share of the population, the share of women in the population, the share of routine occupations in employment, and the average offshorability index of occupations. Observations are weighted by the start-of-period commuting zone share of the national population. Robust standard errors, clustered at the commuting zone level, are reported in parentheses.

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