How are wages set in Beijing?

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Abstract

Over the last fifteen years, China’s export performance has been phenomenal, but some analysts assert that this situation is temporary due to rising labor costs. However, large migration across provinces may increase competition on the labor market of export-intensive provinces and allow firms to keep low wages for many years. This paper attempts to shed some light on this debate over wage dynamics in China. We investigate the respective importance of the upward push of world demand and the downward pressure of migration. We first build on the models of the New Economic Geography (Fujita et al., 1999) to derive an econometric specification. Then, we estimate the maximum wage a firm can afford to pay, given its access to world markets and internal migration. This investigation is conducted on a sample of 29 Chinese provinces between 1995 and 2004. Both market access and internal migration have statistically significant effects on the wage level. We find evidence that the magnitude of the internal migration estimate exerts a downward pressure on wages and offsets the impact of market access.

JEL Codes: F12, F15, R11, R12.

Keywords: Wage, China, Immigration, Economic geography.

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1 Introduction

Over the last fifteen years, China’s export performance has been phenomenal. Its share of world merchandise exports jumped from 1.8% in 1990 to 5% in 2004. The average annual growth of China’s exports, between 2000 and 2004, was 15 points higher than that of world exports (24% versus 9%). Low labor costs, foreign direct investments and an undervalued currency are among the main explanations of China’s success in capturing world export markets (Adams et al., 2006). Imports are also growing but China’s trade balance is substantially positive. This imbalance is a matter of concern for its main trade partners. Between 2000 and 2004, exports to the USA, EU and Japan have been multiplied by a factor 2.4, 2.6 and 1.7 respectively.\(^1\)

Some analysts assert that this situation is temporary. Labor costs are increasing rapidly (Adams et al., 2006; Lett and Banister, 2006)\(^2\) and main trade partners strongly pressure on China to appreciate the yuan (McKinnon, 2006).\(^3\) Other analysts sustain a different and more permanent scenario. They assert that a population in excess of one billion people represents an extensive labor force. Migration across provinces may thus increase competition on the labor market of export-intensive provinces and allow firms to keep low wages for many years.\(^4\)

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\(^1\)Source: Authors’ calculations using data from the World Trade Organization (www.wto.org/).

\(^2\)Chinese wages in dollars have been increasing by 15% per year in 2001 and 2002 (Adams et al., 2006). Using estimates of employers’ costs to hire an hour of labor, Lett and Banister (2006) evaluate that total hourly compensation costs of manufacturing employees in China increased nearly 18%, between 2002 and 2004. See also China’s competitiveness ‘on the decline’, Financial Times, March 22, 2006. Using our data set on the period 1996-2004, we confirm an upward trend of the average real manufacturing wage in China (see Figure 1, in Appendix B).

\(^3\)In July 2005, China revalued the yuan, appreciating it against the U.S. dollar by about 2%. The yuan is now floating within a narrow 0.3% band against a basket of foreign currencies and still slowly appreciating against the dollar (Lett and Banister, 2006).

\(^4\)While hourly compensation costs in China’s manufacturing sector increased rapidly, the Chinese’s average hourly manufacturing compensation in 2004 was only U.S.$0.67, about 3% of the USA’s average (U.S.$22.87)(Lett and Banister, 2006).
This paper attempts to shed some light on this debate. We estimate the maximum wage a firm can afford to pay given its market access to world demand and its internal migrant labor supply. Market access\textsuperscript{5} measures the export demand each entity faces given its geographical position and that of its trading partners (Harris, 1954; Redding and Venables, 2004). Wages are predicted to be higher in central locations, with higher economic activity and demand, and lower in peripheral locations. There is some evidence to support this prediction in China (Lin, 2005), since wages in coastal provinces with good market access, like Fujian, Guangdong and Shanghai, are a factor two higher than the national average.\textsuperscript{6} This upward trend may erode the once unbeatable China price. Internal migrant labor supply measures the additional labor supply each entity faces due to internal migration across provinces. Formally, internal migration is restricted through the hukou system of household registration (see Au and Henderson, 2006). In practice, the system has largely broken down due to more relaxed migration policies (Shen, 1999) and the coastal provinces have proposed its abolition to encourage labor migration from poorer regions.

We build on the models of the New Economic Geography (NEG) (Fujita et al., 1999) to derive an econometric specification. This economic structure makes it possible to estimate both the effect of the market access and that of internal migration on wages. Controlling for these two factors relates our paper to two different strands of the economic literature:

\textsuperscript{5}The literature also refers to market potential (Harris, 1954; Hanson, 2005) or real market potential (Head and Mayer, 2006).

\textsuperscript{6}China started to try out a labor contract system in the mid-1980s, and energetically promoted it in the 1990s. In 1993, the Chinese government began to reform the social relief system in cities, at the same time seeking to try out a minimum living standard security system. To date, China’s 31 provinces, autonomous regions and municipalities have set up minimum wage systems and all, except the Tibet Autonomous Region, have issued a minimum wage, with Shenzhen boasting the highest monthly level of 600 yuan (US$73), Shanghai 570 yuan (US$69) and Beijing 495 yuan (US$60). Different standards between areas within a single province, municipality or autonomous region are allowed.
the NEG and labor economics.

The growing empirical literature on the NEG supports the evidence that regional wages are an increasing function of the region’s market access (Hanson, 2005; Head and Mayer, 2006; Redding and Venables, 2004). By focusing on such demand forces, part of the literature lets aside labor supply factors. For instance, Redding and Venables (2004) and Head and Mayer (2006) explicitly assume that workers are immobile across regions.7 Introducing labour mobility is a more realistic assumption but does not alter the main result of the literature stating that income per capita is higher in places enjoying better market access (Hanson, 2005; Ottaviano and Pinelli, 2006).8 Moreover, the worker’s mobility assumption endogenizes migration, by eliminating differences in real wages (see Puga, 1999), and thus rules out the estimation of the direct effect of migration on wages. We thus assume that in short-run labour is immobile across regions due to some frictions in labour mobility. We then depart from this equilibrium and work out the effects of an immigrant labor supply shock on wages.

Labor economics investigates the impact of such a shift on wages. Thus, recent papers document a negative effect on the wages of competing native workers, with mixed magnitudes: large (Borjas, 2003) or small (Card, 2001).9 While most papers use a microeconomic perspective and highlight the importance to control for education and labor

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7Head and Mayer (2006) investigates the relationship between market potential and wages in Europe and considers that migration between regions in different EU nations is small enough to be approximated as zero.
8Hanson (2005) assumes that workers are mobile across US counties and controls for the migration impact on market potential through housing stocks. Ottaviano and Pinelli (2006) extend the set-up of Redding and Venables (2004) by introducing labour mobility à la Hanson (2005) to measure regional economic performance. However, their wage estimation does not explicitly control for labour mobility factors.
9Ottaviano and Peri (2006) challenge these results. They find positive effects of immigration on native wages by remeasuring the usual assumption that foreign- and home-born workers are perfect substitutes within the same education-experience group and by considering the response of physical capital to immigration.
shift, they mostly assume that demand remains constant across time periods.\textsuperscript{10} In the present paper, we relax this assumption and control for a varying market access variable.

To this end, we estimate a theoretical trade equation on the domestic and international trade of provinces. Thus, we construct a complete version of the province’s market access, consisting of three parts: its local market access (intra-provincial demand), its national market access (demand from other Chinese provinces), and its world market access.

Using a data set covering 29 Chinese provinces between 1995 and 2004, we investigate the respective contribution of our constructed market access and internal migration as determinants of the average provincial manufacturing wage. The empirical results, based on the instrumental variable estimator, show that market access and internal migration have statistically significant effects on the provincial wage level. We find evidence that the magnitude of the internal migrant labor supply estimate exerts a downward pressure on wages and offsets the impact of the market access estimate.

The paper is organized as follows. In the next section, we outline the theoretical framework from which the econometric specification used in the subsequent sections is derived. In section (3), we describe the data sources and how main explanatory variables are computed. In section (4), we investigate the respective contribution of market access and internal migration as determinants of wages in China. In section (5), we conclude.

\textsuperscript{10}For example, in a paper related to ours, Ottaviano and Peri (2005) derive a structural NEG model with migration for estimation and analyze the impact of diversity on average wages of US cities by controlling for several demographic controls, linguistic diversity and city and year fixed effects.
2 Theoretical framework

The theoretical framework underlying the empirical analysis borrows from a standard New Economic Geography model (Fujita et al., 1999). Based on this model, we introduce workers’ skill heterogeneity across regions and implement a strategy to estimate the impact of migration on wages.

The economy is composed of \( i = 1, \ldots, R \) regions and two sectors: an agricultural sector \((A)\) and a manufacturing sector \((M)\) interpreted as a composite of manufacturing and service activities.

2.1 Demand side

The agricultural sector produces an homogeneous agricultural good, with constant returns and perfect competition. The manufacturing sector produces a large variety of differentiated goods, with increasing returns and imperfect competition. Every consumer of region \( j \) shares the same Cobb-Douglas preferences for the consumption of both types of goods \((A\) and \(M)\):

\[
U_j = M_j^\mu A_j^{1-\mu}, \quad 0 < \mu < 1, \tag{1}
\]

where \( \mu \) denotes the expenditure share of manufactured goods. \( M_j \) is defined by a constant-elasticity-of-substitution (CES) sub-utility function of \( v_i \) varieties:

\[
M_j = \sum_{i=1}^{R} \left( v_i q_{ij}^{(\sigma-1)/\sigma} \right)^{\sigma/(\sigma-1)} \quad \sigma > 1, \tag{2}
\]

where \( q_{ij} \) represents demand by consumers in region \( j \) for a variety produced in region \( i \) and \( \sigma > 1 \) is the elasticity of substitution. Given expenditures of region \( j \) \((E_j)\) and the c.i.f price of a variety produced in \( i \) and sold in \( j \) \((p_{ij})\), the standard two-stage budgeting
procedure yields the following CES demand $q_{ij}$:

\[ q_{ij} = \mu \, p_i^{-\sigma} \, G_j^{\sigma-1} \, E_j, \]

where $G_j$ is the CES price index for manufactured goods, defined over the c.i.f. prices:

\[ G_j = \left[ \sum_{i=1}^{R} v_i p_i^{-\sigma} \right]^{1/1-\sigma}. \]

### 2.2 Supply side

Delivering manufactured products from one region to another is costly. The iceberg transport technology assumes that $p_{ij}$ is proportional to the mill price $p_i$ and shipping costs $T_{ij}$, so that for every unit of good shipped abroad, only a fraction $(1 - T_{ij})$ arrives. Thus, the demand for one variety produced in $i$ and sold in $j$ (eq. 3) can be written as:

\[ q_{ij} = \mu \left( p_i T_{ij} \right)^{-\sigma} \, G_j^{\sigma-1} \, E_j. \]

To determine the total sales, $q_i$, of a representative firm of region $i$ we sum sales across regions, given that total shipments to one region are $T_{ij}$ times quantities consumed:

\[ q_i = \mu \sum_{j=1}^{R} \left( p_i T_{ij} \right)^{-\sigma} \, G_j^{\sigma-1} \, E_j T_{ij} = \mu p_i^{-\sigma} M A_i, \]

where

\[ M A_i = \sum_{j=1}^{R} T_{ij}^{1-\sigma} \, G_j^{\sigma-1} \, E_j, \]

represents the market access of each exporting region $i$ (RV, 2004: 59). Each firm $i$ has profits $\pi_i$, assuming that the only input is labor:

\[ \pi_i = p_i q_i - w_i \ell_i, \]
where \( w_i \) and \( \ell_i \) are the wage rate and the labor demand for manufacturing workers, respectively.\(^{11}\) We follow Head and Mayer (2006) in taking into account workers’ skill heterogeneity.\(^{12}\) We assume that labor requirement, \( \ell \), depends on both output, \( q \), and workers’ education level, \( h \), as follows:

\[
\ell_i = (F + cq_i) \exp(-\rho h_i),
\]

(9)

where \( F \) and \( c \) represent fixed and marginal requirements in “effective” (education-adjusted) labor units. \( \rho \) measures the return of education and indicates the percentage increase in productivity due to an increase in the average enrollment rate in institutions of higher education. Replacing (9) in (8) and maximizing profits gives the familiar mark-up pricing rule:

\[
p_i = \frac{\sigma}{\sigma - 1} w_i c \exp(-\rho h_i),
\]

(10)

for varieties produced at region \( i \). Given the pricing rule, profits are:

\[
\pi_i = w_i \left[ cq_i \left( \frac{\exp(-\rho h_i)}{\sigma - 1} \right) - F \exp(-\rho h_i) \right].
\]

(11)

We assume that free entry and exit drive profits to zero. This condition implies that equilibrium output of any firm is:

\[
q^* = \frac{F(\sigma - 1)}{c}.
\]

(12)

Using the demand function (6), the pricing rule (10) and the output equilibrium (12), we determine the manufacturing wage equation when firms break even:

\(^{11}\)Perfect competition in the agricultural sector implies marginal cost pricing so that the price of the agricultural good \( p^A \) equals wages of agricultural laborers \( w^A \). We choose good \( \bar{A} \) as a numeraire, so that \( p^A = w^A = 1 \).

\(^{12}\)The importance of spatial differences in the skill composition of the work force as an explanation for spatial wage disparities is analyzed in detail in Combes et al. (2004).
\[ w_i = \frac{\sigma - 1}{\sigma c \exp(-\rho h_i)} \left[ \mu M \bar{A}_i \frac{c}{F(\sigma - 1)} \right]^{1/\sigma}. \]  

(13)

2.3 Deviation from the short-run equilibrium

Even if the model lacks any explicit dynamics, it is useful to consider that wage equation (13) is determined in a short-run equilibrium, which takes as given the allocation of workers in each region.\(^{13}\) This equilibrium is consistent with the existence of some short-run frictions in labor mobility across regions.\(^{14}\) The associated labor equilibrium input varies across regions, such as:

\[ \ell_i^* = \sigma F \exp(-\rho h_i). \]  

(14)

We now aim to work out the effects of an immigrant labor supply shock on wages, given that in the long-run migration is endogenized. To this end, we turn equation (14) around and express fixed requirements as:

\[ F = \frac{\ell_i^*}{\sigma \exp(-\rho h_i)}. \]  

(15)

Replacing (15) in the wage equation (13) gives:

\[ w_i = (\sigma - 1) \frac{\sigma - 1}{\sigma c \exp(-\rho h_i)} \left[ \mu M \bar{A}_i \frac{c}{F(\sigma - 1)} \right]^{1/\sigma} \ell_i^* \frac{1}{\sigma}. \]  

(16)

We take logs and rearrange equation (16):

\[ \ln w_i = \alpha_0 + \alpha_1 \ln M A_i + \alpha_2 h_i + \alpha_3 \ln \ell_i^* + \epsilon_i, \]  

(17)

\(^{13}\)This assumption defines a Marshallian short-run equilibrium (see Krugman, 1991).

\(^{14}\)Even if the volume of internal migration has been increasing in China due to more relaxed migration policies, the hukou system of household registration still restricts labor mobility across regions. Such frictions are also documented in the Indonesian (Amiti and Cameron, 2007) and European contexts (Puga, 1999; Head and Mayer, 2006).
where \( \alpha_0 = \frac{\sigma - 1}{\sigma} \ln(\sigma - 1) + \frac{1}{\sigma} \ln \mu + \frac{1}{\sigma} \ln \sigma, \alpha_1 = \frac{1}{\sigma}, \alpha_2 = \frac{\sigma - 1}{\sigma} \rho, \alpha_3 = -\frac{1}{\sigma}. \)

Following Friedberg (2001) and Borjas (2003) methodology on the effect of immigration on wages, we depart from the market equilibrium situation \( \ell^*_i \) and assume an exogenous influx of immigrant labor supply \( m_i \) in region \( i \). The resulting rate of change of labor supply due to immigration is given by \( m_i/\ell_i \approx \ln(\ell_i + m_i) - \ln(\ell_i) \). Using this information, we work out the temporary effect of an exogenous inflow of immigrants by estimating the following equation:

\[
\ln w_i = \alpha_0 + \alpha_1 \ln MA_i + \alpha_2 h_i + \alpha_3 \frac{m_i}{\ell_i} + \epsilon_i. \tag{18}
\]

Equation (18) relates regional manufacturing wage to its market access, its educational attainment, the rate of change of labor supply due to immigration and the usual error term \( \epsilon_i \).

### 3 Empirical framework

Using equation (18), the core empirical part of this paper explains the variance of the average provincial manufacturing wages in China. Before proceeding to estimations, we first describe data sources of the explained variable and explain how explanatory ones are constructed. Appendix A provides in greater detail the data sources.

#### 3.1 Explained variable

The set of regions under investigation includes 29 Chinese provinces between 1995 and 2004.\(^{15}\) Our explained variable is the average provincial manufacturing wage rate of

\(^{15}\)The entire country is divided into 27 provinces plus four province-status “super-cities” – Beijing, Chongqing, Shanghai and Tianjin. Our analysis covers all provinces but Tibet, Chongqing and Sichuan.
workers and staff defined as the ratio of the wage bill over the number of workers and staff in the province.

### 3.2 Explanatory variables

We detail here the construction of the market access and the immigrant labor supply. We report in the Appendix A details about the other explanatory variables. Table (4), in Appendix D, provides summary statistics on the various explanatory variables.

#### 3.2.1 Construction of market access

We compute the market access of province $i$ by following a strategy, pioneered by Redding and Venables (2004), that exploits the information from a bilateral trade estimation. However, Redding and Venables (2004) simply assume that shipping costs depend on bilateral distance. We instead allow for differentiated trade cost measures depending on whether trade occurs within province/country, between provinces or between countries.

We obtain exports ($X_{ij}$) from $i$ to $j$ by expressing the volume of sales per firm (Eq. 5) in aggregate value:

$$X_{ij} = \mu N_i (p_i T_{ij})^{1-\sigma} G_j^{\sigma-1} E_j = sc_i \phi_{ij} mc_j,$$

(19)

where $sc_i = n_i (p_i)^{1-\sigma}$ measures the "supply capacity" of the exporting region, $mc_j = G_j^{\sigma-1} E_j$ the "market capacity" of region $j$, and $\phi_{ij} = T_{ij}^{1-\sigma}$ the "freeness" of trade (Baldwin et al., 2003).\(^{16}\) Freeness of trade is assumed to depend on bilateral distances ($dist_{ij}$) and a series of dummy variables indicating whether provincial or foreign borders are crossed.

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\(^{16}\) $\phi_{ij} \in [0, 1]$ equals 1 when trade is free and 0 when trade is eliminated due to high shipping costs and elasticity of substitution ($\sigma$).
\[
\phi_{ij} = \text{dist}_{ij}^{-\delta} \exp \left[ -\varphi B_{ij}^f - \varphi^* B_{ij}^{f*} + \psi \text{Contig}_{ij} - \vartheta B_{ij}^c + \xi B_{ij}^i + \zeta_{ij} \right], \quad (20)
\]

where \( B_{ij}^f = 1 \) if \( i \) and \( j \) are in two different countries with either \( i \) or \( j \) being China and 0 otherwise, \( B_{ij}^{f*} = 1 \) if \( i \) and \( j \) are in two different countries with neither \( i \) nor \( j \) being China and 0 otherwise, \( \text{Contig}_{ij} = 1 \) if the two different countries \( i \) and \( j \) are contiguous, and 0 otherwise, \( B_{ij}^c = 1 \) if \( i \) and \( j \) are two different Chinese provinces and 0 otherwise, \( B_{ij}^i = 1 \) if \( i = j \) denotes the same foreign country and 0 otherwise, and \( \zeta_{ij} \) captures the unmeasured determinants of trade freeness. Consequently, this specification allows for impediments to domestic trade to be different from impediments to international trade\(^\text{17} \) (see Appendix C for details).

Substituting (20) into (19), capturing unobserved exporting (\( \ln sc_i \)) and importing (\( \ln mc_j \)) country characteristics à la Redding and Venables (2004) with exporting and importing fixed effects (\( cty_i \) and \( ptn_j \)) and taking logs yields the following trade regression:

\[
\ln X_{ij} = cty_i + ptn_j - \delta \ln \text{dist}_{ij} + \varphi B_{ij}^f + \varphi^* B_{ij}^{f*} + \psi \text{Contig}_{ij} - \vartheta B_{ij}^c + \xi B_{ij}^i + \zeta_{ij}. \quad (21)
\]

Using our complete dataset of trade, we estimate (21) on a yearly basis from 1995 to 2002 to construct predicted values for market access:\(^\text{18} \)

\[
\overline{MA}_i = \hat{\phi}_i G_i^{\sigma-1} E_i + \sum_{j \in P} \hat{\phi}_{ij} G_j^{\sigma-1} E_j + \sum_{j \in F} \hat{\phi}_{ij} G_j^{\sigma-1} E_j
\]

\[
= \exp (ptn_i) \times \text{dist}_{ii}^{-\delta} + \sum_{j \in P} \exp (ptn_j) \times \text{dist}_{ij}^{-\delta} \times \exp (\vartheta)
\]

\[
+ \sum_{j \in F} \exp (ptn_j) \times \text{dist}_{ij}^{-\delta} \times \exp (\hat{\varphi} + \hat{\psi} \text{Contig}_{ij}),
\]

where \( P \) and \( F \) stand for Chinese provinces and foreign countries, respectively.\(^\text{19} \)

\(^\text{17} \)This is in line with empirical evidence in China (Poncet, 2003)

\(^\text{18} \)Results for 1995, 1999 and 2002 are reported in Appendix C.

\(^\text{19} \)Importer and exporter fixed effects are included in the regression so that the border effect within
elasticity of distance and the impact of contiguity are in line with related literature. We also confirm that the border effect inside China is important (Poncet, 2003). Furthermore, we find impediments to trade to be greater between China and the rest of the world than between countries included in our sample (which are mostly members of the WTO and are therefore much more integrated in the world economy than China in the 1990s).

Figure 2 in Appendix C plots the market access of provinces as a function of their average wage in 1995 and 2002. We observe high market access for high-wage provinces which is in line with the theoretical prediction of the NEG models.

3.2.2 Immigrant share

The rate of change of labor supply due to immigration is given by the internal migration share \((\frac{m}{t})\). We rely on the annual Sample Survey on Population Changes to compute this share as non-residents over population.\(^{20}\) We actually assume that the number of non-residents in a province is a good proxy for the immigrant labor supply \((m_i)\). Non-residents in a province are defined as population living in “township, towns and street communities with permanent household registration elsewhere, [and] having been away from that place for less than one year”.

4 Results

We now proceed to the estimation of the wage equation derived in section (2.3). We run Eq. (18) for 29 provinces and the period (1995-2004). Table (1) reports the results of this foreign countries \((-\delta \ln dist_{ij} + \xi)\) is captured by their fixed effects. The reference category in the regression is within Chinese province trade.

\(^{20}\)Results remain unchanged if we use the number of permanent residents in a province as a proxy for \((t_i)\). They are available upon request. Permanent residents are defined as population “residing in township, towns and street communities with permanent household registration there”, i.e. in province \(i\).
baseline specification, which explains a large part of the variance of provincial wages.

Column (1) reports the OLS estimation of Eq. (18) without the immigrant share but with additional controls to account for the province-status of “super-cities” (municipality),\textsuperscript{21} the number of Special Economic Zones (SEZ)\textsuperscript{22} and the features of coastal and western provinces compared to interior regions.\textsuperscript{23} Market access, on the right hand side of the estimated equation, represents a weighted sum of regional expenditures. Those expenditures depend on incomes, and therefore on wages, raising a concern of a reverse causality. A positive shock to \( w_i \) will raise \( E_i \) and consequently increase \( MA_i \) (Head and Mayer, 2006).\textsuperscript{24} To deal with this problem we first follow Redding and Venables (2004) and lag the market access variable two years to abstract from contemporaneous shocks that affect both left- and right-hand side variables. Later, we devise an instrumental variable strategy.

Estimates of column (1) are worth interpreting. Holding other factor constant, a 10% increase of market access raises wages on average by about 1%. Besides, a point increase in the ratio of the number of students enrolled in institutions of higher education to the population raises wages roughly by 28%.\textsuperscript{25} All additional controls enter positively and significantly, attesting to the wage premium that characterizes the three province-status

\textsuperscript{21} The three province-status cities (Beijing, Shanghai and Tianjin) may display very specific features such as smaller surface area, more developed transport infrastructure but also higher proximity to administrative power. Municipality\( _i \) is a binary variable which is unity if \( i \) is one of the three province-status cities.

\textsuperscript{22} Three SEZ were opened in 1980 in Guangdong province and one in Fujian province in 1981. These open areas adopted preferential policies so that they played the role of windows in developing the foreign-oriented economy, generating foreign exchanges through exporting products and importing advanced technologies. SEZ\( _i \) is computed as the number of Special Economic Zones in a province (0, 1, 2 or 3).

\textsuperscript{23} Coastal\( _i \) is a binary variable which is unity if \( i \) is a coastal province and West\( _i \) is a binary variable which is unity if \( i \) is a western province.

\textsuperscript{24} This will be all the more problematic since \( \phi_{ij} < \phi_{ii} \). In case of extremely high inter-provincial transport costs (\( \phi_{ij} = 0, \forall i \neq j \)), only the local expenditure enters \( MA_i \).

\textsuperscript{25} In terms of beta coefficients, a one standard deviation increase in the higher education ratio raises wages roughly by .06 standard deviation.
Table 1: Manufacturing wage equation

<table>
<thead>
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<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
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<td>0.16***</td>
<td>0.15**</td>
<td>0.16**</td>
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<td>-0.00</td>
<td>-0.00</td>
<td>-0.00</td>
<td>-0.00</td>
<td>0.01</td>
</tr>
<tr>
<td>Year 1998-dummy b</td>
<td>0.17</td>
<td>0.17</td>
<td>0.17</td>
<td>0.17</td>
<td>0.17</td>
<td>0.18</td>
</tr>
<tr>
<td>Year 1999-dummy</td>
<td>0.28***</td>
<td>0.29***</td>
<td>0.29***</td>
<td>0.29***</td>
<td>0.29***</td>
<td>0.31***</td>
</tr>
<tr>
<td>Year 2000-dummy</td>
<td>0.41***</td>
<td>0.67***</td>
<td>0.63***</td>
<td>0.60***</td>
<td>0.65***</td>
<td>0.75***</td>
</tr>
<tr>
<td>Year 2001-dummy</td>
<td>0.49***</td>
<td>0.67***</td>
<td>0.63***</td>
<td>0.61***</td>
<td>0.64***</td>
<td>0.70***</td>
</tr>
<tr>
<td>Year 2002-dummy</td>
<td>0.59***</td>
<td>0.67***</td>
<td>0.67***</td>
<td>0.66***</td>
<td>0.68***</td>
<td>0.71***</td>
</tr>
<tr>
<td>Year 2003-dummy</td>
<td>0.72***</td>
<td>0.80***</td>
<td>0.80***</td>
<td>0.80***</td>
<td>0.80***</td>
<td>0.84***</td>
</tr>
<tr>
<td>Year 2004-dummy</td>
<td>0.84***</td>
<td>0.93***</td>
<td>0.93***</td>
<td>0.93***</td>
<td>0.93***</td>
<td>0.97***</td>
</tr>
<tr>
<td>Adj. R-squared</td>
<td>0.92</td>
<td>0.80</td>
<td>0.87</td>
<td>0.88</td>
<td>0.85</td>
<td>0.79</td>
</tr>
<tr>
<td>Durbin-Wu-Hausman test</td>
<td>17.01</td>
<td>18.07</td>
<td>17.29</td>
<td>18.51</td>
<td>26.09</td>
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<tr>
<td>[p-value]</td>
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<td>[0.00]**</td>
<td>[0.00]**</td>
<td>[0.00]**</td>
<td>[0.00]**</td>
<td>[0.00]**</td>
</tr>
<tr>
<td>Hansen J Statistic</td>
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<td>3.74</td>
<td>4.57</td>
<td>3.23</td>
<td>1.01</td>
<td></td>
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<tr>
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<td>[0.33]</td>
<td>[0.52]</td>
<td>[0.91]</td>
<td></td>
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<tr>
<td>[p-value]</td>
<td>[0.00]**</td>
<td>[0.00]**</td>
<td>[0.00]**</td>
<td>[0.00]**</td>
<td>[0.00]**</td>
<td>[0.00]**</td>
</tr>
<tr>
<td>Shea Partial R² (1st-stage) (in %)</td>
<td>3.31</td>
<td>6.16</td>
<td>7.00</td>
<td>5.42</td>
<td>4.93</td>
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</tr>
<tr>
<td>Immigrant Share</td>
<td>73.29</td>
<td>72.67</td>
<td>74.24</td>
<td>42.87</td>
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<tr>
<td>Population</td>
<td>7.64</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: Heteroskedastic consistent standard errors in parentheses, with ***, ** and * denoting the significance at 1, 5% and 10% level, respectively. aMarket access is two-year lagged to abstract from contemporaneous shocks that affect both left- and right-hand side variables. bTo save some space, we do not report the constant term and the standard errors of year dummies. Standard errors vary between 0.03 and 0.09 and are available upon request. Col. (1) estimates Eq. (18) without the immigrant share but with additional controls. Columns (2) to (6) include the immigrant share, defined as non-residents over population in col. (2) (3) and (6), as female non-residents over population in col. (4) and as male non-residents over population in col. (5). Instrumental variables (depending on the specification): Immigrant Share, Population, two-years lagged ln(Market Access). Instruments (depending on the specification): area, climate variables (Imigtemp and Imigrain) and their square, two-years lagged population and two-years lagged lma. See text for more details.
“super-cities”, the two provinces hosting SEZs and the coastal and western provinces compared to interior regions.\textsuperscript{26} Year dummy estimates also deserve attention. They are significantly increasing over time suggesting the influence of an upward pressure on wages common to all provinces, like total factor productivity growth.\textsuperscript{27}

In columns (2) to (6), we include the immigrant share variable. Estimations are based on the instrumental variable approach, which allows to control for a potential simultaneity between wages and immigration. The reliability of this method lies on the identification of instruments correlated with the inflow of immigrants but uncorrelated with the error term, i.e. with the unobserved component of wage variation. We use a set of three instruments.

A first source of exogenous variation of emigrants may be found in climate variables (see Roback, 1982). We argue that unfavorable climate conditions in provinces of origin may reinforce the probability of departure of potential migrants. We consider two complementary dimensions of the climate conditions, annual temperature and annual precipitations of major cities. Relying on the 1990 Census (National Bureau of Statistics of China, 1991), we compute for each dimension an annual weighted average of climate conditions for the provinces of origin. The weight is the share of a province of origin $j$ in the total immigration received by province $i$ between 1985 and 1990. More precisely, each instrument, related to the destination province $i$, is computed as:

$$ Imig_{climate_{it}} = \frac{\sum_{j \neq i} climate_{ij} \frac{migration_j}{\sum_{j \neq i} migration_j} }{\sum_{j \neq i} migration_j} $$

\textsuperscript{26}The wage differential between western and interior provinces may be explained by employment opportunities in industries offering high wages and salaries in western China, such as oil and gas companies, as well as border trade companies with Central Asian countries. Note however that this difference is not robust to the instrumental variable estimates (Col. 2-6).

\textsuperscript{27}Recent estimates document that China’s total factor productivity growth has increased at an annual rate of 4% during the period 1993-2004 (Boesworth and Collins, 2006).
with climate being base on the temperature ($Imig_{tempi}$) or the rainfall ($Imig_{raini}$) data. To reinforce the exogeneity of these indicators, we exclude from their computation information on the province $i$. Moreover we introduce in the wage equation the annual averages of temperature and precipitations of major cities of the province $i$ as additional control variables. We thus ensure that the instruments do not simply proxy the climate conditions of the destination province. Since we do not have any a priori on the appropriate specification of the relationship between climate indicators and the share of immigrants in the population of destination, we allow for a quadratic relationship in the instrumental equation. A second source of exogeneity may be found in geographic variables. The surface area of the province of destination, measured in squared kilometers, may influence the extent of immigration and is employed as our third instrument.

The small p-value of the Durbin-Wu-Hausman test, in estimation (2), confirms that the OLS estimator is not consistent and that instrumental variable technique is required. As a precondition for the reliability of the procedure, we check the validity of our instruments with the Hansen test of overidentifying restrictions. Insignificant test statistic indicates that the orthogonality of the instruments to the error term can not be rejected, and thus that our choice of instruments is appropriate. Both tests statistics are reported in the bottom of our result Table (1). The Shea partial $R^2$ is a measure of instrument relevance and takes into account the collinearity between the endogenous variables (Shea, 1997). The Shea $R^2$ is quite low in specification (2) but this was expected since the endogenous variable is already well explained by the included instruments, i.e. the exogenous variables of the second stage regression.\footnote{This might raise a concern for multicolinearity but the auxiliary $R^2$ of the first stage regression, with or without the excluded instruments, is lower than the overall $R^2$ of the second stage.} Moreover, we include the Stock and Wright (2000)
statistic that provide weak-instrument robust inference for testing the significance of the endogenous regressors. We reject the null hypothesis which tests that the coefficients of the excluded instruments are jointly equal to zero.

Estimates confirm a positive influence of market access and education on wages. On the opposite, an increase of the immigrant share, defined as non-residents over residents, imposes a downward pressure on the destination region’s wage. The effect is statistically and economically highly significant. On average, given a one point increase of the immigrant share, average wages decrease by approximately 4% (col. 2). As a consequence, in a context of immigration flows, a manufacturing firm, given its access to markets and other regional characteristics, can afford to pay lower wages.

To ease the interpretation of the results and compare the effects of market access and internal migration on wages, we compute their beta coefficients using estimates of Table (1). Results are reported in Table (2).

<table>
<thead>
<tr>
<th>Dependent Variable:</th>
<th>\text{ln(Marketing wage)}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Column:</td>
<td>(2)</td>
</tr>
<tr>
<td>Method:</td>
<td>IV</td>
</tr>
<tr>
<td>Lagged \text{Ln(Market Access)}</td>
<td>0.554***</td>
</tr>
<tr>
<td></td>
<td>(0.106)**</td>
</tr>
<tr>
<td>Immigrant Share</td>
<td>-0.612***</td>
</tr>
<tr>
<td></td>
<td>(0.231)**</td>
</tr>
<tr>
<td>Obs. Nb</td>
<td>232</td>
</tr>
<tr>
<td>\text{Wald Statistic (H0: } \beta = 0\text{)}</td>
<td>0.14</td>
</tr>
<tr>
<td>\text{[p-value]}</td>
<td>0.704</td>
</tr>
</tbody>
</table>

Notes: \footnote{The column numbers refer to the corresponding columns in Table (1). \footnote{Market access is two-year lagged. Beta coefficients are computed using estimates of Table (1). Heteroskedastic consistent standard errors in parentheses. See text for details.}}

Estimates are now easily comparable in terms of standard deviation increase. Interestingly, we observe that the magnitude of the immigrant share, proxying the internal migrant labor supply, offsets the impact of the market access. The bottom of Table 2)
reports the p-value of the Wald statistic indicating that the difference in both parameter estimates is statistically insignificant.

In column (3) of Table (1), we follow Borjas (2003) and address the interpretation problem that arises because a rise in immigrant share can represent either an increase in the number of non-residents or a decline in population. Thus, we add the province’s population level as regressor and the two-year lagged value of population as an additional instrument. Controlling for this size variable does not change much the results. A one standard deviation increase in the immigration share still offsets a one standard deviation increase in market access (column 3, Table 2), even if the former beta coefficient has been reduced.

Current international migration differs from the past mass migration, when immigrants where disproportionately men (Freeman, 2006). As in current international migration, nearly half of current immigrants in China are women (see Table 4 in Appendix D). Our results still hold if we take account of this new trend and redefine in Table (1) the immigrant share as female non-residents over population in column (4) and as male non-residents over population in column (5). In both cases, the effect of migration offsets the positive estimate of market access.

In the last column of Table (1), we address the simultaneity problem of market access and wages and devise an instrumental variable strategy. The literature so far has attempted to resolve this simultaneity problem by isolating variations in market access through geographic variables. While Redding and Venables (2004) use the distance to the nearest central place (Brussels, New York City, or Tokyo), Head and Mayer (2006) use measures of “centrality” of locations obtained by dividing the surface of the globe
in approximately 11,700 squares. Both measures can reasonably be assumed to be exogenous to potential shocks on wages since they do not incorporate any information on market sizes of regions. However, they have the disadvantage of being time invariant and as such only explain the cross-section dimension of the market access. Our interest is to account for both within and cross-sectional dimension of our sample. We therefore follow a different approach and rely on an instrument of demand in location $i$ at time $t$ based on the weighted average of yearly variations of the nominal exchange rate $NER$ of importing partners. The instrument for the market access of a Chinese province $i$ is computed as:

$$I_{ma,t} = \sum_j \Delta NER_{ij} \frac{exports_{ij}}{\sum_j exports_{ij}},$$

with $\Delta NER$ being the first difference of the nominal exchange rate between the partner $j$’s currency and the Chinese yuan. The weighting of the $NER_{ij}$ variation is the share of country $j$ in the exports of province $i$ to $j$. To reinforce the exogeneity of the instrument we rely on bilateral trade flows for the year 1995. Since the bilateral exchange rates are similar across Chinese provinces, our instrumentation procedure relies entirely on the heterogeneity of import partners across Chinese provinces. We argue that a nominal devaluation (appreciation) of the country $j$’s currency vis-à-vis the Chinese yuan translates in a reduction (rise) of $j$’s demand (market capacity) for products from China. The impact of that change differs across Chinese provinces depending on the importance of the partner $j$ in the provincial exports.

The high p-value of the Hansen test of overidentifying restrictions indicates that our instrumentation strategy seems appropriate. It is worth noting that the estimates of the market access variable is now much higher (column 6, Table 1). However, the immigrant
share impact still offsets the increasing effect of the world demand. The Wald statistic reported at the bottom of Table 2 indicates that the difference in both parameter estimates is statistically insignificant.

5 Conclusion

This paper examines the importance of economic geography and migration in explaining the spatial structure of wages in China. Our econometric specification relates wages to a transport cost weighted sum of demand in the surrounding locations and to migratory inflows. We estimate the maximum wage a firm can afford to pay, given its market access and immigrant labor supply. Investigations of the determinants of wage are made on a sample of 29 Chinese provinces between 1995 and 2004. Both market access and migration have statistically significant effects on the wage level. The magnitude of the immigrant labor access offsets the impact of market access and exerts a downward pressure on wages.

References


Appendix A: Description of Data

This appendix describes data sources and explains the construction of the indicators used in the estimations.

Data sources

Various data sources are used to estimate the trade equation on both international and intra-national trade flows for China and its foreign partners. The wage equation relies on various indicators built from the China Statistical Yearbooks which provide average wage of formal employees, population and migration figures. All these economic indicators are at the provincial level, including the province-status municipalities.

A-1 International Data

- International trade flows are in current USD and come from the IMF Direction of Trade Statistics (DOTS).

- Intra-national trade flows are in current USD and are calculated as the difference between domestic primary and secondary sector production minus exports (Wei, 1996).

Production data for OECD countries come from the OECD STAN database. For other countries, ratios of industry and agriculture output in percentage of GDP are extracted from Datastream. They are then multiplied by the associated country GDP (in current USD) coming from the World Development Indicators 2005.

A-2 Chinese Data

A-2-1 Trade flows data

Intra-provincial trade flows

Intra-provincial flows are computed using Wei (1996)’s method. Production data for Chinese provinces are computed as the sum of industry and agriculture output. Output in yuan are converted into current USD using the annual exchange rate. All statistics come from the China Statistical Yearbooks.

Inter-provincial trade flows

Provincial input output tables\(^{20}\) provide the decomposition of provincial output, international and domestic trade of tradable goods. Domestic trade flows, that is trade between each province and the rest of China, were obtained for the year 1997.\(^{30}\)

\(^{20}\)Most Chinese provinces produced input-output tables for 1997. A few of them are published in provincial statistical yearbooks. We obtained access to final-demand columns of these matrices from the input output division in China’s National Bureau of Statistics.

\(^{30}\)IO tables are available for 29 provinces as data are missing for Tibet and Hainan. Four provinces (Anhui, Heilongjiang, Shandong and Guizhou) list only net outflows and are thus not useful for studying inter-provincial trade. Nine provinces separate inflows and outflows into domestic and foreign sectors. Poncet (2005) deduced domestic trade flows for the other provinces using industry-level provincial import
The rest of China, denoted by \( \text{roC} \), differs for each province considered and can be thought of as a distinct country whose characteristics (distance to partners \( d_{i-\text{roC}} \)) are generated on the basis of the characteristics of the provinces that make it up. See Poncet (2005) for more details.

**Provinces' international trade flows**

The provincial foreign trade data are obtained from the Customs General Administration database, which recorded the value of all the import or export transactions through the customs. Provincial imports and exports are decomposed into up to 230 international partners. The background of this database has been discussed in Lin (2005) and Feenstra, Hai, Woo and Yao (1998).

Exchange rate is the average exchange rate of renminbi against the US dollar in the China Exchange Market. It comes from the China Statistical Yearbook.

**A-2-2 Other data**

**Manufacturing wages**

Average wage of manufacturing workers and staff refers to the average wage in money terms per person during certain periods of time for workers and staff in enterprises, institutions, and government agencies. This measures reflects the general level of wage income during a certain period of time.

**Education Level**

The education level is computed as the ratio of the number of students enrolled in institutions of higher education to the population. Institutions of higher education refer to establishments set up according to government evaluation and approval procedures, enrolling graduates from high schools and providing higher education courses and training for senior professionals. They include full-time universities, colleges, and higher/further education institutes.

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and export data from the General Administration of Customs. These data match data reported as international trade by provinces that separate international and domestic transactions in their input-output tables. This finding gives some confidence in the method used as input-output tables and customs data appear to use consistent methodology.
Appendix B: Wage growth

Figure 1: Average real manufacturing wage (1996-2004)
Appendix C: Construction of market access

Bilateral trade flows data

To get market potential measures for each region we rely on different types of relationships: intra-provincial flows, inter-provincial flows, international flows of Chinese provinces, international flows of foreign countries as well as intra-national flows of foreign countries. Thus, we rely on several data sources to cover (i) intra-provincial (or intra-national), (ii) inter-provincial and (iii) international flows. See appendix A for details.

(i) Intra-provincial flows or foreign intra-national flows, i.e. exports to itself, are computed following Wei (1996) as domestic production minus exports.

(ii) Inter-provincial trade is computed as trade flows between provinces.

(iii) International flows comprise trade of provinces with around 200 foreign countries, as well as trade between foreign countries.

These relationships are all merged into a unique dataset which allows computing market capacities of provinces and foreign countries based on their exports to all destinations (domestic and international).

Freeness of trade

The freeness of trade ($\phi_{ij}$) is assumed to depend on bilateral distances ($dist_{ij}$) and a series of dummy variables indicating whether provincial or foreign borders are crossed.

$$\phi_{ij} = dist_{ij}^{-\delta} \exp \left[ -\varphi B_{ij}^f - \varphi^* B_{ij}^{f^*} + \psi_{Contig_{ij}} - \vartheta B_{ij}^c + \xi B_{ij} + \zeta_{ij} \right],$$

We distinguish different cases, according to whether $i$ and $j$ are provinces or foreign countries. Literally this equation says that we allow for differentiated transport costs depending on whether trade occurs between a Chinese province and foreign countries ($-\delta \ln dist_{ij} - \varphi + \psi_{Contig_{ij}}$), between two foreign countries ($-\delta \ln dist_{ij} - \varphi^* + \psi_{Contig_{ij}}$), between a Chinese province and the rest of China ($-\delta \ln dist_{ij} + \vartheta$), within foreign countries ($-\delta \ln dist_{ij} + \xi$) or within Chinese provinces ($-\delta \ln dist_{ij}$). In these last two cases, only internal distance affects trade freeness. Accessibility of a Chinese province or a foreign country to itself is modeled as the average distance between producers and consumers in a stylized representation of regional geography, which gives $\phi_{ii} = dist_{ii}^{-\delta} = (2/3\sqrt{area_{ii}/\pi})^{-\delta}$, where $\delta$ is the estimate on distance in the trade equation.

Note that being neighbors dampens the border effect ($Contig_{ij} = 1$ for pairs of partners that are contiguous) and that $\zeta_{ij}$ captures the unmeasured determinants of trade freeness, which is assumed to be an independent and zero-mean residual.
### Table 3: Trade equation estimations

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<th>Columns</th>
<th>Dependent Variable: Ln(Exports)</th>
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<td>1999</td>
</tr>
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<td>Exporter fixed effects</td>
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<tr>
<td>Importer fixed effects</td>
<td>yes</td>
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<tr>
<td>Foreign country</td>
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</tr>
<tr>
<td>Border Effect</td>
<td>Chinese</td>
</tr>
<tr>
<td>Border Effect</td>
<td>-1.77 (0.56)**</td>
</tr>
<tr>
<td>Border Effect</td>
<td>Contiguity</td>
</tr>
<tr>
<td>Observations Nb</td>
<td>21 142</td>
</tr>
<tr>
<td>R-squared</td>
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Heteroskedastic consistent standard errors in parentheses, with ***, ** and * denoting the significance at 1, 5 and 10% level.
Composition and evolution of market access

Figure 2 plots market access of provinces as a function of their average wage. This is done separately for the two extreme years of our available data (1995 and 2002). Large market potential is found for high-wage provinces which is in line with the theoretical prediction of the NEG models.

Figure 2: Market access and average wage (1995 and 2002)
## Appendix D: Summary statistics

### Table 4: Summary Statistics on indicators, 1995-2004

<table>
<thead>
<tr>
<th>Dependent Variable:</th>
<th>Obs</th>
<th>Mean</th>
<th>St. Dev.</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
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<td>Manufacturing Wage</td>
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<td>9.431</td>
<td>3.714</td>
<td>3.903</td>
<td>27.456</td>
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<td>ln(Manufacturing Wage)</td>
<td>232</td>
<td>9.08</td>
<td>0.36</td>
<td>8.27</td>
<td>10.22</td>
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<table>
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<tr>
<td>Market Potential&lt;sup&gt;a&lt;/sup&gt;</td>
<td>232</td>
<td>0.01</td>
<td>0.02</td>
<td>0.001</td>
<td>0.18</td>
</tr>
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<td>ln(Market Potential)&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>-5.51</td>
<td>1.23</td>
<td>-7.22</td>
<td>-1.72</td>
</tr>
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<td>Education</td>
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<td>0.07</td>
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<td>0</td>
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<td>West</td>
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<td>0.45</td>
<td>0</td>
<td>1</td>
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<td>Rain</td>
<td>232</td>
<td>886</td>
<td>530</td>
<td>134</td>
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<td>Temperature</td>
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<td>Non-Residents (1)</td>
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<td>339</td>
<td>299</td>
<td>12.6</td>
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<td>Female non-Residents (2)</td>
<td>232</td>
<td>165</td>
<td>146</td>
<td>6.6</td>
<td>1,262</td>
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<td>Male non-Residents (3)</td>
<td>232</td>
<td>171</td>
<td>154</td>
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<td>Population (4)</td>
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<td>2,804</td>
<td>482.30</td>
<td>11,847</td>
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<table>
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<th></th>
<th></th>
</tr>
</thead>
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<tr>
<td>(1)/(4)</td>
<td>232</td>
<td>8.69</td>
<td>6.12</td>
<td>1.30</td>
<td>34.18</td>
</tr>
<tr>
<td>(2)/(4)</td>
<td>232</td>
<td>4.25</td>
<td>2.85</td>
<td>0.68</td>
<td>15.37</td>
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<tr>
<td>(3)/(4)</td>
<td>232</td>
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<td>3.30</td>
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Notes: <sup>a</sup>Two-year lagged variables.