Informal self-employment and macroeconomic fluctuations

Norbert M. Fiess, Marco Fugazza, William F. Maloney

Abstract

Informal self-employment is a major source of employment in developing countries. Its cyclical behavior is important to our understanding of the functioning of LDC labor markets, but turns out to be surprisingly complex. We develop a flexible model with two sectors: a formal salaried (tradable) sector that may be affected by wage rigidities, and an informal (non tradable) self-employment sector faced with liquidity constraints to entry. This labor market is then embedded in a standard small economy macro model. We show that different types of shocks interact with different institutional contexts to produce distinct patterns of comovement between key variables of the model: relative salaried/self-employed incomes, relative salaried/self-employed sector sizes and the real exchange rate. Model predictions are then tested empirically for Argentina, Brazil, Colombia and Mexico. We confirm episodes where the expansion of informal self-employment is consistent with the traditional segmentation views of informality. However, we also identify episodes where informal self-employment behaves “pro-cyclically” here, informality is driven by relative demand or productivity shocks to the non tradable sector.

Keywords: Informality, Labor market dynamics, Self-employment, Real exchange rates, Co-integration

1. Introduction

This paper examines the adjustment of informal self-employment, a major component of developing country labor markets, to macroeconomic shocks. It models both the decisions and credit constraints facing heterogeneous workers to enter self-employment, as well as standard labor market rigidities potentially found as impediments to entering the formal sector. Taking advantage of the fact that the vast majority of informal self-employed are found in the non tradable sectors, and most formal in the tradable sector, it then locates this labor market in a standard two sector open economy model. Together, this permits the development of a typology of movements of relative labor shares, relative incomes and the real exchange rate with respect to different sectoral shocks that underlie aggregate business cycles, and degrees of labor market rigidity.

Such an approach is valuable for several reasons. First, the model offers insights into the reasons behind the multiple and shifting patterns of comovement (regimes) of an important component of the informal sector with macroeconomic fluctuations. In particular, it offers an explanation for observed episodes of procyclicality of self-employment which run counter to all existing models of the informal sector. The rationale underlying these pro cyclical movements adds support to an emerging view of informal self-employment that stresses a large voluntary component of entry and hence the desirability of the sector for many workers. However, the model is also general enough to allow for varying degrees of involuntary entry driven by conventional segmentation considerations. In this sense, we offer a very rich and flexible view of the developing country labor market. Second, the derived typology of regimes can be used by analysts and policy makers empirically to exploit the observed comovements of macroeconomic time series for diagnostic purposes: to establish the presence or absence of formal sector segmenting distortions; or to identify the sources of changes in the size of the informal sector. Finally, the framework is flexible enough to incorporate more secular issues of regulation and taxation, and growth that are also relevant to explaining the size of the informal self-employed sector.

1.1. Background

We focus on self-employment, defined in the present case as own account workers as well as owners of firms with under five employees for several reasons. First, in Latin America, the sector accounts for 25 to 50% of employment and in other poorer regions, like Africa, substantially more. Understanding the behavior and raison d’être of
the sector is of clear importance. Second, in the countries we study, the self-employed or micro firm sector is the heart of the informal sector. It has been a longstanding proxy for informality by International Labor Organization and it is highly correlated with informality measured as being unprotected by social and labor protections: In Argentina 75%, Brazil 61%, and Mexico 77% of uncovered workers are found in firms of five or fewer workers and most of these in single person firms, that is, the self-employed. Further, the share of workers that are informal in these firms is over 80%.

The debate over the role of the informal goes back almost half a century. A prominent stream of the literature has intellectual roots perhaps best distilled in Harris and Todaro’s (1970) vision of markets segmented by wage setting in the formal sector that leaves the traditional sector rationed out of modern salaried employment.1 The view of the informal sector as the inferior segment of a dual labor market, expanding during downturns to absorb increased unemployment, became highly influential in the International Labor Organization, its Latin America affiliate, the Latin America Regional Employment Program (PREALC), and the World Bank.2

However, dating at least from Hart’s (1973) work in Africa, a parallel stream has stressed the sector’s dynamism and the likely voluntary nature of much of the entry into informal self-employment.3 Increasingly, theoretical discussions of the sector assume mainstream models of worker sectoral selection, and the firm.4 Still, two of these papers derive and present evidence for the countercyclical nature of informality (Loayza and Rigolini, 2006) or a correlation of informality with unemployment (Boeri and Garibaldi, 2006), consistent with the earlier literature. Were it the focus of his paper, Rauch’s formalization of this more traditional model of markets segmented, in this case, by a minimum wage would generate a similar pattern. However, greater disaggregation of the data suggests more complex patterns of movement of selfinformal employment across macroeconomic fluctuations. In particular, in several country-episodes we study, self-employment appears to be procyclical. As an example, a first look at time series for Mexico suggests cyclical behavior distinct from that of a shock absorber during downturns. Fig. 1a plots the evolution of the relative salaried/informal self-employed sector sizes and GDP growth and shows that during the recovery of 1987–1991 they were negatively correlated. Fig. 1b further shows that across this same period, the earnings of the self-employed relative to formal salaried workers rose. Both are consistent with a procyclical expansion of self-employment. Since over 80% of self-employed are found in domestic services, transportation, commerce, or construction, we argue that that the boom in real estate and other non-tradable industries across this period created new opportunities for micro-entrepreneurs. Contrarily, it is also the case that in the subsequent period leading up to the crisis of 1995, the countercyclical movements envisaged by more traditional segmentation views appear, manifested as a positive co-movement relative salaried/informal self-employed sector sizes and GDP growth (Fig. 1a), as well as a negative co-movement of earnings and labor market sector sizes (Fig. 1b). Similar structural shifts in the relationship between self-employment and growth are visible across the other countries shown in Fig. 1a and b.

We argue that these distinct and changing patterns suggest that the pro- or countercyclicality of the two labor market sectors may depend on the sectoral origin of the shocks, and the presence or absence of binding wage rigidities. That is, a conventional focus on the correlation between self-employment and GDP in the aggregate may conceal important patterns of comovement and hence muddy our understanding of the raison d’être and dynamics of the informal self-employed.

The existence of different regimes with distinct identifying patterns of comovement among a few variables also suggests that time series data on these series may offer potentially useful labor market diagnostics for policy makers, for instance, in identifying the roots of expansion of the informal sector across a given period: That is, it could shed light on whether it is due to more onerous union or legislation induced rigidities that may require politically costly reforms to offset, or alternatively a construction boom, or simply a slowdown of the formal manufacturing sector that would not. Studying the relationship among three variables easily extracted from repeated cross sections and financial data can offer a wealth of insight into the underlying operation of the labor market that has not been previously possible. It also provides an alternative to the conditional income comparisons commonly used to demonstrate the inferiority of informal work, which are rendered highly suspect by their inability to control for unobserved job and individual effects.5

2. Modeling approach

2.1. The labor market

For such diagnostics to be feasible, we need to understand the drivers of the very large observed movements in relative wages which in a simple textbook world, would be forced to equivalence. Three effects in principle may be at play: barriers to the arbitrage of labor earnings due to barriers to entry to either sector either through quantity or price rigidities, barriers to arbitraging of returns to capital of the self-employed which are generally not separable in labor market surveys from earnings of labor per se, and changes in the skills composition of the sectoral work forces.

To capture these effects, we begin by constructing a model of the labor market in developing countries that is firmly rooted in the established advanced country literature and which enjoys increasing support from the developing country data. We postulate two sectors: a tradable sector where workers receive a wage and are covered by labor legislation or unions that may or may not introduce distortions; and a non tradable self-employed sector of the kind postulated by Lucas (1978) with heterogeneity in level of entrepreneurial ability, and where, credit constraints can constitute a barrier to entry from salaried work. The idea that the self-employed enter voluntarily, but that there may be barriers to salaried workers opening an enterprise enjoys increasing support from the both the economics and sociology literature. To begin, surveys from both Mexico and Brazil suggest that around 70% of the self-employed entered or have remained there voluntarily, largely for reasons of higher incomes or greater flexibility. Indeed, the sociologists Balan, Browning, and Jelin (1973) interviewed Mexican workers and found being one’s own boss to be well regarded and that movements into self-employment from salaried position

1 In fact, in Harris and Todaro’s model, the “traditional” sector was the rural sector disposed to migrate. However, it represents perhaps the first analytically worked out view of the dual labor market and remains highly relevant to the debate over the informal sector and its relative inferiority. See Schneider and Enste (2000) for a more comprehensive review of existing views. A rich theoretical literature is emerging that poses more sophisticated mechanisms that relate informality to unemployment. See, for example, Boeri and Garibaldi (2006).
2 For early statements, see Sethuraman (1981), Tokman (1978), and Mazumdar (1975), respectively.
3 See for more recent formulations in this vein, de Soto (1989), Loayza (1996) and Maloney (1999).
5 See Maloney (1999), and Pratap and Quintin (2006). Total returns to informal self-employment and salaried employment incorporate differences in taxes, risk premia, flexibility, etc., all of which will lead to incomes not being equated, even in the absence of segmentation.
Fig. 1. a). Relative sector shares and GDP growth: Argentina, Brazil, Colombia and Mexico. b). Relative sector shares and earnings, real exchange rate. Argentina, Brazil, Colombia and Mexico.
generally represented an improvement in job status.\textsuperscript{6} Entrants tend not to be misfits or those most likely to be dismissed: Fajnzylber et al. (2006) document that in Mexico, entrants into self-employment tended to have conditionally high wages in their previous job suggesting that they were relatively successful before moving.

Second, Fajnzylber et al. (2006) document patterns of entry into self-employment for Mexico that are very similar to those documented by Evans and Jovanovic (1989) for the US — namely that it increases at a diminishing rate with age. In cross section, a similar pattern across age cohorts of share of the work force in self-employment by age is found across the countries we study suggesting that this is not a Mexico-specific phenomenon (see Perry et al. 2007). Evans and Jovanovic explain this by credit constraints that inhibit less risk averse young people from entering. Again, the sociology literature suggests that such constraints are critical in developing countries as well. As Balan, Browning, and Jelin (1973: page 213) interviews with informal micro firm owners suggest

“First, the man must accumulate capital. This is no easy matter when he has a manual job and must provide for a large family, so it generally takes years to accumulate enough capital. There must be sufficient funds not only to set up the business, but also to keep it going during the months or years while it runs at a deficit.... These kinds of capital requirements are modest enough, but the capital is not easy to come by for the working classes of Monterrey or elsewhere in Mexico.”

As our simplest case, we assume this is the only rigidity and that, otherwise, labor moves freely across sectors although moving back into salaried employment logically would require disinvesting in this capital. However, later we introduce the traditional view of informality as being driven by segmentation inducing regulation such as minimum wages as part of our core specifications.

Critical to our approach is the fact that we can map the informal self-employed to the non tradable sector and the formal salaried to the tradable: the high concentration of the informal self-employed or micro firms in the non tradable sector is 81% in Argentina, 84% in Brazil, 83% in Colombia, and 87% in Mexico. Recent evidence from La Porta and Shleifer (2008) based on World Bank firm level surveys further supports the mapping. It first confirms that informal firms are small in size (on average less than three employees in the Informal Survey and less than four employees in the Micro Survey). Second informal firms are found to export on average only 0.1% of their sales. Clearly, there is another sector comprised of non tradable such as financial services or telecommunications which are likely to be produced by larger formal firms. Modeling this group would add additional complexity without affecting the central intuition. Empirically, though there are some tradable among the informal and some non tradable among the formal, what is important is that the former is relatively more non-traded than the latter.

2.2. The macro context

We then locate this labor market in a standard macroeconomic framework (Obstfeld and Rogoff, 1996) that allows us to capture additional information on the sectoral origin of the shocks through the real exchange rate — a measure of relative prices of tradables and non tradables. This allows us to move beyond simply defining cyclical movements as a deviation from trend and to characterize the nature of the shocks driving it. We are thus able to derive patterns of comovement between the relative returns and relative sizes of salaried and self-employed sectors, and the real exchange rate in response to productivity and demand shocks.\textsuperscript{7}

Finally, we introduce potential wage rigidities in the salaried tradable sector. As in the classic Harris–Todaro formulation, formalized in Rauch (1991), the labor market can become segmented with workers rationed out of salaried/tradable employment and being forced into the self-employed/non tradable sector where earnings adjust to equate labor supply and demand. This segmentation gives rise to distinct patterns of comovement of the three series.

Thus, we provide a very flexible model of a large segment of LDC labor markets that permits developing a typology of comovements of macroeconomic time series that, once identified, can help identify the source of shocks and the presence or absence of formal sector segmenting distortions. Empirically, we employ multivariate co-integration techniques to establish these predicted patterns of comovement and their evolution over the last two decades in Argentina, Brazil, Colombia and Mexico. These countries all have large informal self-employed sectors, and have experienced very large movements in levels of economic activity, the relative sizes of the two labor market sectors, and real exchange rates.\textsuperscript{8}

We confirm episodes of expansion of informal self-employment consistent with the traditional segmentation views. However, we also identify episodes consistent with the sectoral expansion being driven by relative demand or productivity shocks to the non tradable sector that can lead to “procyclical” behavior of the informal self-employed sector.

Two final points are worth noting. First, while the necessary introduction of worker heterogeneity prevents the model from being simple, nor is it especially restrictive and the results do not hinge on unusual assumptions. Fundamentally, we have mapped the two labor sectors to the tradable and non tradable sector of the workhorse open economy macro model and then incorporated a mainstream view of entry into self-employment in the simplest way possible. Though empirically supported, mechanically this has the effect of throwing sand into the labor market so that wages do not adjust instantaneously and we thus generate the observed large swings in relative earnings across sectors in the short run. Adding a standard nominal wage rigidity in the formal sector permits generating a very rich set of relatively intuitive findings that, in the end, are supported by the data.

Second, the model is not at all incompatible with approaches that stress informality as the result of taxation or regulation. To the degree that these represent a reduction in formal sector productivity or change in the relative earnings across sectors, they are easily nestable. Hence, both innovations in this area as well as secular rises in productivity arising from growth fit comfortably with our approach.

3. Model details

We consider the case of a small economy that produces two composite goods, tradable and non tradable. The salaried sector is assumed to produce tradables (T), the numeraire, while the production of non

\textsuperscript{6} Of the moves from formal positions into self-employment they studies, 57% were upward moves in job quality, 30% were horizontal (which they argue was welfare improving because of the greater independence) and only 11% were downward.

\textsuperscript{7} We include utilities, construction, wholesale and retail trade, hospitality, transport, public administration, education, health and social work, community service, private household service, and real estate as non tradables. We assign all of agriculture, fishing, mining, manufacturing, financial intermediary to tradables which probably overstates the share of tradables. These numbers are for firms of under six individuals where possible. The statistics for the self-employed per se are roughly ten percentage points higher. Statistics correspond to most recent available waves of surveys: for Argentina 2003:1 EPH, Brazil PME (2002), Colombian ENH (2004), and Mexico ENEU (2004).

\textsuperscript{8} In Mexico from 1988–1995, Argentina 1990–1995, and Brazil beginning in 1992, the exchange rate appreciated, often dramatically, following stabilization policies that fixed the nominal exchange rate, liberalized capital markets, and implemented other reforms.
tradables is concentrated in the self-employed sector \((N^s)^9\). All workers are homogeneous when salaried. However, following Lucas (1978), self-employed sector individuals \((j)\) differ in terms of entrepreneurial capability, \(\phi_j\) distributed uniformly on \([0, 1]\). For simplicity, we also normalize the labor force to unity so that, provided that the economy is not in a corner solution, the value of entrepreneurial ability of individual \(m\), who is indifferent between salaried work and self-employment, also corresponds to the size of the salaried labor force, \(L_T\). That is, \(\phi_m=\phi^s=L_T\) where \(\phi^s\) is the ability of the individual who is indifferent between self-employment and wage work. Thus, we preserve the overall labor supply constraint while building in a decrease in the marginal entrepreneurial ability as labor shifts toward self-employment. The size of self-employment is referred to as \(L_s\) thereafter.

Tradbale output \(Y_T\) is in CRS in capital \(K_T\) and labor \(L_T\): \(Y_T=A_T F(K_T,L_T)=A_T K_T^{\alpha} L_T^{1-\alpha}\). Production of individual \(j\) in the self-employed sector is given by \(y_j=A_t^s \phi_j k_{t,j}^{\alpha}\).

Labor is supplied inelastically and is mobile across sectors. However, entrepreneurs planning to switch sectors must accumulate or decumulate their capital between two successive periods for self-employed individuals, \(k_T\), is inversely related to the speed of adjustment. \(h(k_t)\), a linear function of capital accumulated by the self-employed individual \(j\). We further assume that individuals willing to leave self-employment must dispose of all the capital they have in place before they become employed in the salaried sector.\(^10\) This specification ensures that the labor market will not adjust fully in one period and that differentials in net remuneration among sectors are not instantly arbitraged by labor flows. This permits us to analyze both steady state movements in relative wages, relative sector sizes and exchange rates, but, also transitional dynamics.

3.1. Production

The representative tradable sector firm maximizes

\[
\max_{0\leq t} \sum_{t=0}^{\infty} \left( \frac{1}{1+r} \right)^{t+1} [A_T F(K_t, L_t)-w_T L_t]-r w_T L_t \]

subject to: \(L_t = K_t + 1-K_t\)

where \(w_T\) is the wage (gross) prevailing in the tradable sector at time \(t=s\). The world interest rate \(r\), expressed in terms of tradables, is assumed to be constant. The first order conditions are standard:

\[
A_T f'(k_t) = r \tag{1}
\]

\[
A_T f'(k_t) - f'(k_t) k_t = w_T \tag{2}
\]

Because \(r\) is the world interest rate expressed in terms of tradables, it must correspond to the marginal product of capital in the salaried/}

\(^9\) As usually assumed, one unit of tradables can be transformed into a unit of capital at no cost. The reverse is also true. Non tradables can be used only for consumption. Capital can be used for production and then consumed (as a tradable) at the end of the same period.

\(^10\) This specification ensures that (de)installation costs are always finite. Further, since marginal costs of capital (de)installation are increasing, capital adjustment will not happen instantaneously.

\(^{11}\) It would be equivalent to consider the case where producers directly borrow capital from the representative consumer and the latter is the one who would take the investment decisions as shown in Obstfeld and Rogoff (1996) chapter 2.5.
The representative consumer faces a lifetime budget constraint
\[
\sum_{s=1}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} (C_{r,s} + pC_{N,s}) = (1 + r)Q_t + \sum_{s=1}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} \times \left( \frac{w_{r,t}L_{r,s} + (1-\alpha_N) \int_p \frac{p_{s,t}A_{s,t}b_{j,s}^{\gamma}k_{j,s}^{\gamma} \phi^\gamma b_{j}}{2} \Delta p_{N,s} \right)
\]
where \( \left( \frac{p}{s} \right)_{N,s} \sum_{s=1}^{\infty} \frac{1}{\phi^s} \int b_{j} \phi^s \) and where national financial wealth \( Q_t = B_t + K_{N,t} + K_{r,t} \) is measured in terms of tradables and \( B_t \) stands for net aggregate holdings of foreign assets, \( I_{N,s} \) represents total investment and \( K_{s,t} \) total capital accumulated in the self-employed sector at date \( s \).

For the general case of a CES utility function\(^{12}\)
\[
\frac{C_t}{C_N} = \frac{y}{(1-y)^{1-p}}
\]
relative intra-temporal consumption depends only on the relative price \( p \) and not upon consumer's spending level where \( y \) indicates the weight of the traded good in the utility function and \( \theta \) represents the (strictly positive) elasticity of substitution between tradable and non-tradable goods.

Moreover
\[
\frac{C_{r,s+1}}{C_{N,s+1}} = \frac{p_{s,t} + 1}{p_{s,t}} \frac{C_{r,s}}{C_{N,s}}
\]
A rise in the relative price of non tradables causes growth in tradables consumption growth relative to non tradables consumption.\(^{13}\)

Since, by assumption non tradables can only be consumed, in equilibrium consumption equals production in the self-employed sector. Substitution and the combination of the Euler equation for tradables consumption with the lifetime budget constraint of the representative consumer yield an expression for the optimal consumption of tradables:
\[
C_{r,t} = \frac{(1 + r)B_t + \sum_{s=1}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} \left( \frac{w_{r,t}L_{r,s} - \frac{1}{2} \gamma \phi^\gamma \Delta p_{N,s} \right)}{\sum_{s=1}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} \left( \frac{p_{s,t}}{p_{s,t}} \right)^{\gamma} \phi^s}
\]
where \( P \) is the price index \( P = [\gamma + (1-\gamma)p^{1-\theta}]^{1/\gamma} \) which is increasing in \( p \).

### 3.3. Properties of the model

Before turning to the dynamics of the economy, we first describe its steady state equilibrium and assess the impact of permanent productivity and consumption shocks. We then introduce a wage rigidity in the salaried sector. The results of all exercises are tabulated in Table 1.

#### 3.3.1. Shocks in the long run

Productivity shocks are represented by a permanent variation in the \( A \) productivity scale coefficients and demand shocks by a permanent variation in the \( \gamma \) parameter. In the following, variables with hats refer to rates of change (\( \hat{x} = \frac{dx}{dt} \)). Log differentiation leads to the following results, assuming that initial \( p = 1 \) and initial \( \gamma \) is equal to one half.

\(^{12}\) See Obstfeld and Rogoff (1996, pp 226–235) for a full derivation.

\(^{13}\) Note that if \( \alpha = \theta \), tradables consumption remains constant along the perfect foresight paths.

<table>
<thead>
<tr>
<th>Table 1 Predicted patterns of comovement among relative earnings, relative sector sizes, and the real exchange rate.</th>
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<tbody>
<tr>
<td>( \Delta(w_{L/Lt}) )</td>
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<tr>
<td>-----------------------------------------------</td>
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<tr>
<td><strong>Short /Medium run</strong></td>
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<td><strong>Long run</strong></td>
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<td>Wage rigidities</td>
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### 3.3.1.1. Relative prices. Differentiating Eq. (4’) and aggregating across all \( j \) gives
\[
\hat{p} + \hat{\Lambda}_N + \hat{\delta} \gamma - (1-\alpha_N) \hat{k}_N = \hat{r} = 0
\]

Although individual ability remains constant by assumption, \( \hat{\delta} = 0 \) and hence the capital growth rate is the same for everyone, the labor reallocation after a shock results in a change in the pivotal individual so that \( \hat{\delta} \) is no longer equal to zero for the labor force as a whole. By the same logic
\[
\hat{p} + \hat{\Lambda}_N + \hat{\delta} \gamma + \hat{\alpha}_N \hat{k}_N = \hat{w}_T
\]
where \( \hat{k} = \hat{k}_N \) and is given by Eq. ((4’)). Defining \( \eta_{LT} = \frac{\hat{w}_T}{\hat{w}_L} \), labors’ share in tradables output, \( \hat{w}_T = \frac{1}{1+\theta} \hat{A}_T \), and then
\[
\hat{p} = \frac{1}{1+\alpha_N} \hat{A}_T \hat{\Lambda}_N
\]
This simply restates the Balassa–Samuelson result that, for values of \( \frac{1}{1+\alpha_N} \) close to 1, the real exchange rate is determined by the relative rates of productivity growth.

#### 3.3.1.2. Relative sector size. Demand for tradables and non tradables can be re-written as,
\[
C_t = \frac{\gamma Z}{\gamma + (1-\gamma)p^{1-\theta}} \quad \text{and} \quad C_N = \frac{p^{-\theta}(1-\gamma)Z}{\gamma + (1-\gamma)p^{1-\theta}}.
\]
where \( Z = w_{L}L_{T} + (1-\alpha_N) \left\{ \int_{\delta}^{p} \frac{p_{s,t}A_{s,t}b_{j,s}^{\gamma}k_{j,s}^{\gamma} \phi^\gamma b_{j}}{2} \Delta p_{N,s} \right\} \).

In order to simplify the analysis we assume that total financial wealth remains constant at \( Q \) across steady states. We assume implicitly that any variation in the total level of physical capital is fully offset by an equal, but opposite variation in foreign assets holdings. That is, with international borrowing, a rise in the stock of physical capital for instance, can be financed by an equal fall in \( B \) without affecting the level of total financial wealth.\(^{14}\) This allows us to write
\[
\hat{Z} = \psi_{LT} [\hat{w}_T + \hat{L}_T] + \psi_{sLT} \left[ \frac{1}{1-\alpha_N} \hat{A}_N + \frac{1}{1-\alpha_N} \hat{p} \right] + \hat{\delta} \gamma \psi_{T}
\]

\(^{14}\) See Obstfeld and Rogoff (1996, chap. 4) for an application.
Changes in non tradables consumption can be written as

\[ \hat{C}_N = -\hat{\gamma} + \hat{Z} - (\hat{\theta} \hat{\gamma} + (1 - \hat{\gamma})) \hat{\rho}, \]

and changes in total production in the self-employment sector (expressed in units of tradables) by

\[ p \hat{Y}_N = \frac{1}{1 - \alpha_N} [\hat{\rho} N + \hat{\dot{\rho}}] - \Psi \hat{\phi}^\ast. \]

Since non tradable goods market equilibrium requires that \( \hat{C}_N = \hat{\gamma}_N \), the entrepreneurial ability of the pivotal worker, and implicitly, the share of the workforce in tradables, can be written as:

\[ \hat{\phi}^\ast = -\Omega_1 \left[ -\hat{\gamma} + \hat{\Delta}_1 \hat{\psi}_{1T} + \hat{\psi}_{1T} - 1 + (1 - \alpha_N)(\hat{\gamma}^2 - 1) + \hat{\Delta}_1(1 - \gamma^2) \right]. \]

where \( \Omega_1 = [(1 - \phi^\ast)(\Psi + \phi^\ast)]^{-1}. \)

3.3.1.3. Relative earnings. The change in self-employment production expressed in tradable units is now:

\[ p \hat{Y}_N = \frac{\hat{\Delta}_1}{(1 - \alpha_N)} [\hat{\rho} N + \hat{\dot{\rho}}] - \Psi \hat{\phi}^\ast. \]

The change in total production also corresponds to the relative variation in total entrepreneurs' earnings, as the latter is a constant proportion of the former. Thus, average informal workers earnings expressed in terms of tradable units \( w_N \) vary according to:

\[ \hat{\psi}_N = \frac{\hat{\Delta}_1}{\hat{\eta}_N} \phi^\ast = \frac{\phi^\ast}{\hat{\eta}_N} \hat{\phi}^\ast = \frac{\hat{\Delta}_1}{\hat{\eta}_N} \]

\[ + \Omega_2 \left[ -\hat{\gamma} + \hat{\Delta}_1 \phi^\ast + \phi^\ast - 1 + (1 - \alpha_N)(\hat{\gamma}^2 - 1) + \hat{\Delta}_1(1 - \gamma^2) \right] \]

where \( \Omega_2 = \frac{\psi^\ast \phi^\ast}{(1 - \phi^\ast)(\Psi + \phi^\ast)} > 0. \) It is straightforward to verify that \( \Omega_3 = \Omega_2. \)

3.3.2. Dynamics

In order to qualify the dynamics of the model in the event of a shock, we linearize the first order conditions for profit maximization by the self-employed around the steady state. The latter being characterized by \( \bar{q} = 1 \) (\( q \) denotes the shadow price of installed capital in non tradables) and, \( \bar{k}_j \) we obtain

\[ k_{j+1} - k_j = \frac{q_j - 1}{\lambda} h(\bar{k}_j); \]

\[ q_{t+1} - q_t = r \left[ (1 - \alpha_N) \frac{h(\bar{k}_j)}{\lambda} \bar{k}_j + 1 \right] (q_j - 1) + r(1 - \alpha_N) \bar{k}_j [(k_{j+1} - \bar{k}_j)]. \]

The equations \( \Delta k_j = 0 \) and \( \Delta q_t = 0 \) characterize the equilibrium dynamics. They are depicted in a two-equation phase diagram in \( q \) and \( k_j \) that shows the dynamics of the investment decisions of self-employed individuals (Fig. 2). The line denoted by SS indicates the perfect foresight path.

As the steady state level of investment chosen by each individual is not identical, we expect to observe that a common shock affects heterogeneous individuals differently. When a shock leads to a contraction of the self-employment sector, for workers whose entrepreneurial ability falls below the threshold steady state value of \( \phi^\ast \) (those who would be better off in the wage work sector), the perfect foresight path leads to zero capital and zero capital shadow value at steady state, as depicted in Fig. 3. Should self-employment expand, new-entrants invest initially \( k_l = \frac{L \alpha}{1 - \alpha} \) independent of the wage prevailing in the salaried sector since the initial shadow value of their capital is above 1 (\( q_0 = 1/r \)). Due to heterogeneous entrepreneurial ability, workers will not all move across sectors in the same period. For instance, in the case of a shock leading to a rise in returns to self-employment, more able entrepreneurs in the salaried sector would move first. A detailed analysis is presented in Appendix A1.

The adjustment to the steady state depends on the relative values of \( \sigma \) and \( \theta \). Indeed, \( C_{it} \) is given by Eq. (7) which suggests that the level of tradables consumption along the saddle path is affected by variations in \( p \) in a manner that could either reinforce or offset the impact of a shock. The impact of a rise in \( p \) on consumption is dampened by consumers’ inter-temporal choices if \( \sigma > \theta \), and amplified if \( \sigma < \theta \). If \( \sigma > \theta \), consumption of non tradables declines slower than consumption of tradables. The opposite occurs if \( \sigma < \theta \). This implies that migration takes longer in a situation when inter-temporal substitution prevails over intra-temporal substitution.

3.4. Responses to productivity and demand shocks

In order to define short/medium term properties we need to qualify “on-impact” effects of various shocks. Short/medium term properties would then reflect variables’ behavior after impact and during the transition towards the new steady state. On impact, levels of production and consumption must remain constant. Thus any wealth effects generated by the shock must be offset by an instantaneous change in prices. In order to simplify the analysis, we assume that changes in wealth occurring on impact reflect only the shock’s direct effects.15 That is, changes in wealth due to subsequent changes in prices are accounted for in the long run. This assumption does not affect qualitatively the properties of the model.

We first assess the impact of permanent productivity and consumption shocks which, as mentioned earlier, could include changes in regulation or taxes. We then introduce wage rigidities in the salaried sector. The results of all exercises as well as their empirically testable counterpart are presented in Table 1.

15 Reference equations for determining on-impact effects become: \( \hat{Z} = \hat{\phi}^\ast \hat{\psi}_T + \frac{\psi^\ast \phi^\ast}{\Psi + \phi^\ast} \hat{\Delta}_0 \) and \( \hat{C}_0 = -\hat{\gamma} + \hat{Z} - (\hat{\theta} \hat{\gamma} + (1 - \hat{\gamma})) \hat{\rho}. \)

3.4.2. Productivity shock to the non tradable sector

A productivity shock to the tradable sector, $\hat{A}_T > 0, \hat{A}_N = 0$ and $\hat{\gamma} = 0$, increases both production of the sector as well as returns to capital and labor. This increases demands for both types of goods and causes the exchange rate to appreciate. Since labor productivity falls below one, it is not very plausible and, while included for completeness they can be disregarded for most practical purposes.

The shadow value of their capital falls below 1 and, as it falls towards zero in the short run they cannot migrate until their capital has been completely dismantled. Tradable firms must also wait for the following period to adjust their capital. Therefore, on impact only prices adjust and average self-employed earnings follow the initial rise in $p$. As the economy adjusts, self-employed earnings fall relative to salaried sector wages as does the share of workers in self-employment. Hence, in both the short run and long run, $w_T/w_N$ increases, $l_T/l_N$ increases and, consistent with Balassa–Samuelson, $p$ rises relative to its initial level.

3.4.3. Shift in preferences toward non tradables

A shift in consumer preference towards non tradables $\hat{A}_T = 0, \hat{A}_N > 0$, and $\hat{\gamma} = 0$ increases self-employment and absolute as well as relative non tradables consumption. On impact, the increased demand for non tradables causes the exchange rate to appreciate, and relative self-employed earnings and the shadow value of capital increase. This attracts new entrepreneurs to the sector, expanding non tradables supply and driving the relative price of non tradables, $p$, back to its initial, relative productivity-determined level. However, because marginal entrepreneurs are attracted to the sector, relative self-employment earnings must rise in the steady state. This represents an important case where both $w_T/w_N$ and $l_T/l_N$ fall with an initial appreciation and then continue to do so as the exchange rate depreciates again back to its initial level.

3.4.4. Negative salaried/tradable productivity shock with salaried sector wage rigidities

Unions or mandatory minimum wages may introduce downward nominal wage rigidities in the salaried sector that can reverse some of the above findings. A negative shock to productivity in the tradable sector, $\hat{A}_T < 0, \hat{A}_N = 0$, and $\hat{\gamma} = 0$, translates into nominal wage downward pressures in the salaried sector. In our set-up wage rigidities can only be temporary if we want conditions (Eqs. (1) and (2)) to be satisfied at the steady state. We assume that the adjustment process occurs along four steps: i) capital in the tradable sector adjusts to satisfy Eq. (1), as a consequence labor productivity falls; ii) formal workers move to the self-employed sector as long as Eq. (2) is not satisfied; iii) capital adjusts once again as its marginal productivity has increased due to the displacement of workers. At this point, the equilibrium becomes unstable and we need to (iv) impose an additional adjustment in the nominal wage to a lower but fixed level to satisfy condition (Eq. (2)), thereby precluding further labor flows.

The end result is the classic pattern associated with a formal sector wage rigidity in this context: a relative shift in labor toward the informal sector and a fall in relative earnings there: $w_T/w_N$ and $l_T/l_N$ falling against each other. In the present set up, the pivotal individual may, but not necessarily, prefer a job in formal sector. The rise in informal production leads to a depreciation in the real exchange rate. For the already self-employed, the fall in $p$ observed along the transition path, leads to disinvestment in capital. Technical details characterizing transitional dynamics and the steady state are deferred to Appendix A2.

4. Empirics

The previous section shows that very standard models anchored in the mainstream literature yield clear hypotheses of comovements among the three series. Different permutations of patterns of comovement across series correspond to distinct regimes that we hypothesize differ across country contexts and time periods. Clearly, conventional approaches to simply confirming or rejecting a particular and unique $H_p$ are not applicable in this context and hence our empirics are more complex. Effectively, we postulate four hypotheses and employ empirical tools that can distinguish among them and identify structural breaks when countries move from one regime (postulated set of parameter values) to another.
Before proceeding, two conclusions are important. First, independent of skill heterogeneity and adjustment costs, under no conditions can we generate a counter movement of relative sector sizes and earnings in the absence of a wage rigidity: observed counter movements imply segmentation and if we detect them empirically, this is evidence of labor market distortions. Second, in all cases, the short run labor market dynamics move in the same direction as the steady state and only in the case of a shock to preferences for non tradables does the exchange rate overshoot in the short-run.

We explore the patterns of comovement between relative sector sizes, relative earnings and the real exchange rate for Argentina, Mexico, Brazil and Colombia using the multivariate Johansen (1988) approach. (see Appendix A3). Although co-integration is sometimes given the economic interpretation of capturing “long run” relations, as Granger (1991) and Hakkio and Rush (1991) at core it is a statistical relationship existing among non-stationary series that can occur at any frequency or span.23 In our case, relative sector sizes, earnings and the real exchange rate are plausibly non-stationary and integrated of order of one and they always appear to be so in the analysis.24 Since overshooting or undershooting (as found in the case of a productivity shock or a demand shock respectively to the non tradable sector) can take a number of years to return to long run equilibrium, our short/medium runs can, in fact, represent quite persistent phenomena that will be identified by the co-integration relationship as well.

4.1. Data

We use quarterly data for Mexico, Brazil and Colombia and semi-annual data for Argentina (see Appendix A4 for data definitions and details) to generate the earnings ratio of salaried over self-employed workers, \(w_T/w_N\), and the ratio of the absolute size of the salaried over the self-employed sector, \(L_T/L_N\). To the degree possible, we try to be consistent across surveys and in spirit close to the traditional ILO definition based on firm size and the more recent focus on labor protections: we treat the male population that reports being employed in firms of greater than 6 workers as salaried (tradable) workers. Own-account workers or heads of firms employing fewer than 5 employees paying no social security contributions and excluding professionals and technicians, constitute the informal self-employed (non tradable) sector. Real exchange rates, \(p\), were taken from International Financial Statistics. The series are plotted in Fig. 1b with the exchange rate inverted for greater graphical clarity (an upward movement here and here alone is a depreciation).

Three issues merit note. First, even if remuneration is equalized in both sectors, we do not observe non-monetary remuneration (independence, benefits foregone, taxes avoided, implicit returns to capital, etc.) and hence we may observe a wedge in observed returns even in equilibrium. We assume that these non-monetary components are a constant fraction of monetary earnings and hence that changes in relative monetary earnings are a good proxy for relative changes in total remuneration. Second, variations in definitions and the composition of payment can cause substantial differences in ratios of relative earnings across countries. As a final reminder, we do not model or study those salaried workers who are uncovered by labor legislation and hence are informal. The particular cyclical behavior of this group merits independent study in another paper.

23 See Hakkio and Rush (1991) Cointegration: How long is the long-run?: “Clearly, the length of the ‘long-run’ may vary between problems, that is, for some issues the long-run may be a matter of decades while for others a matter of months.”
24 Theoretically, however, it is legitimate to include an \(I(0)\) variable in the co-integrating relationship, although we would expect at least one co-integrating vector to emerge that captures simply the stationary series. In practice, these series were never stationary across our sample and the problem was moot.

4.2. Results

We begin by estimating separate VAR models for Argentina, Mexico, Brazil and Colombia (Figs. 4–7). We include a constant, lags for \(p\), \(w_T/w_N\) and \(L_T/L_N\) as well as time dummies in the co-integration space. These specifications prove sufficient to produce random errors. The specifications for the models are presented in Tables A1–A3 in the Appendix A5 along with tests for long run exclusion, stationarity and weak-exogeneity. All variables appear to be non-stationary and the diagnostics on the residuals appear reasonable in terms of autocorrelation and normality. Sensitivity analysis for different lag lengths and with and without dummies sustains the robustness of the findings. Trace tests (\(\lambda_{trace}\)) indicate one significant co-integrating vector for all three models (Table A4).

Normalizing the co-integration vectors on the 1st element, yields the estimates for the \(\beta\) (Table 2) as a co-integration vector that can be read as:

\[
L_T/L_N + \beta_0 w_T/ w_N + \beta_1 p + \beta_2 = 0
\]

(8)

Eq. (8) provides the workhorse specification for generating co-integration vectors which correspond to one of the four regimes detailed in Table 1.

Regime A (\(H_f\): \(\beta_0<0, \beta_2<0\)) corresponds to productivity shocks to one or the other sectors in the presence of a integrated (non-segmented) labor market captured by \(\beta_0<0\).

Regime B (\(H_b\): \(\beta_2<0\)) corresponds to a demand shock and the resulting over (under) shooting in the case of shift in preferences toward (away from) non tradable/informal goods. Again, \(\beta_2<0\) since labor markets adjust freely, but \(\beta_2>0\) corresponds to the reverse movement exchange rate in this case.

Regime C (\(H_c\): \(\beta_0>0, \beta_2>0\)) corresponds to the case of a negative shock to the formal sector where wages cannot adjust downward and the labor market becomes segmented, \(\beta_0>0\); the two labor variables move oppositely—workers are shed from the tradable/formal sector and rationed into the non tradable/informal sector depressing relative earnings in that sector. \(\beta_2>0\) since the exchange rate depreciates.

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Fig. 4. Mexico: Parameter stability of co-integration space. Note: Parameter stability of co-integration spaces is assessed using Hansen and Johansen (1993, 1999). The test displayed is for constancy of full sample estimate as in Table 2, Interpretation is as follows, 1 presents the normalized critical value at the 5% level of significance. Values below 1 indicate parameter stability. Black dotted line represent to test statistic based on backward recursion (using period of 1987 Q1 to 2004 Q4 as base sample and adding one period at a time until the start of the sample is reached. The grey line represents the test statistics based on forward recursion (using period of 1987 Q1 to 1993 Q4 as base period and adding one observation at the time until the end of the sample is reached. Backward and forward recursions are used to in parallel to investigate parameter stability at the beginning and end of the sample. The full sample estimate points to integration, as such, we support integration per 1991 and post 1997. During 1992–1996 the full sample estimate of integration is rejected. This merits further subsample analysis.

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Lowering their relative price again rendering rates of return, expanding production of non tradables and hence detail. Since we deal with 10 separate periods, we will discuss only a few in the restrictions of each regime are estimated for at least one subperiod. will be discussed later. That is, co-integration vectors corresponding to have no long run effect on the exchange rate.

Column of each country panel of Table 2. However, the theoretical model suggests that different shocks, or differing degrees of formal integration spaces is assessed using Hansen and Johansen (1993, 1999). The test displayed is for constancy of full sample estimate as in Table 2, Interpretation is as follows, 1 presents the normalized critical value at the 5% level of significance. Values below 1 indicate parameter stability. Black dotted line represent to test statistic based on backward recursion (using the period of 1995Q1 to 2002Q4 as base sample and adding one period at a time until the start of the sample is reached). The grey line represents the test statistics based on forward recursion (using period of 1984 Q1 to 1989 Q4 as base period and adding one observation at the time until the end of the sample is reached). Backward and forward recursions are used to in parallel to investigate parameter stability at the beginning and end of the sample.

Regime D $(H_D: \beta_W<0, \beta_b=0)$ corresponds to the long run (in the economic sense) version of “B” where capital has moved to equalize rates of return, expanding production of non tradables and hence lowering their relative price again rendering $\beta_b=0$: taste changes have no long run effect on the exchange rate.

We identify three of these regimes in the data plus one more that will be discussed later. That is, co-integration vectors corresponding to the restrictions of each regime are estimated for at least one subperiod. Since we deal with 10 separate periods, we will discuss only a few in detail.

The estimates across the whole sample are presented in the first column of each country panel of Table 2. However, the theoretical model suggests that different shocks, or differing degrees of formal sector rigidities, should lead to different regimes and hence different co-integration vectors across subsamples. To investigate the stability of the co-integration space, we follow Hansen and Johansen (1993, 1999). We perform backward and forward recursions stability to explore the stability of the co-integration space at both sample ends. In the event of parameter instability, we then test for specific co-integrating vectors across subperiods.

For Argentina, the Hansen and Johansen tests identify no significant change in co-integration coefficients across the sample. The full sample estimations are reported in Table 2 and suggest a classic segmented labor market that corresponds to Regime “C”. The co-movements of the series, $\beta_W>0, \beta_b<0$ appear driven by shocks to the formal sector in the presence of binding wage rigidities. This is arguably consistent with the very high rates of unemployment that rose from roughly 6.5% in 1991 to 18% in 1995 and remained in the high double digits for much of the rest of our sample period.

However, recursive estimations of the co-integration space in the other three country cases do suggest significant co-efficient instability. Due to the existence of these multiple regimes, we label the full sample estimates “mixed” even though the estimated vector may suggest a particular regime.

Taking the full sample, Colombia presents a case similar to Argentina with $\beta_W>0$ suggesting segmentation in the labor market. The sub-period from 1997–2004, in particular is consistent with a classic segmented market and productivity shocks to the formal sector driving the movements of the three series. Colombia, in fact, entered a severe recession in the late 1990s concomitant with a sharp rise in the real minimum wage. The latter was driven by indexing wages to a forecast of inflation that later turned out to be pessimistically high by a substantial margin. Although the co-efficient on $\beta_b$ is not estimated precisely, Fig. 1b shows a classic case of Regime “C” across this period where the two labor market series are very clearly moving against each other while the exchange rate depreciates.

The backward recursion test suggests, however, that this vector is not stable across the whole period and we identify two other regimes. In the intermediate 1991–1996 period, we find $\beta_W<0$ suggesting the labor market is behaving in an integrated fashion and the $\beta_b>0$ consistent with an increase in relative informal sector size and earnings driven by a positive demand shock to the informal/ non tradable sector. In this example of Regime “B,” informality is “procyclical.” A similar pattern appears broadly to characterize the full sample in Mexico: $\beta_W$ is not significant suggesting the absence of significant
segmentation, and as in Colombian sub sample, $\beta_2 > 0$. This Regime “B,” pattern is most sharply visible in the period 1987–1991: $\beta_2$ is very significantly $< 0$ suggesting an integrated labor market, and $\beta_2 > 0$ is consistent with the expansion of the informal sector across this period being driven by a positive consumption shock to the non tradable sector and attracting more workers into informality. Again, the estimates are consistent with the evolution of the series in 1b. Both this and the 1991–1996 period in Colombia, are consistent with a view where a period of liberalization of the capital account in the context of broader reforms leads to an upward revision of permanent income and an ability to borrow that led to a relative rise in consumption in non tradables. This leads to a reallocation of labor toward the informal/tradable sector and an appreciation of the exchange rate.

However, the forward recursive tests for parameter stability suggest that the relation changes entering the early 1990s. In fact, the subperiod 1992–95, shows the emergence of the classic segmented regime with a negative shock to tradables in the presence of labor market rigidities “C” found in Colombia in the 1997–2004 period as Mexico slides towards, and then is engulfed by the 1994 Tequila crisis. In contrast to the previous period, $\beta_2 < 0$ suggesting an emerging segmentation across this period. This is consistent with the idea of a slowing formal/tradable sector and an inability to downwardly adjust earnings across, especially, the crisis period.

Fig. 1b does, however, suggests that were we able to break this period into smaller sub-samples, the labor market segmentation would be preserved, but the exchange rate correlation might change, and that is it the major depreciation of the peso in 1994–1995 that is driving the positive sign on $\beta_2$. That is, rather than depreciating as in the Colombian 1997–2004 case, the lead up to the crisis suggests that the exchange rate was appreciating. This gives us a combination, as in the Colombian case of 1985–90, where $\beta_2 < 0$, not found in Table 1. What we postulate to be driving this are nominal rigidities in the nominal exchange rate that are outside of the purview of the model. In both Mexico and in Colombia (see Fiess and Shankar, forthcoming) this was a period where the nominal ER was managed and hence impeded the real adjustments dictated by the model.25

The backward recursive tests signal that this new model is distinct from that found after 1996 and, in fact, we again find an integrated labor market beginning in 1999. However, the exchange rate is now enters negatively putting us in Regime “A,” where it is productivity shocks rather than demand shocks that drive the system. This is consistent with the slowdown of the US economy across this period on which the Mexican export sector is very dependent. Formal exporters thus would have felt the equivalent of a negative productivity shock to the tradable sector, leading to both a depreciation and a re-allocation in a relatively undistorted labor market toward the informal/tradable sector.

Brazil presents additional examples of these regimes although the graphical depictions of the series are much less clear than in the other cases. Though the full sample model points to an overall integrated labor market, the recursive tests suggest again, roughly three periods to be examined. In the first, roughly 1983–87, $\beta_2 < 0$ suggests an integrated labor market and, combined with $\beta_2 > 0$, is consistent with Regime “A,” and a series of productivity shocks across the period driving the system. However, from 1989–1993, $\beta_2 > 0$, $\beta_2 < 0$ as in the Colombian and Mexican crises, suggesting a negative shock to the tradable sector with rigidities in the labor market impeding adjustment and segmenting the market, Regime “C.” This, in fact, was a period of deep recession in Brazil beginning around 1990.

We return to an integrated labor market in the 1998–2002 period. This sub-period seems again consistent with relative sector allocations and earnings determined by sectoral productivity shocks, Regime “A.”

The sub-periods studied in the four countries identify co-integrating relationships consistent, in most cases, with scenarios generated by the model presented in Section 2. As importantly, in three of the four countries, we identify periods where the informal and formal labor markets appear to be integrated. That is, the informal sector does not appear to be the residual of a segmented market, but rather a competing sector that workers may choose to enter depending on relative rates of return to their assets. This is consistent with recent work studying patterns of transition among the formal and informal sectors in Mexico and Brazil that find that worker flows correspond much more to those in the US patterns of reallocation across jobs. That is, flows in both directions are very high and increase in upturns and slow in downturns.26

Other evidences on the prevalence of rigidities in the cases where the job market appears segmented are also consistent with our findings. For instance, while clearly not exhausting plausible rigidities, kernel plots testing for how binding minimum wages are suggest that in the late 1990s Brazil and Mexico when labor markets appear integrated, they were not while in Colombia, which behaves as

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25 As our Argentine sample also spans a period of anchoring the peso to the dollar, it is perhaps surprising that the data do not support a similar pattern there however, were we to be able to estimate with the few observations between 1990 and 2002, it might surface.

26 See Bosch and Maloney (2006), and Bosch et al. (2006).
segmented in this period, they were among the most binding in the region. Further, the periods of apparent segmentation in Brazil, Colombia and Mexico correspond to periods of deep recession where, as is often the case, wages do not adjust enough to prevent unemployment or, in this case, segmentation.

We find several episodes where the informal sector appears to expand concomitant with a rise in its relative earnings, during upturns. That is, it is procyclical. Loayza and Rogolini do find some countries in their global panel, for which self-employment (also their measure of informality) is procyclical, however the majority are not. Since, for both Colombia and Mexico (insignificantly) full sample findings of segmentation conceal periods of integration and procyclicality, we suspect that their sample averages are similarly concealing some more complex cyclical stories. The same can be said about the cross sectional correlations found in Boeri and Gribaldi. Hence empirically, the various papers are probably not necessarily inconsistent. Conceptually, our guess is that were most of the discussed models to add a second sector, their models could likely accommodate the findings here as well.

5. Conclusion

This paper has offered a framework through which to study self-employment across macroeconomic fluctuations. We model a two-sector labor market in an Obstfeld–Rogoff small economy model to include heterogeneous entrepreneurial ability and credit constraints to entering informal self-employment. This allows us to generate a set of hypotheses about the comovement of relative sector sizes and earnings and sectoral shocks as captured by the real exchange rate.

These patterns of comovement are then tested in a co-integration framework in Argentina, Brazil, Colombia and Mexico. Three important general findings emerge. First, we find examples of all the co-integration vectors suggested by theory suggesting that attention to country and period context is important to approaching the informal sector. In particular, and second, although the informal self-employed and formal salaried sectors often appear as elements of segmented or dual labor markets as customarily envisaged, we also find numerous episodes where they appear as one integrated labor market: numerous periods show strong comovement between relative sector sizes and earnings. This suggests that a large component of the informal sector should not be viewed as somehow inferior or queuing for formal sector employment. However, it is also the case that rigidities in the formal salaried sector can become very binding, as is most clearly the case in the dramatic crises that affected all four countries at some period, and apparently in Argentina across the entire sample. Third, these distinct patterns suggest that the pro- or countercyclicality of the sectors may depend on the sectoral origin of the shocks, and the presence of binding wage rigidities. We find numerous examples where either a positive productivity or demand shock to the non tradable/informal sector leads to its expansion.

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Appendix A1. Migration timing

Because we assume that the self-employed individual, who is willing to move to the wage-work sector, has to disinstall the capital she borrowed before moving, migration occurs whenever,

\[ p^N_{\text{A}_s, \text{B}_j} = \frac{\chi (\frac{\beta_s}{2} \frac{(\frac{B_j}{B_k})}{\lambda h(N_s, B_k)})}{N_s} - r_{B_k} + \sum_{s=t+1}^{n} \left( \frac{1}{1 + \tau} \right)^{s-t} \left[ p^N_{\text{A}_s, \text{B}_j} \frac{\chi (\frac{\beta_s}{2})}{N_s} - r_{B_k} \right] \]

\[ \leq p^N_{\text{A}_s, \text{B}_j} = \frac{\chi (\frac{\beta_s}{2} \frac{(\frac{B_j}{B_k})}{\lambda h(N_s, B_k)})}{N_s} - r_{B_k} + \sum_{s=t+1}^{n} \left( \frac{1}{1 + \tau} \right)^{s-t} w_t \]

Labor could adjust within the first period following the shock. However, because individuals are non homogenous when producing in the self-employed sector, the optimal time for leaving the latter may differ across workers.

The Left Hand Side of the above expression is increasing with entrepreneurial ability. Namely, more able individuals earn more than less able ones. Then the opportunity cost of migrating to the salaried sector at time \( t \), without considering the direct migration costs corresponding to capital disinstallation, is increasing in the level of entrepreneurial capability. The last term of the RHS, which represents the present value of labor earnings in the salaried sector is identical for all individuals at time \( t \). However, the first term of the RHS is likely to be different. The sign of the partial derivative of the latter with respect to \( \phi^I \) is given by

\[ 1 - \frac{x}{2(1 - \alpha_q)} \frac{\alpha_q}{r} \left[ (a + k_j)^2 - (a + k_j)^2 \right] \]

If the above expression appears to be positive, that would imply that the cost of migrating to the salaried sector at time is increasing with the level of entrepreneurial capability. If this is the case, then the total cost of migration is unambiguously increasing with \( \phi^I \). As a consequence we may expect more able entrepreneurs to postpone their migration towards the wage sector with respect to less able ones.

In the case of a shock leading to an expansion of the self-employed sector, migration can occur within the first period following the shock, even though capital accumulation may take more than a period because of installation costs. Individuals migrate at the end of period \( s \) whenever

\[ \frac{w_t - x}{\beta_s + \frac{x}{h(N_s, B_k)}} \left[ p^N_{\text{A}_s, \text{B}_j} \frac{\chi (\frac{\beta_s}{2})}{N_s} - r_{B_k} \right] \geq w_t + \sum_{s=t+1}^{n} \left( \frac{1}{1 + \tau} \right)^{s-t} W_t \]

Following arguments similar to those presented above, we can infer that more able entrepreneurs will leave the salaried sector first, in order to “cash in” the expected earnings differential the soonest.

Appendix A2. Details on negative tradables productivity shock with salaried sector wage rigidities

Unions or mandatory minimum wages may introduce downward nominal wage rigidities in the salaried sector that can reverse many of the findings above.

A negative shock to productivity in the tradable sector translates into nominal wage downward pressures in the salaried sector. Nominal wage downward rigidities, if persistent, would lead to a non-optimal and thus unstable equilibrium. In order to obtain a possibly stable equilibrium, we assume that nominal wages are adjusted to satisfy the first order conditions of firms operating in the tradable sector. However, we assume that wage variations represent the last element of adjustment. That is, labor movements are
precluded after wages have been adjusted. As a consequence, the pivotal individual could end up in a situation where belonging to either one or the other sector does make a difference. This is a case of segmentation where the non tradable sector behaves in part as a residual sector.

In summary, capital adjustment is a two-step process while labor adjustment is only a one-step process. Capital first adjusts to meet Eq. (1) in a context of constant salaried labor force. It further adjusts to meet Eq. (1) considering labor variation obtained by solving Eq. (2) with constant wage. Wages adjust in a final stage to satisfy Eq. (2).

Taking for instance the case of a Cobb–Douglas production function, salaried labor outflow\(^{28}\) corresponds to

\[
\dot{L}_t = \frac{\dot{A}_t}{\eta_{yt}(1-\eta_{yt})} = \frac{(1 + \eta_{yt})\dot{A}_t}{\eta_{yt}(1-\eta_{yt})} < 0 \quad \text{and} \quad \dot{L}_t = \frac{\dot{A}_t}{\eta_{yt}(1-\eta_{yt})} < 0 \quad \text{and} \quad \dot{w} = \frac{\dot{A}_t}{\eta_{yt}(1-\eta_{yt})} < 0.
\]

Equilibrium of the demand and supply conditions in the non tradable sector

\[
\hat{c}_N = \frac{(2 - \eta_{yt})\psi_{yt} - \rho_{yt}}{\eta_{yt}(1-\eta_{yt})} + \frac{\hat{A}_t}{\eta_{yt}(1-\eta_{yt})} + \frac{\psi_{yt}}{1 - \alpha_N} - \left(\theta y + (1 - \gamma)\right) \hat{p}
\]

and

\[
\hat{y}_N = \frac{\alpha_N}{1 - \alpha_N} \hat{p} - \Psi \frac{\hat{A}_t}{\eta_{yt}(1-\eta_{yt})}
\]

give

\[
\hat{p} = \frac{\hat{A}_t}{\eta_{yt}(1-\eta_{yt})} \left[1 - \alpha_N\right] \frac{(2 - \eta_{yt})\psi_{yt} + (1 - \psi_{yt})\Psi}{\alpha_N - \alpha_N \gamma \theta + (1 - \gamma)} \left[\left(\left(\theta y + (1 - \gamma)\right)\hat{p} - \Psi \frac{\hat{A}_t}{\eta_{yt}(1-\eta_{yt})}\right) - \left(\theta y + (1 - \gamma)\right)\hat{p}\right]
\]

The sign of both real exchange rate and average earnings depends upon the sign and magnitude of expression \(\alpha_N - \psi_{yt} + (1 - \alpha_N)(\gamma \theta + (1 - \gamma))\). This expression is increasing with \(\theta\), the elasticity of substitution. For \(\theta = 1\) (preferences are Cobb–Douglas) for instance, the expression is equal to \(1 - \psi_{yt}\). In that case, both the real exchange rate and average earned wages are decreasing unambiguously. A sufficient condition for the real exchange rate to depreciate is \((\alpha_N - \psi_{yt}) > (1 - \theta)\). Unless \(\alpha_N\) and \(\theta\) are both very close to zero and \(\gamma\) very close to one the condition is likely to be always satisfied. However, the sufficient condition for both the relative price of non tradables and average earnings to be decreasing is more restrictive, namely \(\theta \leq 1\).

Averaged earnings in the self-employment sector could rise despite the fall in \(\hat{p}\) because in the context of an expansion of the sector the contribution per unit of entrepreneurial ability is higher for less able workers. This is a feature of the model essentially due to the fact that ability enters in a linear manner in the production function of self-employed workers.

As far as relative earnings are concerned, self-employed workers would become on average worst off with respect to salaried workers if

\[
\frac{(2 - \eta_{yt})\psi_{yt} + (1 - \psi_{yt})\Psi}{\alpha_N - \psi_{yt} + (1 - \alpha_N)(\gamma \theta + (1 - \gamma))} - \left[\theta y + (1 - \gamma)\right] > (1 - \eta_{yt}) \quad (A1)
\]

for \(\theta = 1\) we must have that

\[
\left\{\frac{(2 - \eta_{yt})\psi_{yt} + (1 - \psi_{yt})\Psi}{\alpha_N - \psi_{yt} + (1 - \alpha_N)(\gamma \theta + (1 - \gamma))} - \theta y + (1 - \gamma)\right\} > (1 - \eta_{yt})
\]

This condition is likely to be satisfied for any plausible set of values.

When conditions presented above are satisfied, as labor migrates towards the self-employed sector, production rises, the real exchange rate depreciates, and average earnings in the self-employed sector fall. Moreover, as workers cannot migrate back to the salaried sector, those whose entrepreneurial ability is relatively low earn less than what they would get in the salaried sector. For those workers “trapped” in the self-employed sector earnings performance has worsened relative to those employed in the salaried sector as earnings in the salaried sector are preserved by institutional rigidities. The two labor force series move against each other. Critically, the same result would hold in the case where indexation of wages to past inflation forces salaried sector wages above equilibrium: we should see relative sector sizes and incomes move against each other.

**Appendix A3. Details of Johansen co-integration procedure**

The Johansen procedure allows us to test for co-integration in a multivariate system. Starting from an unrestricted vector autoregressive model (VAR), the hypothesis of co-integration is formulated as a hypothesis of reduced rank of the long run impact matrix \(\Pi\) (Johansen, 1988, Johansen and Juselius, 1990). The VAR is generated by the vector \(z_t\), which defines the potential endogenous variables of the model, in our case, the three series. Taking first differences of the variables, the VAR can be transformed into an error correction model

\[
\Delta z_t = \Gamma_1 \Delta z_{t-1} + \ldots + \Gamma_{n-k} \Delta z_{t-n+k} + \Pi z_{t-k} + \Psi \Delta t_t + \epsilon_t, \quad \epsilon_t \sim N(0, \Sigma)
\]

where the estimates of \(\Gamma_i = -(I - A_i - \ldots - A_{i,k})\), \(i = 1, \ldots, k\) describe the short run dynamics to changes in \(z_t\) and \(\Pi = -(I - A_1 - \ldots - A_k)\) captures the long run adjustments and \(D\) contains deterministic terms.

Co-integration occurs in the case of reduced rank of \(\Pi\). If the rank is reduced \((r < n)\) it is possible to factorize \(\Pi\) into \(\Pi = \alpha\Psi\) where \(\alpha\) denotes the adjustment coefficients and \(\beta\) the co-integration vectors. The co-integration vectors \(\beta\) have the property that \(\beta z_t\) is stationary even though \(z_t\) itself is non-stationary. If the rank is reduced it is also possible to interpret the VAR in first differences as a vector error correction model and to obtain estimates of \(\alpha\) and \(\beta\) via the reduced rank regression. Since the rank of \(\Pi\) is equal to the number of independent co-integration vectors and the rank of \(\Pi\) is also equal to the number of non-zero Eigenvalues, the test of co-integration thus amounts to a test for the number of non-zero Eigenvalues. The trace statistics, \(\lambda_{\text{trace}}\), is a non-standard distributed likelihood-ratio test, which is commonly used to determine the number of co-integration vectors, (Johansen, 1988). The trace statistic tests the null hypothesis that there are at most \(r\) co-integration vectors:

\[
H_0 : \lambda_r = 0, \quad \text{for } r = 1 + \ldots n
\]

where only the first \(r\) Eigenvalues, \(\lambda_r\), are non-zero against the unrestricted hypothesis that \(n\).

---

\(^{28}\) The null hypothesis of at most \(r\) co-integration vectors implies that there are \(n-r\) unit roots and, theoretically, \(n-r\) zero Eigenvalues. This is because the hypothesis of co-integration is formulated as the reduced rank of \(I - \alpha \Psi\) and the full rank of \(\alpha \Psi\), where \(\alpha\) and \(\beta\) are \(n \times r\) matrices and \(\alpha\) and \(\beta\) are \(n \times (n-r)\) matrices orthogonal to \(\alpha\) and \(\beta\). This allows us then to distinguish between \(r\) co-integrating \(\{0\}\) relations and \(n-r\) non-co-integrating \(\{1\}\) relations.
Appendix A4. Details on data

<table>
<thead>
<tr>
<th>Country</th>
<th>Survey</th>
<th>Time coverage and frequency</th>
<th>Spatial coverage</th>
<th>Sample</th>
<th>Definition of formal sector</th>
<th>Definition of S.E. sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>Pesquisa Mensal de Emprego — PME (monthly employment survey)</td>
<td>From first quarter of 1983 to fourth quarter of 2002</td>
<td>6 major metropolitan regions (covering 25% of the national labor market): Paulo, Rio de Janeiro, Belo Horizonte, Porto Alegre, Recife and Salvador.</td>
<td>Males above 15 years old</td>
<td>– to be working or to have a work during the survey’s week</td>
<td>– to be working or to have a work during the survey’s week</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Each quarter is represented by the last month of that quarter.</td>
<td></td>
<td>– to be employees in their work</td>
<td>– to be employers</td>
<td>– to be self-employed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>– to have a work-card (carenta de trabajo)</td>
<td>– to be employed of firms with more than 5 employees with social benefits</td>
<td>– to be employers of firms with more than 5 employees without benefits</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>– to have a work-card and to be working in some activity related to the public sector</td>
<td>– to be owners of firms with more than 5 employees with social benefits</td>
<td>– to be employers of firms with more than 5 employees without benefits</td>
</tr>
<tr>
<td>India</td>
<td>Encuesta Nacional de Empleo Urbano — ENEU (National Survey of Urban Employment)</td>
<td>From first quarter of 1987 to fourth quarter of 2004</td>
<td>16 major urban areas, covering 60% of urban population</td>
<td>Males between 11 and 99 years</td>
<td>– to be working during the survey’s period</td>
<td>– to be working or to have a work during the survey’s week</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>– to be employees of firms with more than 5 employees</td>
<td>– to have a pension plan in their current employment</td>
<td>– to be employers of firms in 5 or less workers **</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>– to be self-employed</td>
<td>– to be employees of firms in 5 or less workers without benefits</td>
<td>– to be employers of firms with more than 5 employees without benefits</td>
</tr>
<tr>
<td>Argentina</td>
<td>Encuesta Permanente de Hogares — EPH (Permanent Employment Survey)</td>
<td>From second wave of 1985 to first wave of 2003 (two waves per year, one in May, one in October)</td>
<td>Gran Buenos Aires</td>
<td>Males between 12 and 75 years</td>
<td>– to be working during the survey’s period</td>
<td>– to be working or to have a work during the survey’s week</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>– to be employees of firms with more than 5 employees</td>
<td>– to have a pension plan in their current employment</td>
<td>– to be employers of firms in 5 or less workers **</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>– to be self-employed</td>
<td>– to be employees of firms in 5 or less workers without benefits</td>
<td>– to be employers of firms with more than 5 employees without benefits</td>
</tr>
<tr>
<td>Colombia</td>
<td>Encuesta Nacional de Empleo Urbano — ENEU (National Household Survey)</td>
<td>From first quarter of 1987 to second quarter of 2004</td>
<td>7 major metropolitan areas (Barranquilla, Bucaramanga, Bogota, Manizales, Medellin, Cali, and Pasto)</td>
<td>Males between 11 and 99 years with less than 12 years of education***</td>
<td>– to be working or to have a work during the survey’s period</td>
<td>– to be working or to have a work during the survey’s week</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>– to be self-employed</td>
<td>– to have a pension plan in their current employment</td>
<td>– to be employers of firms in 5 or less workers **</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>– to be employees of firms with more than 5 employees</td>
<td>– to be self-employed</td>
<td>– to be employers of firms with more than 5 employees without benefits</td>
</tr>
</tbody>
</table>

*Due to a modification in the questionnaire (1994), a firm is considered to be small if it has 6 or less workers for all periods before to third quarter of 1994.

**Employees in big firms were dropped to avoid unnecessary pro-cyclicality in formal wages. These individuals account for a reduced number so the sector sizes are not affected after dropping them (e.g. in 2003 1.7% of the formal workers were employers in big firms).

***All observations with incomplete monetary income declarations are dropped from the sample.

Appendix A5. Model specification tests for the VAR models

Table A1
Tests for long run exclusion, stationarity and weak exogeneity.

<table>
<thead>
<tr>
<th>Country</th>
<th>Lag length: 4</th>
<th>Dummies: 1995 Q1 (Peso crisis)</th>
<th>Test for long run exclusion: LR-test ($\chi^2(r)$)</th>
<th>Test for stationarity: LR-test ($\chi^2(p – r)$)</th>
<th>Test for weak-exogeneity: LR-test ($\chi^2(r)$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Mexico</td>
<td></td>
<td></td>
<td>r</td>
<td>r</td>
<td>r</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>df</td>
<td>df</td>
<td>df</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$\chi^2(5)$</td>
<td>$\chi^2(5)$</td>
<td>$\chi^2(5)$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.84</td>
<td>5.99</td>
<td>3.84</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>1</td>
<td>1</td>
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<tr>
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<tr>
<td>Argentina</td>
<td></td>
<td></td>
<td>nT</td>
<td>nT</td>
<td>nT</td>
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</tr>
</tbody>
</table>

### Table A2
Multivariate statistics (residual analysis).

<table>
<thead>
<tr>
<th></th>
<th>Argentina</th>
<th>Mexico</th>
<th>Brazil</th>
<th>Colombia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information criteria:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC</td>
<td>−10.80</td>
<td>−21.09</td>
<td>−15.81</td>
<td>−13.37</td>
</tr>
<tr>
<td>HQ</td>
<td>−11.99</td>
<td>−21.81</td>
<td>−16.52</td>
<td>−13.85</td>
</tr>
<tr>
<td>Autocorrelation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ljung-box: $χ^2(42) = 42.93$, $p$-value = 0.43</td>
<td></td>
<td></td>
<td>$χ^2(114) = 126.3$, $p$-value = 0.05</td>
<td>$χ^2(150) = 159.5$, $p$-value = 0.18</td>
</tr>
<tr>
<td>$LM(1)$</td>
<td>$χ^2(9) = 8.58$, $p$-value = 0.44</td>
<td>$χ^2(9) = 8.1$, $p$-value = 0.53</td>
<td>$χ^2(9) = 4.52$, $p$-value = 0.87</td>
<td>$χ^2(9) = 7.6$, $p$-value = 0.58</td>
</tr>
<tr>
<td>$LM(4)$</td>
<td>$χ^2(9) = 7.62$, $p$-value = 0.57</td>
<td>$χ^2(9) = 17.2$, $p$-value = 0.05</td>
<td>$χ^2(9) = 13.1$, $p$-value = 0.16</td>
<td>$χ^2(9) = 7.9$, $p$-value = 0.54</td>
</tr>
<tr>
<td>Normality</td>
<td>$χ^2(6) = 0.929$, $p$-value = 0.16</td>
<td>$χ^2(6) = 9.94$, $p$-value = 0.13</td>
<td>$χ^2(6) = 16.4$, $p$-value = 0.01</td>
<td>$χ^2(6) = 31.5$, $p$-value = 0.00</td>
</tr>
</tbody>
</table>

### Table A3
Univariate test statistics (residual analysis).

<table>
<thead>
<tr>
<th></th>
<th>Argentina</th>
<th>Mexico</th>
<th>Brazil</th>
<th>Colombia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.532</td>
<td>0.374</td>
<td>0.845</td>
<td>0.290</td>
</tr>
<tr>
<td>Skewness</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kurtosis</td>
<td>1.965</td>
<td>2.339</td>
<td>4.815</td>
<td>2.345</td>
</tr>
<tr>
<td>ARCH</td>
<td>5.041</td>
<td>1.601</td>
<td>0.994</td>
<td>0.941</td>
</tr>
<tr>
<td>Null hypothesis Alternative hypothesis Lag: 4 with constant Lag: 4 with constant Lag: 3 with constant Lag: 2 with constant 95% critical value</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$λ_{trace}$ test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$r = 0$</td>
<td>33.11 (p-value: 0.077)</td>
<td>46.79 (p-value: 0.00)</td>
<td>38.12 (p-value: 0.02)</td>
<td>54.97 (p-value: 0.00)</td>
</tr>
<tr>
<td>$r = 1$</td>
<td>11.35 (p-value: 0.52)</td>
<td>15.63 (p-value: 0.20)</td>
<td>8.253 (p-value: 0.80)</td>
<td>11.93 (p-value: 0.46)</td>
</tr>
<tr>
<td>$r = 2$</td>
<td>4.19 (p-value: 0.40)</td>
<td>5.44 (p-value: 0.25)</td>
<td>1.48 (p-value: 0.87)</td>
<td>0.644 (p-value: 0.97)</td>
</tr>
</tbody>
</table>

Note: Trace statistics and p-values are small sample corrected (Johansen (2002)). *Trace statistics not adjusted for small sample properties reads: 42.64 (p-value = 0.000).

### Table A4
Cointegration test statistics.

<table>
<thead>
<tr>
<th></th>
<th>Argentina</th>
<th>Mexico</th>
<th>Brazil</th>
<th>Colombia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Null hypothesis Alternative hypothesis Lag: 4 with constant Lag: 4 with constant Lag: 3 with constant Lag: 2 with constant 95% critical value</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$Δτ_c$ test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$r = 0$</td>
<td>33.11 (p-value: 0.077)</td>
<td>46.79 (p-value: 0.00)</td>
<td>38.12 (p-value: 0.02)</td>
<td>54.97 (p-value: 0.00)</td>
</tr>
<tr>
<td>$r = 1$</td>
<td>11.35 (p-value: 0.52)</td>
<td>15.63 (p-value: 0.20)</td>
<td>8.253 (p-value: 0.80)</td>
<td>11.93 (p-value: 0.46)</td>
</tr>
<tr>
<td>$r = 2$</td>
<td>4.19 (p-value: 0.40)</td>
<td>5.44 (p-value: 0.25)</td>
<td>1.48 (p-value: 0.87)</td>
<td>0.644 (p-value: 0.97)</td>
</tr>
</tbody>
</table>

Note: $Δ$ indicates a variable in first differences. $τ$ statistics in parentheses.

### Table A5
Adjustment coefficients.

<table>
<thead>
<tr>
<th></th>
<th>Argentina</th>
<th>Brazil</th>
<th>Colombia</th>
<th>Mexico</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Δτ_{c t} / τ_t$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$ΔW_t / W_t$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$Δp$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: $Δ$ indicates a variable in first differences. $τ$ statistics in parentheses.

### References


