Currency Crises and Dynamics of Real Wages

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Abstract

How do currency crises impact real wages of workers? Rigidity of nominal wages implies a large and temporary decline in real wages. Alternatively, if there is a long-lasting decline in labor productivity after currency crises, there will be a similar decline in real wages. Finally, currency crises can reduce the bargaining power of labor and lead to lower real wages in the long-term even without a similar decline in labor productivity. Using a panel of 86 countries during 1970-2010, I examine the dynamics of real wages and labor productivity following a large depreciation of the nominal exchange rate in the short-, medium, and long run. The results indicate in a sample of countries with median exchange rate depreciation of 58%, real wage per employee on average declines between 20-35 percent just a year after a large depreciation. Even ten years following a currency shock, real wages are still 10-20 percent below the pre-crisis level. Labor productivity also declines; however, the decline in real wages is larger and more persistent. The long-lasting nature of the decline in real wages implies that factors beyond nominal rigidities are at work. In addition, the weak link between real wages and labor productivity during currency crises provides some suggestive evidence in favor of bargaining power hypothesis. The results are robust to different definitions of currency crises and estimation methods.

Keywords: currency crisis, employment, real wage, labor productivity
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I. Introduction

How do large sudden depreciation episodes, known as currency crises, affect real wages? The inflationary shock as the result of depreciation as well as rigidity of nominal wages imply that real wages decline in the short-run until wages catch up with higher prices. On the other hand, empirical evidence shows that reallocation of resources during currency crises can lead to a large and persistent loss in labor productivity and Total Factor Productivity (TFP) (see Kehoe & Ruhl, 2009; Meza &Quintin, 2005; Pratap & Quintin, 2010; Queralto, 2011). A permanent loss in labor productivity entails a permanent decline in real wages.

Alternatively, currency crises can also affect 'bargaining power' of labor and lead to a long-lasting decline in real wages. The argument is that globalization characterized by greater trade and financial openness has made it easier and less costly for capital to relocate abroad. However, the fixed cost of relocating is still very high for labor. Therefore, during currency crises when output and the domestic returns to capital and labor decreases, capital can relocate abroad relatively easy while labor is not quite as mobile. This leaves labor in a weaker position in the bargaining process and capital can pressurize labor to accept lower wages to restore profits (see Diwan, 2001; Harrison, 2002; Jayadev, 2007; Rodrik, 1998). Diwan (2001) refers to financial crises as episodes of distributional fights, which leave 'distributional scars'. If 'bargaining power' argument holds true then not only the decline in real wages is long-lasting but also it is beyond the decline in labor productivity. As discussed by Bentolila and Saint-Paul (2003), changes in the bargaining power of labor can derive a

gap between labor productivity and real wages. [1]

The aim of this paper is to examine the dynamic adjustment of real wages following currency crises in a large panel of countries. In particular, the paper attempts to answer the following questions: on average by how much do real wages fall after currency crises? How long does it take for real wages to recover to the pre-crisis level? Is the decline temporary and suggestive that it is caused by nominal rigidities or long-term and hence associated with lower bargaining power of labor or lower labor productivity? Is the decline in real wages accompanied by a similar decline in labor productivity or is the link between real wages and labor productivity weak during currency crises?

The answers to these questions are important because real wages are the main source of income for majority of the population in most countries. Therefore, how much do real wages fall and whether the changes in real wages are temporary or permanent have important inequality implications. Furthermore, lower real wages lead to a decline in consumption and aggregate demand, which can either reverse any expansionary effect of currency crises or aggravate the decline in output during crises (see Alexander, 1952). Thus, the answer to these questions has policy implications also from crisis management standpoint.

The literature on labor market impact of currency crises is divided into two main categories: country case studies and panel studies. Panel studies focus on the short-run impact of currency crises on labor share of income (Diwan, 2001; Harrison, 2002; Jayadev, 2007; Rodrik, 1998).[2] They find that labor share of income declines during currency crises

[1] Bentolia and Saint-Paul (2003) derive a relationship between labor share and capital-output ratio, which they call share-capital schedule. On this schedule, labor is paid its marginal product. Thereafter, they argue that some factors such as changes in bargaining power of unions under efficient bargaining model, product market power, and labor adjustment costs move the economy off the share-capital (SK) schedule creating a gap between marginal productivity of labor and real wages.

[2] Bazillier and Najman (2010) find that all else equal, labor share is 0.9 percentage points lower in the three years following currency crises. Using a panel dataset, Diwan (2001) and Harrison (2002) also find some

and they attribute such a decline to lower bargaining power of labor, even though they do not explicitly test this hypothesis. This paper is different from these panel studies in that it examines the impact of currency crises on components of labor share, namely real wages and labor productivity, separately. From policy standpoint, it is beneficial to separate out these two impacts.[3] On the other hand, country case studies assess the impact of currency crises on a wide range of labor market variables such as real wages, labor productivity, hours worked, and employment. The main finding of these studies is that the adjustment in labor market was primarily through substantial real wage cuts (see Cunningham & Maloney, 2000; Fallon and Locus, 2002; McKenzie, 2004; Onaran, 2007; Smith et al., 2002). While these country-case studies provide a valuable insight, most of them focus on a limited set of recent currency crises in late 1990s. Therefore, it is difficult to derive general conclusions about the average behavior of real wages and labor productivity after currency crises from these studies. This average behavior is better assessed in a panel framework. Furthermore, similar to panel studies, the country case studies are often concerned with the immediate or short-term impact of currency crises on real wages. Thus, the important question of how long it takes on average for real wages to recover remains unaddressed.

The main contribution of this paper is to explore the dynamic behavior of real wages and labor productivity in the short and long run after currency crises using a panel of 86 countries during 1970-2010. The results suggest that real wage per employee declines substantially following a currency crisis. In particular, in a sample of countries with median

suggestive evidence of a decline in labor's share after episodes of financial turmoil. Jayadev (2007) explains the fall in the labor share with the capital openness. Rodrik (1998) finds a negative impact of trade openness on wages, especially for OECD countries.

[3] For example, if the decline in labor share after currency crises is mainly due to changes in labor productivity, then active labor market policies such as job training programs are appropriate. However, if real wages are the main source of decline in labor share following crises, then policies to redistribute income are better suited.

nominal exchange rate depreciation of 58%, depending on the definition of crisis and estimation method, real wage per employee declines by about 20-35 percent just a year after a crisis. The results also suggest that real wage per employee is 10-20 percent below its pre-crisis level even ten years after the crisis. Labor productivity declines by 2-4 percent and remains below its pre-crisis level even in ten years. If we define crises broad enough to include hyperinflation episodes as well, then labor productivity initially declines by 3 percent but fully recovers within four years. Total Factor Productivity (TFP) also declines by about 3-4 percent, but fully recovers within four years. The large and persistent decline in real wages, which is well beyond the loss in labor productivity, provides suggestive evidence in favor of 'bargaining power' hypothesis. The robustness of the results is assessed with different measures of real wages and labor productivity, different currency crises definitions, and estimation methods.

II. Data

The main sources of data include: Total Economy Database (TED), World Development Indicators database (WDI), International Financial Statistics (IFS), and United Nations (UN). Table 1 provides detailed description of data sources.[4] Labor productivity is defined as output per worker. Although output per hour worked is a better indicator of productivity, using this measure will considerably reduce the size of the dataset. In addition, Total Factor Productivity growth (TFP) data is obtained from TED as an alternative measure of productivity.

As a proxy for nominal wages, I use compensation of employees (Current LCU) from Table 2.3 of United Nations National Account database, which is available for over hundred

[4] Total Economy Database, has the data on employment and productivity measures. Employment figures in this dataset include all employees, the self-employed, unpaid family members who are economically engaged, apprentices, and the military.

countries during 1970-2010. As pointed out by Gollin (2002), using the UN compensation of employees as a proxy for nominal wages has a major drawback. This measure excludes earnings of self-employed and informal sector workers. During currency crises it is likely for workers to move to informal sector or become self-employed. Therefore, we are likely to overestimate the decline in real wages during crises. In order to address this shortcoming, I check the robustness of the results controlling for the share of agricultural employment in the total employment as a proxy for share of informal sector in the economy. [5]

I calculate real wage per person employed by dividing nominal compensation of employees by employment and then by a price deflator. For the purposes of robustness, I use both Consumer Price Index (CPI) and GDP deflator to deflate nominal wages. "Consumption Wage" is real wage per employee deflated by CPI and is labeled "*RWC*". Alternatively, "Product Wage" is real wage per employee deflated by GDP deflator and is labeled "*RWG*". Thereafter, I calculate the growth in *RWC* and *RWG*. Moreover, I limit the analysis to the countries that have at least ten years of consecutive data on real wages, which results in total of 86 countries.[6]

I identify currency crises episodes over the 1970-2010 period with three different currency crises identification criteria. First, following Leaven and Valencia (2008), a currency crisis is defined as "a nominal exchange rate depreciation of 30 percent or more, which is also 10 percent higher than the rate of depreciation in the previous period". The first condition guarantees that only large depreciation episodes are captured. The second condition excludes episodes of hyperinflation in which nominal exchange rate constantly depreciates to

[5] The better way to handle this issue is to adjust the wage data as proposed by Gollin (2001) for income of self-employed workers. However, with this adjustment the dataset shrinks significantly and prevents the analysis.
[6] Out of 86 countries, only 44 of them experienced at least one currency crisis characterized by *LV* during the 1970-2010 period, the rest of the countries are used as the 'control group'.

catch up with higher inflation. The dummy variable *LV* is constructed based on these criteria, and *LV* is coded one when the two criteria are met and is coded zero otherwise. Moreover, to avoid counting an ongoing crisis as a new crisis, I exclude any crises within a three-year window of each crisis. As presented in Table 3, given the wage data availability, this definition yields 49 episodes of currency crises in the 87 countries over the 1970 to 2010 period for which the real wage data is available. The median (mean) nominal depreciation during these episodes is 57 (85) percent (Table 2).

Second, following Diwan (2001), I form another dummy, which is labeled as "*Diwan*". This dummy variable defines a currency crisis more broadly, as a "30 percent or more depreciation in nominal exchange rate during a calendar year". The definition yields 122 currency crises over the 1970-2010 period for which the real wage data is available. In contrast with *LV*, the *Diwan* dummy variable does not rule out episodes of hyperinflation and I do not consider any window around each crisis.[7] The median (mean) nominal depreciation during these episodes is 54 (90) percent (Table 2).

Finally, following Cerra and Saxena (2008), an Exchange Market Pressure Index (EMPI) is constructed. This index is based on the percentage depreciation in the nominal exchange rate plus the percentage loss in foreign exchange reserves.[8] Cerra and Saxena (2008) form a dummy variable, which I labeled "*Crisis1*" in Table 1, that is equal to one when EMPI is in the upper quartile of all observations across the panel. In contrast with the *Diwan* and *LV* dummies, the *Crisis1* dummy variable captures both the speculative attacks that resulted in a large depreciation of nominal exchange rate (successful attacks) and those that were neutralized through utilizing central bank's foreign reserves (unsuccessful attacks).

[7] Diwan dummy includes all episodes characterized as crisis by LV dummy and more.
[8] The nominal exchange rate is the average of the period bilateral exchange rate with U.S. dollars.

Therefore, in order to make the *Crisis1* dummy more compatible with the other two indicators of currency crises, I construct *Crisis2* dummy. This dummy equals one if the currency depreciation component of EMPI accounts for at least 50 percent of the index when the index signals a crisis.[9] Moreover, the depreciation of currency crisis must be at least 30 percent.[10]

III. Empirical Model

The empirical approach follows the Cerra and Saxena (2008) approach which examines the impact of financial crises on GDP in a large panel of countries. In particular, I estimate an autoregressive distributed lag model allowing for country fixed effects and country specific time trends and thereafter calculate cumulative responses of each variable of interest to a currency shock: [11]

$$g_{it} = \alpha_i + \lambda_i . t + \sum_{j=1}^{j} \beta_j g_{i,t-j} + \sum_{s=0}^{s} \delta_s D_{i,t-s} + \varepsilon_{it} \quad (1)$$

Where the dependent variable, g_{it} , is the variable of interest (real wages or labor productivity) for country i, D_{it} is the currency crisis dummy for country i, α_i represents country fixed effects, and $\lambda_i . t$ is country specific time trend. I estimate equation (1) for each dependent variable, separately.

To avoid spurious regression, I perform unit root tests on logarithm of labor productivity and real wages. The Maddala and Wu (1999) and Pesaran (2007) panel unit root tests are presented in Table 4. The main advantage of these panel unit root tests is that they

[9] Similar method has been used by Aziz et al. (2001) to separate currency crashes and reserve crises in their 'event study' analysis of currency crises.

[10] This condition guarantees that moderate depreciation episodes, where EMPI is in the upper quartile and currency component of EMPI is more than 50 percent of the index, are excluded. In addition, I check the robustness of the results to the change of this threshold to 20 percent.

[11] Using *testparm* command in STATA, I check for the significance of time fixed effects and country specific time trends. I could not reject the joint significance of country specific time trends, however the null hypothesis of "all time fixed effects are jointly significantly different than zero", was rejected.

do not require a balanced panel. In addition, both tests allow for heterogeneous autoregressive coefficient. Maddala and Wu (1999) test performs a Fisher-type test by combining the *p*-values from panel specific unit root tests. Pesaran (2007) on the other hand, augments augmented Dickey-Fuller (ADF) regressions with the cross-section averages of lagged levels and first differences of the individual series. Therefore, unlike Maddala and Wu (1999), Pesaran (2007) test allows for cross sectional dependence. The null hypothesis in both tests is that all series in the panel are non-stationary. The results in Table 4 suggest that neither of the unit root tests can reject the null of unit root for any of the variables. This implies that these variables are integrated of order 1[12]. Therefore, I use the growth rate of real wage per employee and labor productivity rather than their levels to estimate equation (1). Thereafter, the estimated coefficients in equation (1) are used to calculate the cumulative impulse response of real wages and labor productivity to a currency shock. For example, the initial response of real wage per employee ($\partial RWC_{it}/\partial D_{it}$) to a currency shock will be δ_0. The 1-year ahead cumulative response ($\partial RWC_{it+1}/\partial D_{it}$) will be $\delta_0 + (\delta_1 + \beta_1.\ \delta_0).$, and so on. The significance of the impulse responses are assessed by computing one standard deviation confidence bands, which are derived from 1000 Monte-Carlo simulations. The responses are statistically significant if the confidence bands exclude the zero line. Note, that even though equation (1) is estimated using the growth rate of real wage per employee and labor productivity, the impulse responses are all presented in levels.

The autoregressive lags and the lags of dummy variables in equation (1) are selected based on the Schwarz Information Criteria (SIC) as well as considerations regarding the

[12] The unit root test on real wage growth and labor productivity growth rejects the null of unit root. Results available upon request.

length of the time series in the dataset.[13] Therefore, I estimate ARDL (1, 3) for real wage growth (*RWC* and *RWG*), and ADRL (2,4) for labor productivity and Total Factor Productivity (TFP) growth. [14] The results are presented in Figure 1-5 and show the response of real wage per employee and labor productivity to a currency crisis shock and few robustness checks.

IV. Real Wage Dynamics following a Currency Crisis

The cumulative impulse response of real wage per employee to a currency crisis is presented in Figure 1. The impulses are calculated for each of the currency crises characterizations: *LV, Diwan,* and *Crisis2.* Note that the median (mean) nominal exchange rate depreciation during the currency crises episodes in the sample, is about 54%-60% (85%-104%) . A number of interesting insights emerge from the impulse functions. [15]

FIGURE 1 ABOUT HERE

First, the immediate response of real wage per employee in almost all cases is negative, and significant. Second, the largest decline in real wage per employee in all cases (except for *Diwan*) occurs a year after a currency shock. The decline of *RWC* (*RWG*) is about 20-30 (20-35) percentage points in the first year after a shock. These results are in line with country case studies that find a significant decline in real wages right after a currency crisis. Fallon and Locus (2002) find a decline of about 44 percent and 31 percent in manufacturing real wages after the crises in Indonesia [1998] and Turkey [2001], respectively. Furthermore, Cunningham and Maloney (2000) assess the impact of the 1994 Mexican financial crisis on the labor market and find similar results. David McKenzie (2004) decomposes the change in labor income of households after the Argentine's 2001currency crisis into changes in wages,

[13] The real wage growth data is available for some countries in the panel is available for only ten consecutive
[14] In ADL (p, q), p corresponds to autoregressive lag and q corresponds to the lags of the dummy variable.
[15] The estimation results are reported in Appendix, Table A1-A5.

hours of work, job entry and exit, and work programs. He finds that three-quarters of average fall in labor income following the crisis was because of real wage cuts. [16]

Third, real wage per employee starts to rebound in the second year. However, the recovery is partial and even ten years following a currency crisis real wage per employee *RWC* (*RWG*) is still about 10-20 (15-25) percentage points below its pre-crisis level. To summarize, the results suggest that currency crises are followed by a large, significant, and persistent decline in real wage per employee.

Why do real wages fall after currency crises? One possible explanation for the large fall in real wages following a currency crisis is that nominal wages are sticky and they do not adjust to the inflationary shock immediately. A simple approach to test this hypothesis is to examine whether among cries episodes, country-years with largest initial decline (declines that are in upper quartile of real wage cuts) in real wages experienced higher inflation rates compared to crises the rest country-years. In fact this holds true in the sample: the median inflation rate in country-years with highest initial real wage cuts is almost two times larger than inflation rate during crises in the rest of country-years. The long-lasting nature of the decline in real wages implies that forces beyond nominal rigidities are at work.

There are two atenative hypotheses that can explain the long-lasting decline in real wages. First hypothesis is currency crises lead to a permanent decline in labor productivity and therefore, real wages. If this hypothesis were true then we would expect to see a similar decline in real wages and labor productivity. The second hypothesis is that currency crises

[16] Also, Onaran (2007) examines wage shares in Mexico [1994], Turkey [1994,2001], and Korea [1998] following their currency crises, and find a significant, negative and long lasting effect of crises on manufacturing wage share (or labor share) in all three countries. Moreover, he finds that while the main source of decline in wage share in Mexico and Turkey is the drop in real wages, in Korea the decline in employment was the main reason behind the fall in the wage share.

reduce bargaining power of labor and lead to a permanent decline in real wages. The argument is that globalization featured by greater trade and capital openness has increased the mobility of capital vis-à-vis labor. Therefore, when output and returns to factors of production decreases during crises, the gap between foreign and domestic returns widens. Because capital can relocate relatively easy to seek the higher return abroad, labor's bargaining power over already squeezed rents decreases. Hence, real wages decline.

There are few country level studies, which are aligned with the 'bargaining power' hypothesis. Dafour & Orhangazi (2009) report a cut in wages of public employees and a decrease in the number of unionized workers in Turkey after the currency crisis in 2001.Onaran (2007) also finds a large decline in labor share of income after the Turkish crisis [2001], which does not recover to its pre-crisis level even five years after the crisis. In fact, he reports that the labor share in 2006 was even lower than its 1994 level. In the same context, Kang et al.(2001) on the labor outcome of the Korean (1997-1998) financial crisis note "…Of 3,337 workplaces 2,259 agreed to a (nominal) wage freeze, and another 559 agreed to wage cuts. In 1998, inflation rose to 7.5 percent, real wages dropped by almost 10 percent. As growth in real wages fell, so did the rate of unionization…"

Unfortunately considerations related to availability labor market institutions data for developing countries prevent me to explicitly test the bargaining power hypothesis with an indicator for the bargaining power of labor in the model. However, I am able to test this hypothesis indirectly. Bentolia and Saint-Paul (2003) discuss how some factors such as changes in the bargaining power of labor can derive a wedge between labor productivity and real wages. Therefore, a persistent decline in real wages along with a gap between real wages and labor productivity in the long-run can only be explained with the 'bargaining power'

hypothesis. This means that in order to provide evidence in favor of the 'bargaining power' hypothesis, we need to look into labor productivity dynamics following currency crises. But before doing that in the next two sections we discuss a different interpretation of real wages decline and also check for the robustness of the results.

V. Real Wage per Hour

The real wage per employee results must be interpreted with caution. This is because the changes in employment rate only partly reflect the quantity adjustment in the labor market; the other part of adjustment is through a decline in hours worked (Horton & Mazumdar, 2001; Fridhanusetyawan, 2002; Ramesh, 2009). In fact, Horton and Mazumdar (2001) find that after the 1997-1998 crisis in Korea, the average number of hours worked per week fell from 46.7 in 1997, to 45.9 in 1998. Therefore, the estimations of the decline in real wages in the previous section may be overstated by ignoring the decline in the hours worked. I investigate if this is the case by exploring the dynamics of real wage per hour after currency crises in a sub-sample of 43 countries during 1970-2010.[17]The data on total annual hours worked is obtained from Conference Board Total Economy Database (TED). I calculate real wage per hour by dividing real wage deflated by CPI by total hours worked per year. Thereafter, I calculate real wage per hour growth. It is worthy to note that this sub-sample includes mostly developed countries and is different from the sample in the previous section. Therefore, in order to be able to compare the results in this section with the previous section, I re-estimate the response of real wage per employee deflated by CPI (*RWC*) in this sub-sample and present both these impulses side by side.

FIGURE 2 ABOUT HERE

[17] For some countries the hours worked data is available only after 1990.

The first column in Figure 2 shows the impulse responses of real wage per hour to a currency shock and the second column presents the responses of real wages per employee deflated by CPI (*RWC*) to currency crises. Each row corresponds to a different definition of currency crisis. I use the same model and estimation method as the section IV (ARDL (1,3)). Similar to the previous section, growth rate of the variables are used in estimation of equation (1), however the impulse responses are presented in levels.

It is evident that the dynamics are almost identical and real wage per hour closely follows real wage per employee. The significance of the results is specially affected when crises episodes are characterized by LV dummy. This is likely due to the small number of crises observations (13 crises) characterized by *LV* in this sample. Number of crises characterized by *Diwan* and *Crisis2* is 49 and 33 events, respectively. The narrower standard errors during these episodes reflect that these estimates are more reliable.

Even if we only consider real wage per hour dynamics, there is a large, significant (except for *LV*) and persistent decline in real wage per hour. The decline is about 10 percent in ten years, which implies that even taking the cut in hours into account, real wages decline significantly. Overall, the result in this section provides some suggestive evidence that cut in nominal wages is an important part of the decline in real wage per employee.

VI. Robustness

Nickell (1981) points out that using the fixed effect estimator for autoregressive dynamic models leads to an inconsistent estimate of coefficients when the number of periods is kept fixed. The autoregressive coefficient in this case tends to be biased downward. The order of bias is 1/T and thus serious in short panels. To check the robustness of results to dynamic panel bias, I re-estimate the results with an alternative estimation method. One way

to deal with dynamic panels is to use Arellano and Bond (1991) GMM estimator that eliminates the fixed effects by first-differencing the data and then use the lagged levels of the endogenous variables as instruments for the first differenced endogenous variables. Arellano and Bover (1995) and Bundell and Bond (1998) improve the efficiency of GMM estimations by developing "system" GMM estimator. System GMM mitigates the poor instrument problem in Arellano and Bond (1991) by using additional moment conditions arising from the model in the level. The instruments in level equation are the lagged differences of the endogenous variables, assuming that they are uncorrelated with the error term. The system GMM is robust to heteroskedasticity and autocorrelation in the error term. The main problem with system GMM estimator is that it generates "too many" instruments. This means instruments can over-fit instrumented variables and bias the coefficients towards OLS or GLS estimators (Roodman 2009). Thus, I reduce the number of instruments by the lag length of endogenous variable to be used as instruments to 3. [18] However, the results are robust to changes in the lag length.

I estimate Equation (1) for *RWC* growth and *RWG* growth using system GMM estimator. Country specific time trends are included in all specifications. The contemporaneous dummy variable is treated as endogenous. The rest of independent variables are treated as exogenous. I only use internal instruments- no external instruments are included- in the estimations.

FIGURE 3 ABOUT HERE

[18] There is no clear-cut answer to how many instruments is too many. The rule of thumb is to keep the number of instruments smaller than the number of panels (countries) by either limiting the lag length of instrumented variable to be used as an instrument or by collapsing the instrument matrix or combination of both methods. In this case I limit the lag to 3 and collapse the instrument matrix.

Overall, the response of real wages to *LV* currency crises periods is very similar to the presented results in section IV. Depending on the definition of crisis, *RWC* (*RWG*) declines about 15-20 (10-20) percentage points a year after the currency shock. Again, there is a partial recovery within three years; however, the real wages never recover to pre-crisis level. Ten years following a currency crisis, *RWC* (*RWG*) is still 10 percentage points below pre-crisis level. The loss in real wages is greater (about 20 percentage points) during currency crises characterized by *Diwan.*

The other concern with the results is that as discussed by Diwan (2001), in many developing countries during currency crises labor moves from formal to informal sector (agriculture sector). Therefore, focusing on formal wages may overestimate the loss in purchasing power of labor during crises. Part of the large decline in real wages may be explained by the expansion of informal (agricultural) sector. Unfortunately, there is no reliable data on wages in the informal sector. However, to somehow address this issue, I control for the share of agricultural employment in the total employment as a proxy for share of informal sector and re-estimate the loss in real consumption wage (*RWC*) using fixed effect estimation method with country specific time trends.

FIGURE 4 ABOUT HERE

Figure 4 shows the impulse responses. It is obvious from Figure 4 that the initial response of real wages is still negative. In case of crises characterized by *LV* the loss in real wages is insignificant in all time horizons, however, in crises characterized by all other dummies, real wage per employee declines significantly after a crisis and never recovers to

its pre-crisis level. [19] Finally, I include time fixed effects, instead of country specific time trend, and re-estimate the results using two way fixed effects estimation method. The results are very similar to the reported results therefore they are not reported for brevity. [20]

VIII. Dynamics of Labor Productivity Following Currency Crises

Empirical evidence suggests that financial crises lead to a large and long-lasting decline in labor productivity and Total Factor Productivity (TFP). Such a decline in labor productivity can be due to labors' movement across sectors, perhaps moving from other sectors toward more export-oriented sector. For example, using household survey data for Mexico, Pratap and Quintin (2010) find that many workers became less productive during crisis of 1994-1995 as they switched industry or occupation. These workers on average lost about 10% of their hourly earnings compared to those who did not switch. Benjamin and Meza (2009) explore Korean crisis of 1997 and argue that the large decline in TFP during the crisis was mostly due to a sectoral reallocation of labor from the more productive manufacturing and construction sectors to the less productive wholesale trade sector, the public sector and agriculture.

Furthermore, in order to explain the persistence of the decline in output and TFP growth during financial crises Queralto (2013) develops a model in which TFP growth is endogenously determined through firm creation. In this context, balance sheet deterioration (for example due to depreciation exchange rate) or higher interest rates during financial

[19] Once the share of agricultural employment is controlled for, the number of crises in the sample with the available real wage data shrinks to 18, 54, and 34 crises episodes characterized by *LV, Diwan,* and *Crisis2,* respectively. The sample size includes 82 countries during 1970-2010 period.

[20] Results are available upon request.

crises reduces net worth of firms and banks, aggravates the asymmetric information problem and leads to an increase in the cost of borrowing and a credit crunch. Therefore, firm creation and TFP growth decline during these episodes. Using a panel of 17 emerging countries and a methodology similar to this paper, Queralto (2013) estimates the output and TFP loss during banking crises. He finds a permanent decline of 6 percent in TFP during these episodes.

In this section, I examine the dynamic adjustment of labor productivity and TFP following a currency crisis to see whether the decline in labor productivity is similar to that of real wages. If this is not the case, then I interpret that as evidence in favor of 'bargaining power' hypothesis. To further assess the robustness, I use TFP as an alternative measure of productivity.

Therefore, an ARDL (2,4) for labor productivity growth and TFP growth is estimated. The estimation method is system GMM because as previously stated it handles the concerns regarding the dynamic panel bias and endogeneity of the repressors. Lower productivity can lead to a slower growth, which in turn can trigger a currency crisis. Hence, in order to avoid this endogeneity bias, I treat the contemporaneous currency crisis dummy variable as endogenous in the GMM estimation. All instruments are internal and lag length of endogenous variables to be used as instruments is limited to 3[21]. The cumulative impulse responses are presented in Figure 5. All impulses are presented in levels of variables of interest.

FIGURE 5 ABOUT HERE

The left panels in Figure 5 represent labor productivity response whereas the right panels represent TFP response after a currency crisis.

[21] Results are robust to the changes in number of instruments and are available upon request.

Results suggest that there is an initial loss of about 2-3 percent in labor productivity regardless of estimation method or currency crises criteria. The initial loss in TFP is larger and about 4-6 percent. The long-run dynamics are mixed. While TFP fully recovers to its pre-crisis level within three years (except during *LV* episodes), labor productivity permanently declines (except during *Diwan* episodes). Ten years following a large depreciation of 30 percent or more, the loss in labor productivity accumulates to about 2 to 4 percent, depending on the definition of crisis. In case of currency crises identified by Diwan, labor productivity fully recovers to its pre-crisis level within five years.

The TFP results are in contrast with that of Queralto (2013), which finds a permanent decline in TFP following banking crises. This difference can be due the difference in the sample as his results are based on 17 emerging economies. In addition, Queralto (2013) results are related to banking crises rather than currency crises episodes.[22] Credit crunch is a main feature of banking crisis episodes; hence large and permanent decline in TFP is a likely outcome of these crises.

To summarize, the results suggests that while both real wages and labor productivity fall during currency crises, the decline in real wages is well above the decline in labor productivity or TFP in all time horizons. The permanent decline in real wages along with divergence of labor productivity and real wages further confirm 'bargaining power' hypothesis put forth in the previous section.

[22] In earlier version of the paper, Queralto (2011) looks into the impact of currency crises on TFP and finds that TFP permanently declines for emerging countries. However, again his sample is smaller than mine. In addition, his identification of currency crises follows Cerra and Saxena (2008). Hence, he captures both large depreciation episodes and defense episodes. During defense, Central Banks raise the interest rates and/or lose their foreign exchange reserves to buy their own currency back and avoid depreciation. Such actions can lead to a credit crunch and a loss in TFP. On the other hand, my identification captures only those episodes of pressure that led to a crash in the value of a currency.

VII. Conclusion

Sudden and large depreciation of nominal exchange rate is known to be inflationary. Rigidity of nominal wages implies that during these episodes real wage declines. The nominal nature of this rigidity implies that in the long-run real wages will fully recover. However, there are two alternative channels in which currency crashes can lead to a decline in real wages even in the long run. First channel is through labor productivity losses. Theoritical and empirical literature of financial crises, shows that these events lead to a large and persistent decline in labor productivity and Total Factor Productivity. A large and permanent loss in labor productivity implies a large and permanent decline in real wages as well. The second channel emphasizes on the changes in bargaining power of labor after currency crashes/crises. The argument is that globalization featured by greater trade and capital openness has increased the mobility of capital vis-à-vis labor. When output and domestic return to factors of production decline during currency crises, capital has the option of re-locating abroad in search of higher return. This alternative is not available to labor, as labor is not quite as mobile. Hence, bargaining power of labor in negotiations over already squeezed rents deceases and capital can pressurize labor to accept lower real wages to restore profits. If 'bargain power' argument holds true, then one would expect to observe a long lasting decline in real wages following a currency crisis. Moreover, Bentolila & Saint-Paul (2003) argue that some factors such as lower bargaining power of labor weakens the link between real wages and labor productivity. Therefore, a divergence of real wages and labor productivity provides further evidence in factor of 'bargaining power' evidence.

This paper examined the dynamic adjustment of real wages and labor productivity in a panel of 86 countries during 1970-2010 period to answer the following questions: on

average how much do real wages decline during currency crises? How long does it take for real wages on average to recover to pre-crisis level? Is the decline in real wages is associated with a similar fall in labor productivity?

I use an Autoregressive Distributed Lag (ARDL) model to calculate impulse response of real wages and labor productivity to a currency crisis. The methodology allows me to examine the short, medium and long run impact of currency crises on real wages and productivity. The results suggest that a year after a large depreciation of 30% or more (median depreciation is about 58 percent in our sample of crises), real wages per employee declines about 20 to 35 percent, depending on crisis identification scheme. The decline in real wages is permanent; even ten years after a currency shock, the decline in real wage per employee accumulates to about 15-20 percent.

Labor productivity declines by 2-3 percent during currency crashes. The decline accumulates to 2-4 percent in ten years. As an alternative measure of productivity, TFP is used. The results suggest that the initial loss in TFP is 4-6 percentage points and significant. However, TFP recovers fully within four years.

Overall, the large and persistent decline in real wages along with divergence of labor productivity from real wages provides evidence in favor of 'bargaining power' hypothesis. However, to provide more definite proof of bargaining power argument, one needs to make use of direct indices for bargaining power of labor such as labor market institutions that impact the bargaining power of labor (e.g. presence of collective bargaining). Unfortunately lack of time series data for labor market institutions for majority of countries in our sample, prevents us from directly testing bargaining power hypothesis.

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Table 1- Data Sources and List of Countries

Data	Description
Employment	Total Economy Database[23]
Labor productivity	Total Economy Database
TFP growth	Total Economy Database
Total annual hours worked	Total Economy Database
CPI	World Development Indicators
GDP deflator	World Development Indicators
Compensation of Employees	United Nations Database
Real wage per employee	Author's calculations
Agricultural Employment (%Total)	World Development Indicators
Foreign Reserves	International Financial Statistics
Average Period Exchange rate	International Financial Statistics
LV Currency Crisis	A nominal exchange rate depreciation of 30 percent or more which is also 10 percent higher than the rate of depreciation in the previous period. (Laeven and Valencia (2008)).
Diwan	A depreciation of 30 percent or more in nominal exchange rate during a calendar year (Diwan (2001)).
Crisis1	EMPI=The percentage depreciation in the exchange rate + the percentage loss in foreign exchange reserves. Crisis1=1 if EMPI> Upper quartile of all observations Crisis1=0 if EMPI< Upper quartile of all observations in the panel. (Cerra and Saxena (2008)).
Crisis2	Crisis2=1 if Crisis1=1 & dle>30% & dle /EMPI>50% Crisis2=0 Otherwise.

List of Countries (United Nations Sample):

Algeria, Australia, Austria, Armenia, Belgium, Burkina Faso, Bulgaria, Bahrain, Belarus, Bolivia, Brazil, Canada, Switzerland, China, Cote d'Ivoire, Cameroon, Colombia, Costa Rica, Cyprus, Germany, Denmark, Dominican Republic, Ecuador, Egypt, Spain, Estonia, Finland, France, United Kingdom, Georgia, Greece, Guatemala, Hong Kong, China, Croatia, Hungry, India, Ireland, Iran, Iraq, Iceland, Italy, Jamaica, Jordan, Japan, Kenya, Korea, Rep., Kuwait, Sri Lanka, Lithuania, Luxembourg, Latvia, Morocco, Moldova, Mexico, Malta, Mozambique, Niger, Nigeria, Netherlands, Norway, New Zealand, Oman, Peru, Philippines, Poland, Portugal, Qatar, Russian Federation, Saudi Arabia, Sudan, Senegal, Singapore, Serbia, Slovenia, Sweden, Thailand, Tajikistan, Trinidad and Tobago, Tunisia, Turkey, Tanzania, Ukraine, United States, South Africa, Zimbabwe.

[23] Available at: http://www.conference-board.org/data/economydatabase/.

Table 2- Mean and Median Depreciation of Nominal Exchange Rate Based on each Definition of Currency Crisis

Crisis	Mean	Median
LV	85% (86%)	57 (59%)
Diwan	90% (99%)	54% (58%)
Crisis2	104% (95%)	60% (58%)

Note: The numbers in the parenthesis are the mean and median of nominal exchange rate depreciation in the sample based on each currency crisis definition. The numbers that are not in the parenthesis represent mean and median of nominal exchange rate depreciation during episodes for which real wage data is available.

Table 3- Number of Crises

Crisis	UN data
LV	49 (84)
Diwan	122 (230)
Crisis2	70 (121)

Note: The number in the parenthesis is the total number of crises in the sample based on each currency crisis definition. The numbers that are not in the parenthesis represent number of crises for which real wage data is available.

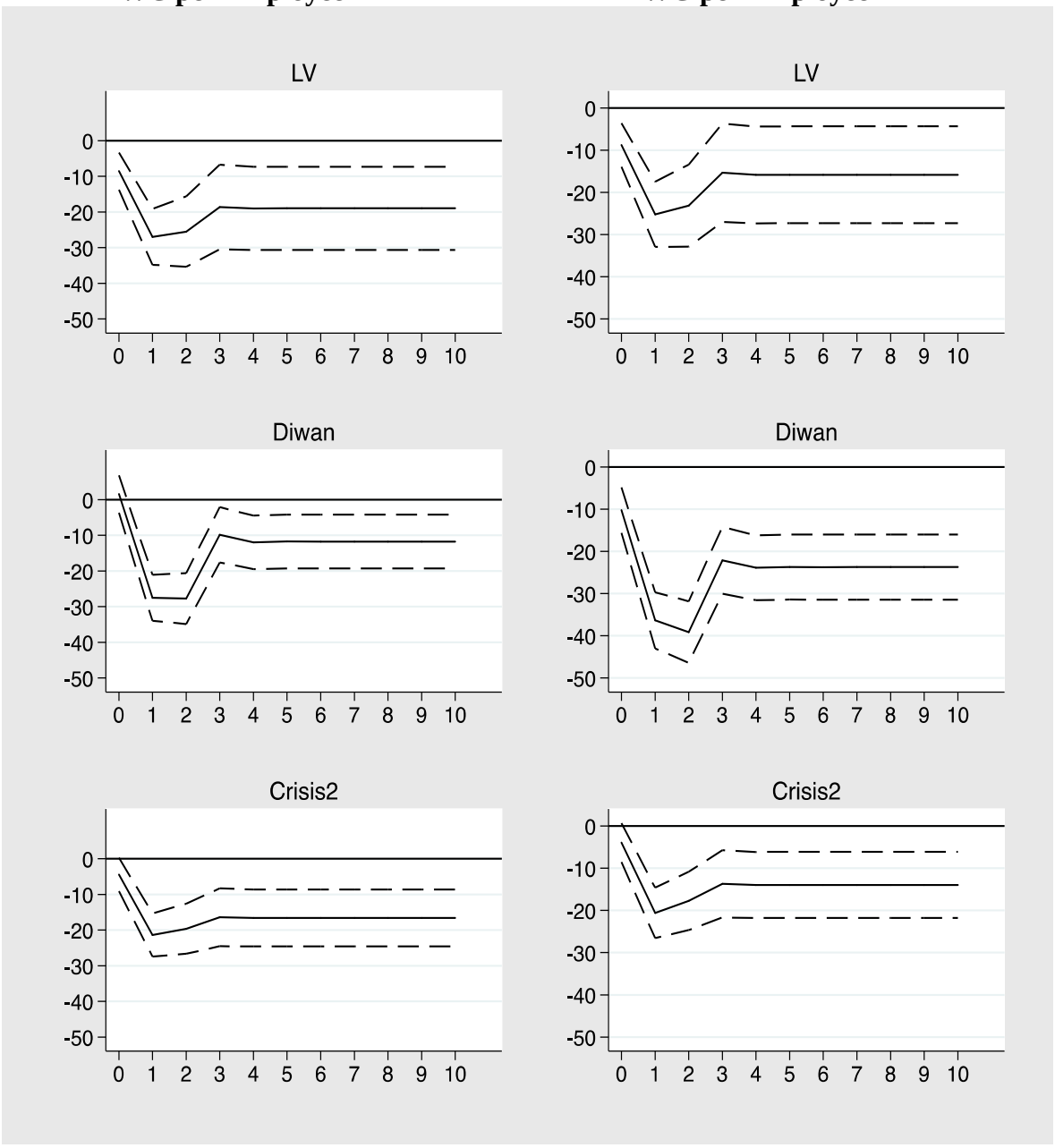
Table 4 - Maddala and Wu- Chi Square Panel Unit Root Test

Tests	Maddala & Wu Chi-Square	Pesaran (2007) Zt-bar
Variables:		
Log (RWC)	164.285 (0.69)	1.347 (0.91)
Log (RWG)	180.526 (0.35)	2.723 (0.99)
Log (Labor Productivity)	188.220 (0.21)	5.931 (1.000)

Note: P-values are indicated in parenthesis. The sample range from 1970-2010 and includes 86 countries. Real Consumption Wage (RWC) is real wage per person employed deflated by Consumer Price Index (CPI). Real Product Wage (RWG) is real wage per person deflated by GDP deflator. Labor productivity is defined as output per worker. Maddala and Wu use Fisher type tests and allow for heterogeneous autoregressive coefficient across the panel and can be used with unbalanced panel data. Pesaran (2007) panel unit root test allows for heterogeneous autoregressive coefficient and eliminates the cross-dependence of the series before applying standard panel unit root tests to the transformed series. All ADF regressions include an individual intercept. Null hypothesis in both tests is that all series in the panel are non-stationary.

Figure1- Response of Real Wage per Employee to a Currency Crisis (fixed effects)

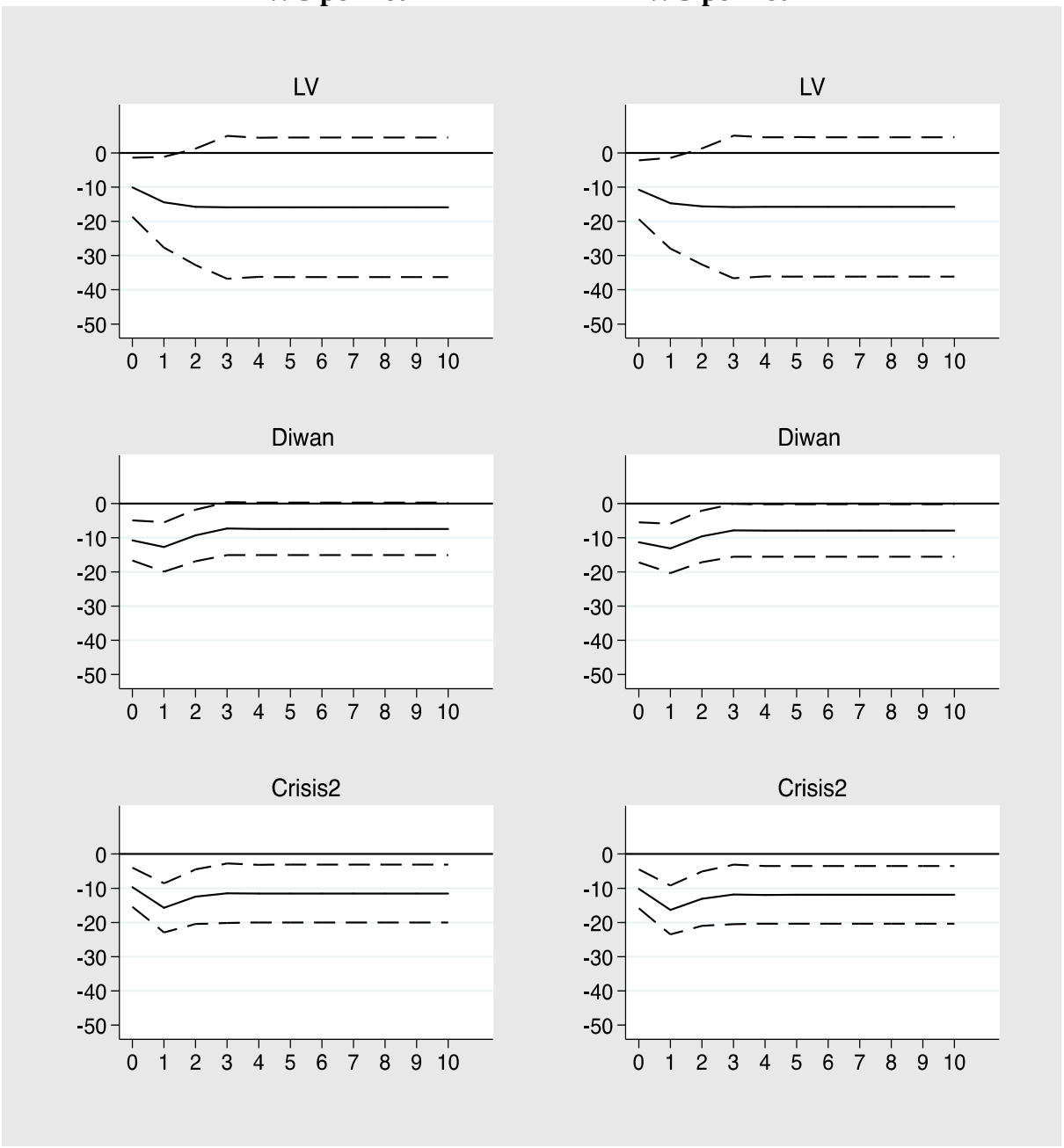
RWC per Employee **RWG per Employee**



Note: The horizontal axes indicate time in years. The vertical axes measure responses in percentages. The left panels show impulse responses of real wage per person employed deflated by the CPI (RWC). The right panels show impulse responses of real wage per person employed deflated by the GDP deflator (RWG). The estimation method is **panel fixed effect** with country specific time trends. The dotted lines represent one standard deviation confidence intervals based on 1000 Monte Carlo simulations. The sample includes 86 countries during the 1970-2010 period.

Figure 2- Response of Real Wage per Hour to a Currency Crisis

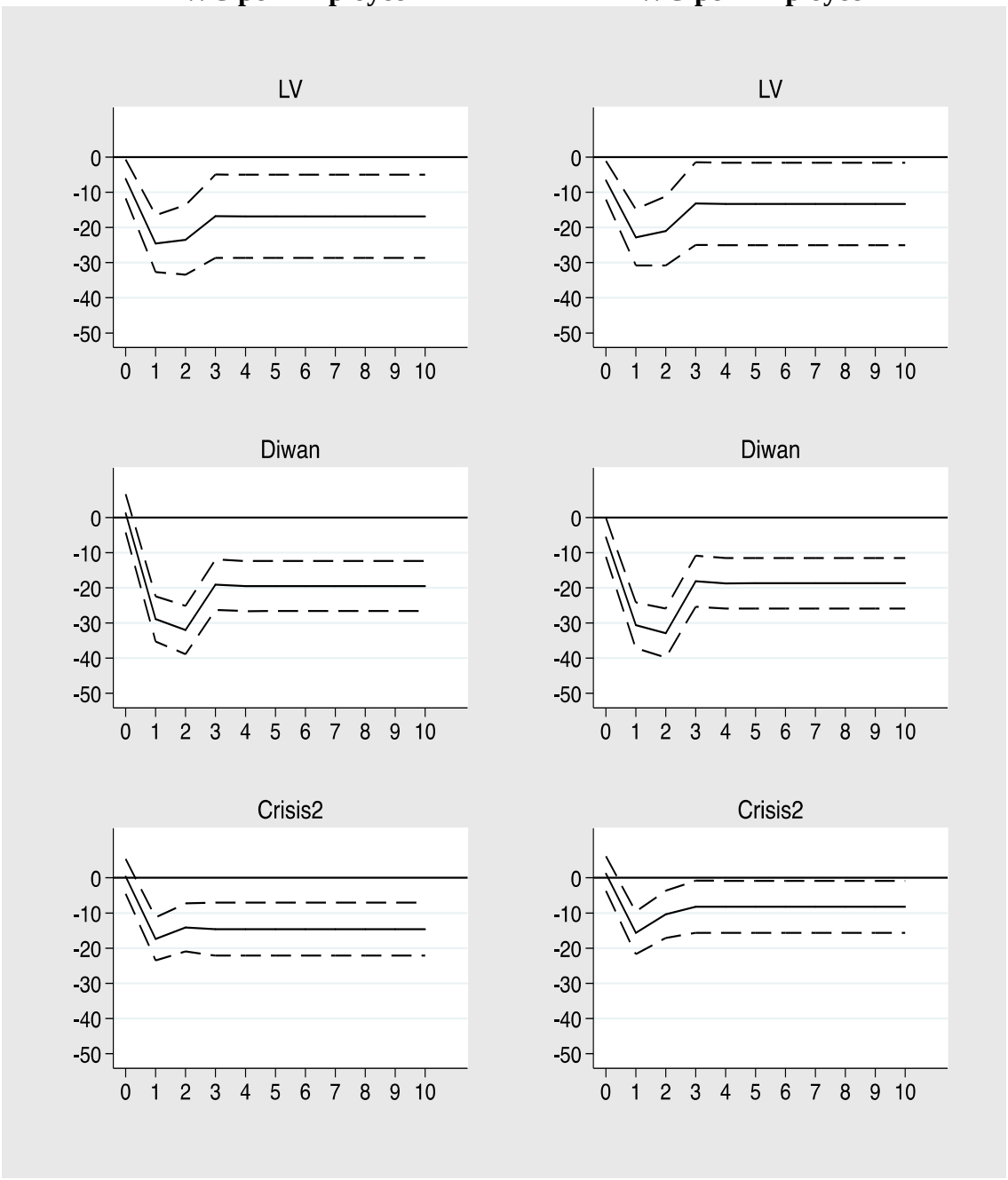
RWC per hour **RWG per hour**



Note: The horizontal axes indicate time in years. The vertical axes measure responses in percentages. The panels show impulse responses of real wage per hour deflated by the CPI. The right panels show impulse responses of real wage per employee deflated by the CPI for the same sample. The estimation method is **panel fixed effect** with country specific time trends. The dotted lines represent one standard deviation confidence intervals based on 1000 Monte Carlo simulations. The sample includes 43 countries during the 1970-2010 period.

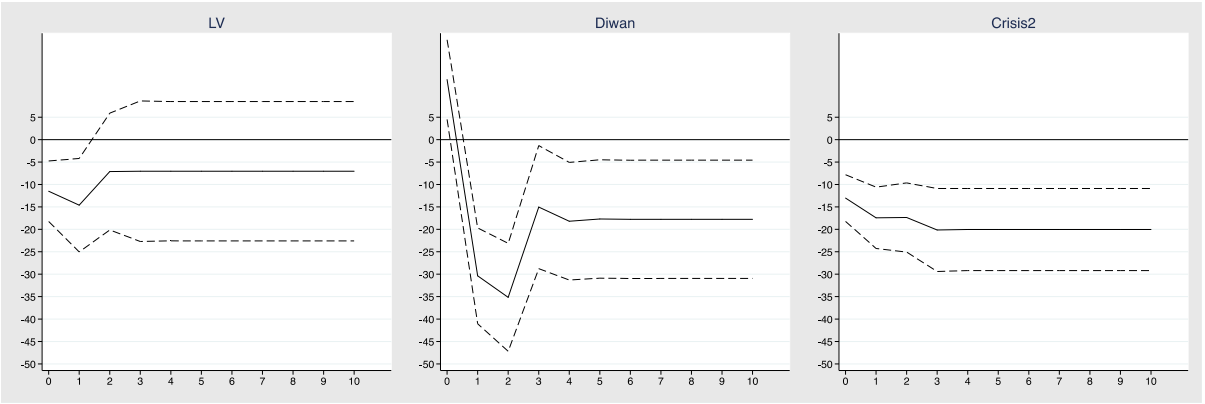
Figure 3- Response of Real Wages per Employee to a Currency Crisis (System GMM)

RWC per Employee **RWG per Employee**



Note: The horizontal axes indicate time in years. The vertical axes measure responses in percentages. The left panels show impulse responses of real wage per person employed deflated by the CPI (RWC). The right panels show impulse responses of real wage per person employed deflated by the GDP deflator (RWG). The estimation method is **system GMM** with country specific time trends. The dotted lines represent one standard deviation confidence intervals based on 1000 Monte Carlo simulations. The sample includes 86 countries during the 1970-2010 period.

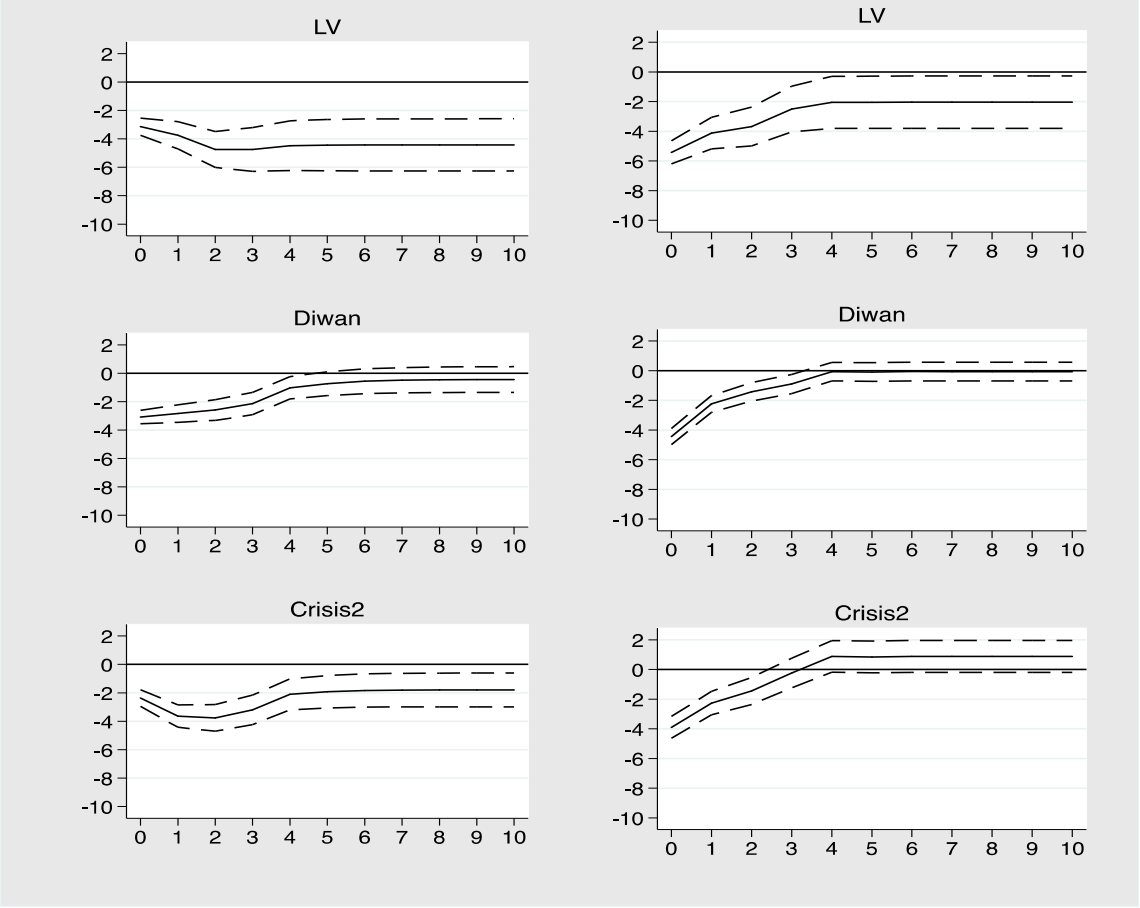
Figure 4- Real Wage per Employee with Agricultural Employment Controlled for



Note: The horizontal axes indicate time in years. The vertical axes measure responses in percentages. The panels represent impulse responses of level of real wages deflated by CPI to a currency crisis characterized by different definitions. Agricultural employment as a percentage of total employment is controlled for. The estimation method is **fixed effects.** Country specific time trends are included. The dotted lines represent one standard deviation confidence intervals based on 1000 Monte Carlo simulations. The sample includes 87 countries during the 1970-2010 period. There are 18 episodes of currency crises identified by LV, 54 by Diwan, and 34 by Crisis.

Figure 5- Response of Labor Productivity and TFP to a currency crisis

Labor Productivity **TFP**



Note: The horizontal axes indicate time in years. The vertical axes measure responses in percentages. The right panels represent impulse responses of level of labor productivity and left panels show impulse responses of level of Total Factor Productivity to a currency crises characterized by different definitions. The estimation method is **system GMM**. Country specific time trends are included. The dotted lines represent one standard deviation confidence intervals based on 1000 Monte Carlo simulations. The sample includes 87 countries during the 1970-2010 period.

Appendix: Not for Publication

Table A1: Real Wage per Employee deflated by CPI (RWC)-fixed effects

	(1) Log (RWC)	(2) Log (RWC)	(3) Log (RWC)	(4) Log (RWC)
Log (RWC) t-1	-0.0588***	-0.119***	-0.0621***	-0.0611***
	(0.0190)	(0.0222)	(0.0195)	(0.0193)
LV	-8.540			
	(5.287)			
LV (t-1)	-18.93***			
	(5.027)			
LV (t-2)	0.375			
	(5.020)			
LV (t-3)	7.010			
	(4.813)			
Diwan		1.568		
		(5.331)		
Diwan (t-1)		-28.90***		
		(5.265)		
Diwan (t-2)		-3.685		
		(5.212)		
Diwan (t-3)		17.87***		
		(4.867)		
Crisis2			-4.432	
			(4.736)	
Crisis2 (t-1)			-17.23***	
			(4.636)	
Crisis2 (t-2)			0.690	
			(4.676)	
Crisis2 (t-3)			3.336	
			(4.463)	
N	1820	2006	1732	1733
R^2	0.053	0.103	0.056	0.048
#Countries	86	86	85	85

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The model specification is ARDL (1,3) with fixed effects and country specific time trend. The lags are selected based on AIC and SIC criteria. The sample includes panel of 87 countries during 1970-2010 period. The RWC represent real wage per employee deflated by Consumer Price Index (CPI). See table 1 for description of currency crisis identification.

Table A2: Real Wage per Employee deflated by GDP Deflator (RWG)-fixed effects

	(1) Log (RWG)	(2) Log (RWG)	(3) Log (RWG)
Log (RWG) t-1	-0.0664***	-0.105***	-0.0678***
	(0.0189)	(0.0229)	(0.0194)
LV	-8.767*		
	(5.232)		
LV (t-1)	-17.02***		
	(4.974)		
LV (t-2)	0.954		
	(4.965)		
LV (t-3)	7.942*		
	(4.764)		
Diwan		-10.22*	
		(5.454)	
Diwan (t-1)		-27.18***	
		(5.449)	
Diwan (t-2)		-5.520	
		(5.410)	
Diwan (t-3)		16.72***	
		(5.052)	
Crisis2			-3.907
			(4.675)
Crisis2 (t-1)			-16.95***
			(4.577)
Crisis2 (t-2)			1.697
			(4.618)
Crisis2 (t-3)			4.252
			(4.407)
N	1822	2019	1734
R^2	0.056	0.076	0.061
#Countries	86	86	85

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The model specification is ARDL (1,3) with fixed effects and country specific time trend. The lags are selected based on AIC and SIC criteria. The sample includes panel of 86 countries during 1970-2010 period. The RWG represent real wage per employee deflated by GDP deflator. See table 1 for description of currency crisis identification.

Table A3: Real Wage per Employee deflated by CPI (RWC)- System GMM

	(1) Log (RWC)	(2) Log (RWC)	(3) Log (RWC)
Log (RWC) t-1	-0.00745	-0.0316	-0.00431
	(0.0226)	(0.0271)	(0.0230)
LV	-6.202		
	(5.611)		
LV (t-1)	-18.44***		
	(5.026)		
LV (t-2)	0.909		
	(5.052)		
LV (t-3)	6.756		
	(5.057)		
Diwan		1.219	
		(5.522)	
Diwan (t-1)		-30.05***	
		(5.438)	
Diwan (t-2)		-4.095	
		(5.442)	
Diwan (t-3)		12.81**	
		(5.151)	
Crisis2			0.393
			(5.043)
Crisis2 (t-1)			-17.75***
			(4.795)
Crisis2 (t-2)			3.181
			(4.812)
Crisis2 (t-3)			-0.475
			(4.672)
N	1820	2006	1732
AR1test	0.000	0.000	0.000
AR2test	0.841	0.794	0.893
Sargan_P	0.809	0.731	0.989
#Countries	86	86	85

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The model specification is ARDL (1,3) with System GMM and country specific time trend. The lags are selected based on AIC and SIC criteria. The sample includes panel of 86 countries during 1970-2010 period. The RWC represent real wage per employee deflated by CPI. See table 1 for description of currency crisis identification.

Table A4: Real Wage per Employee deflated by GDP Deflator (RWG)- System GMM

	(1) Log (RWG)	(2) Log (RWG)	(3) Log (RWG)
Log (RWG) t-1	-0.0146	-0.0403	-0.0111
	(0.0226)	(0.0282)	(0.0230)
LV	-6.579		
	(5.575)		
LV (t-1)	-16.32***		
	(4.992)		
LV (t-2)	1.570		
	(5.015)		
LV (t-3)	7.817		
	(5.023)		
Diwan		-5.633	
		(5.609)	
Diwan (t-1)		-25.24***	
		(5.555)	
Diwan (t-2)		-3.231	
		(5.562)	
Diwan (t-3)		14.66***	
		(5.264)	
Crisis2			1.230
			(4.987)
Crisis2 (t-1)			-16.89***
			(4.744)
Crisis2 (t-2)			5.101
			(4.757)
Crisis2 (t-3)			2.223
			(4.624)
N	1822	2019	1734
AR1test	0.000	0.000	0.000
AR2test	0.908	0.632	0.966
Sargan_P	0.657	0.524	0.895
# Countries	86	86	85

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The model specification is ARDL (1,3) with System GMM and country specific time trend. The lags are selected based on AIC and SIC criteria. The sample includes panel of 86 countries during 1970-2010 period. The RWG represent real wage per employee deflated by GDP deflatorI. See table 1 for description of currency crisis identification.

Table A5: Labor Productivity per employee Growth- System GMM

	(1) Labor Pro Growth	(2) Labor Pro Growth	(3) Labor Pro Growth
(Labor Pro Growth) t-1	0.129***	0.214***	0.128***
	(0.0282)	(0.0267)	(0.0309)
(Labor Pro Growth) t-2	0.0413	0.104***	0.0678**
	(0.0281)	(0.0267)	(0.0302)
LV	-3.144***		
	(0.590)		
LV (t-1)	-0.197		
	(0.592)		
LV (t-2)	-0.794		
	(0.578)		
LV (t-3)	0.154		
	(0.575)		
LV (t-4)	0.311		
	(0.583)		
Diwan		-3.087***	
		(0.461)	
Diwan (t-1)		0.906*	
		(0.496)	
Diwan (t-2)		0.518	
		(0.490)	
Diwan (t-3)		0.376	
		(0.492)	
Diwan (t-4)		0.988**	
		(0.464)	
Crisis2			-2.368***
			(0.565)
Crisis2 (t-1)			-0.965*
			(0.568)
Crisis2 (t-2)			0.195
			(0.563)
Crisis2 (t-3)			0.671
			(0.546)
Crisis2 (t-4)			1.026*
			(0.548)
N	2606	2948	2408
AR1test	0.000	0.000	0.000
AR2test	0.594	0.869	0.754
Sargan_P	0.974	0.000	0.089
# Countries	86	86	86

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The model specification is ARDL (2,4) with System GMM and country specific time trend. The lags are selected based on AIC and SIC criteria. The sample includes panel of 86 countries during 1970-2010 period.

Table A6: Total Factor Productivity Growth- System GMM

	(1)	(2)	(3)
	TFP	TFP	TFP
TFP (t-1)	-0.0463*	-0.0455*	-0.0600**
	(0.0278)	(0.0267)	(0.0281)
TFP (t-2)	0.0244	0.0306	0.0285
	(0.0266)	(0.0256)	(0.0274)
LV	-5.419***		
	(0.763)		
LV (t-1)	1.049		
	(0.652)		
LV (t-2)	0.634		
	(0.616)		
LV (t-3)	1.162*		
	(0.605)		
LV (t-4)	0.498		
	(0.613)		
Diwan		-4.436***	
		(0.533)	
Diwan (t-1)		1.998***	
		(0.514)	
Diwan (t-2)		1.051**	
		(0.466)	
Diwan (t-3)		0.494	
		(0.450)	
Diwan (t-4)		0.831*	
		(0.432)	
Crisis2			-3.901***
			(0.721)
Crisis2 (t-1)			1.402**
			(0.607)
Crisis2 (t-2)			1.025*
			(0.565)
Crisis2 (t-3)			1.209**
			(0.526)
Crisis2 (t-4)			1.167**
			(0.525)
N	1207	1385	1172
AR1test	0.00	0.00	0.00
AR2test	0.155	0.153	0.118
Sargan_P	0.00565	0.0532	0.0249
#Countries	79	79	79

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The model specification is ARDL (2,4) with System GMM and country specific time trend. The lags are selected based on AIC and SIC criteria. The sample includes 1970-2010 period.